SELECTED NUTRIENTS AND PCBs IN THE FOOD SYSTEM OF THE SAHTÚ (HARESKIN) DENE/METIS

A Thesis

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© NATALIA E. DOOLAN

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ABSTRACT

Vitamin A, protein, iron, zinc, and polychlorinated biphenyls (PCBs) were studied in the food system of the Sahtú (Hareskin) Dene/Metis of Fort Good Hope (FGH) and Colville Lake (CL), NWT. Traditional foods contributed significantly more ($p<0.005$) protein, iron, and zinc than did market foods. The average protein intake (296 ± 272 grams) of CL women over three seasons was higher than previously reported for Native Canadian women. Significant seasonal differences for protein, iron, zinc, and PCB intakes were found, with women in CL generally consuming more than those in FGH. On average, adult women consumed >100% of the Canadian Recommended Nutrient Intake (RNI) for protein, iron, and zinc but vitamin A consumption was generally <50% RNI. In all seasons, market foods provided significantly more vitamin A ($p\leq0.05$) than traditional foods for FGH adults. Body weights were assessed for comparison of PCB intakes with the tolerable daily intake level (TDI) (<1 ug/kg body wt/day). Women ≥19 yrs weighed 59.9 ± 10.7 kg while men weighed 71.7 ± 11.4 kg. Most of the adult population consumed <25% TDI for PCBs.

RÉSUMÉ

La vitamine A, les protéines, le fer, le zinc et les biphényles polychlorés (BPC) ont été étudiés dans le système alimentaire de Dénés et Métis Sahtú (Hareskin) de Fort Good Hope (FGH) et de Colville Lake (CL) dans les Territoires-du-Nord-Ouest. Les aliments traditionnels procurent beaucoup plus de protéines, de fer et de zinc ($p<0,005$) que les produits alimentaires disponibles sur le marché. La consommation moyenne de protéines (275 ± 279 grammes) des femmes de CL pendant trois saisons est supérieure à celle des Canadiennes autochtones. La consommation de protéines, de fer, de zinc et de BPC varie considérablement d'une saison à l'autre, les femmes de CL en consommant généralement plus que celles de FGH. En moyenne, l'apport en éléments nutritifs recommandés au titre des protéines, du fer et du zinc des femmes adultes est > à 100% mais l'apport en éléments nutritifs recommandés au titre de la vitamine A est généralement < à 50%. Quelle que soit la saison, les aliments disponibles sur le marché procurent beaucoup plus de vitamine A ($p \leq 0,05$) que les aliments traditionnels, pour les adultes de FGH. Le poids corporel a été déterminé dans le but de comparer ces données de la consommation de BPC par rapport à la dose journalière admissible (DJA) (< 1 µg/kg poids corporel/jour). Les femmes ≥ à 19 ans pèsent 59,9 ± 10,7 kg et les hommes 71,7 ± 11,4 kg. Pour la majorité de la population adulte, la DJA de BPC est < 25%.

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1.0 INTRODUCTION

1.1 Background

In the early 1980's, residents of Fort Good Hope (FGH), Northwest Territories (NWT) began noticing that the livers of loche (Lota lota) caught in the Mackenzie River (Dehcho) were becoming smaller and discoloured while the flesh of lake and broad whitefish (Coregonus clupeaformis, and Coregonus nasus respectively) was becoming more watery. Some of these fish were considered unfit for consumption. As the changes were concurrent to an expansion of oil production at Norman Wells, upriver from FGH, studies were conducted by Fisheries and Oceans Canada to determine whether the condition of the fish was related to hydrocarbon exposure (Lockhart et al., 1987, 1989). Results from the studies indicated that contamination by petroleum products could not be ruled out conclusively (Lockhart et al., 1989).

At the same time, the report documented the widespread contamination of fish in the Mackenzie Basin with several organochlorine compounds, notably toxaphene and polychlorinated biphenyls (PCBs) (Lockhart et al., 1987). As fish form an important part of the diet of Native People living in the Mackenzie Valley Region, the Dene Nation responded to this report with a request for an evaluation of the risk incurred through the consumption of fish caught in Dehcho. The Dene Nation is a Native Indian Nation whose members include individuals from the Hareskin, Yellowknife, Chipewyan, Bear Lake, Loucheux, Slavey, Mountain, and Dogrib tribes (Holmes and Barnaby, 1989). As will be described in section 1.3, it is the Hareskin to whom this thesis attends.

An evaluation of risk resulting from the consumption of fish caught in Dehcho must be considered within the context of the larger food system. In this thesis, the term food system refers to the realm of food utilization (i.e. from procurement through hunting, fishing, gathering, sharing, or purchasing; to preparation for storage or for immediate consumption; and, finally, to

consumption). As the food system of the Hareskin includes both market and traditional foods, the market food component of the diet must be explored with the traditional food component when evaluating the risk involved with fish consumption. In this thesis, market foods refer to those foods which are imported and sold in retail outlets while traditional foods are those wild foods identified by the Hareskin as traditional to their culture. Such an evaluation must also consider the benefits of the existing food system (e.g. nutrients) together with its risks (e.g contaminants).

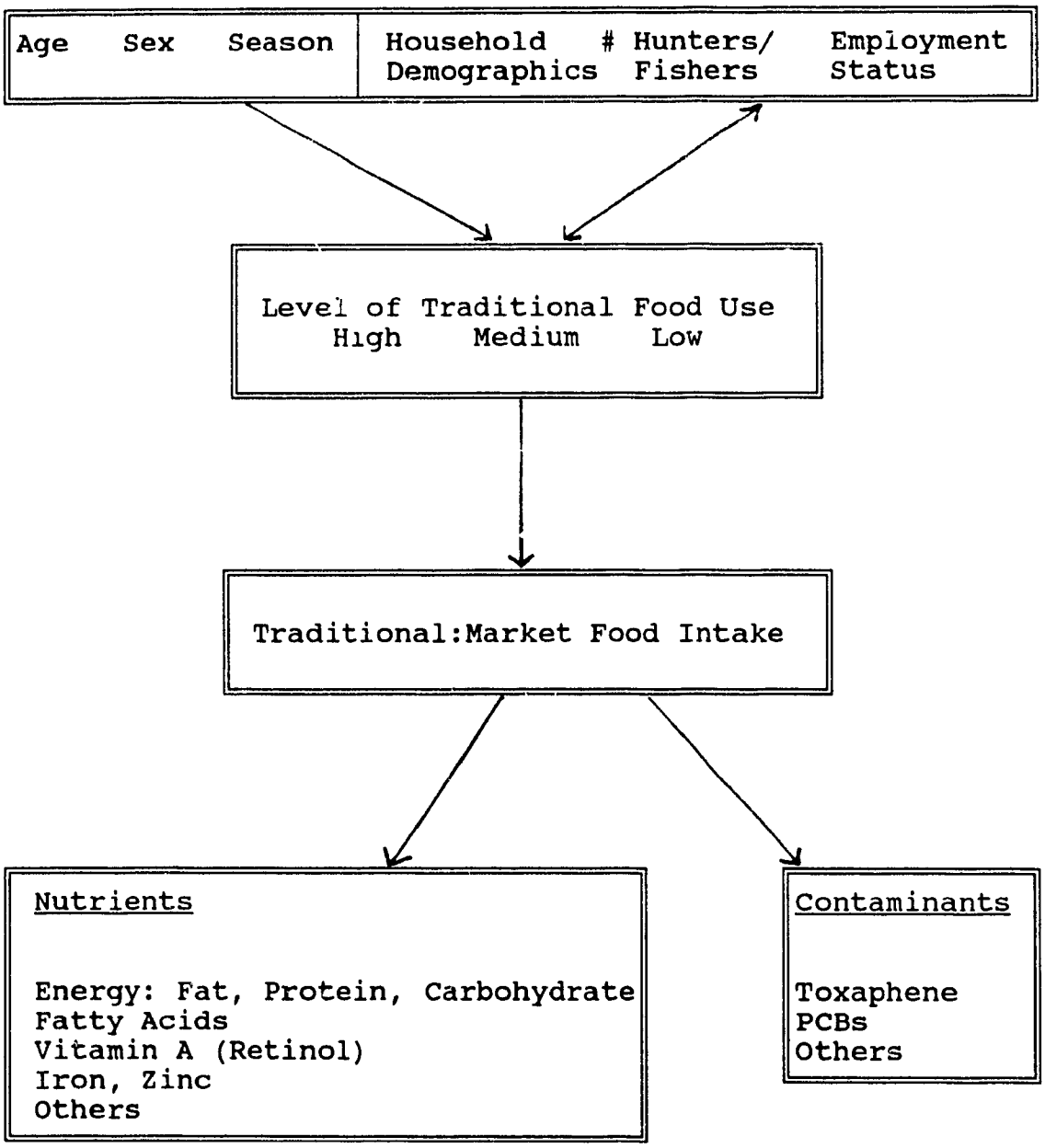
Health and Welfare Canada, together with the NWT Department of Health, arranged funding to the School of Dietetics and Human Nutrition, McGill University (Dr. H.V. Kuhnlein), for dietary evaluation and food sample collection in FGH and Colville Lake (CL). The question guiding the dietary assessment was ultimately to determine whether the intake of contaminants from traditional foods, particularly from the fish component, was sufficient to warrant advice to alter current dietary patterns.

1.2 **Project Overview**

To address this question, a model was developed which sought to ascertain the sources of various nutrients and contaminants in the contemporary food system of the Sahtú (Hareskin) Dene/Metis as well as to determine the levels actually consumed (Figure 1.1).

First of all, determinants of traditional food use which, in turn, influence the intake of nutrients and contaminants were proposed including age, sex, season, household demographics (e.g. size of household), number of hunters or fisherpeople in the household, and employment status. As indicated at the top of Figure 1.1, the factors to the left of the single line (age, sex, season) are thought to have a uni-directional association with level of traditional food use while a two-way directionality is assumed for those to the right of the line (household demographics, number of hunters and/or fishers in the household, and employment status). Other factors which may be involved in determining traditional

Figure 1.1 Project Overview: Determinants of Dietary Intake of Nutrients and Contaminants by the Sahtu (Hareskin) Dene/Metis



Adapted from Kuhnlein (1989b) and Appavoo (1990).

food use but which were beyond the scope of this project will be discussed in the literature review.

The level of traditional food use influences the proportion of traditional to market food consumed. This ratio of traditional to market food consumed is proposed to affect the intake of various nutrients and contaminants (Figure 1.1).

In her Master of Science thesis, Donna Appavoo discussed selected determinants of traditional food use in addition to providing details on the fats, fatty acids, and toxaphene found in the food system of the Sahtú (Hareskin) Dene/Metis of FGH and CL, NWT (Appavoo, 1990; Appavoo et al., 1991) This work drew on data collected in the summer (July/August) and winter (November/ December) seasons of 1988 and will be referred to throughout this thesis as Phase I of the project.

The current thesis concentrated on protein, iron, zinc, vitamin A and PCBs in the same food system surveyed in Phase I (1990) Data from Phase I were supplemented with information collected in the late spring (May/June) of 1990 (Phase II). The rationale behind the choice of dietary constituents is presented in the literature review.

In addition to providing relevant descriptive data, the relationship between level of traditional food use and the selected dietary constituents were analytically examined. Seasonal variation in food use, nutrient intake, and PCB intake were analytically explored.

Other nutritional and toxicological elements will be presented separately by Dr. Kuhnlein and other members of the research team.

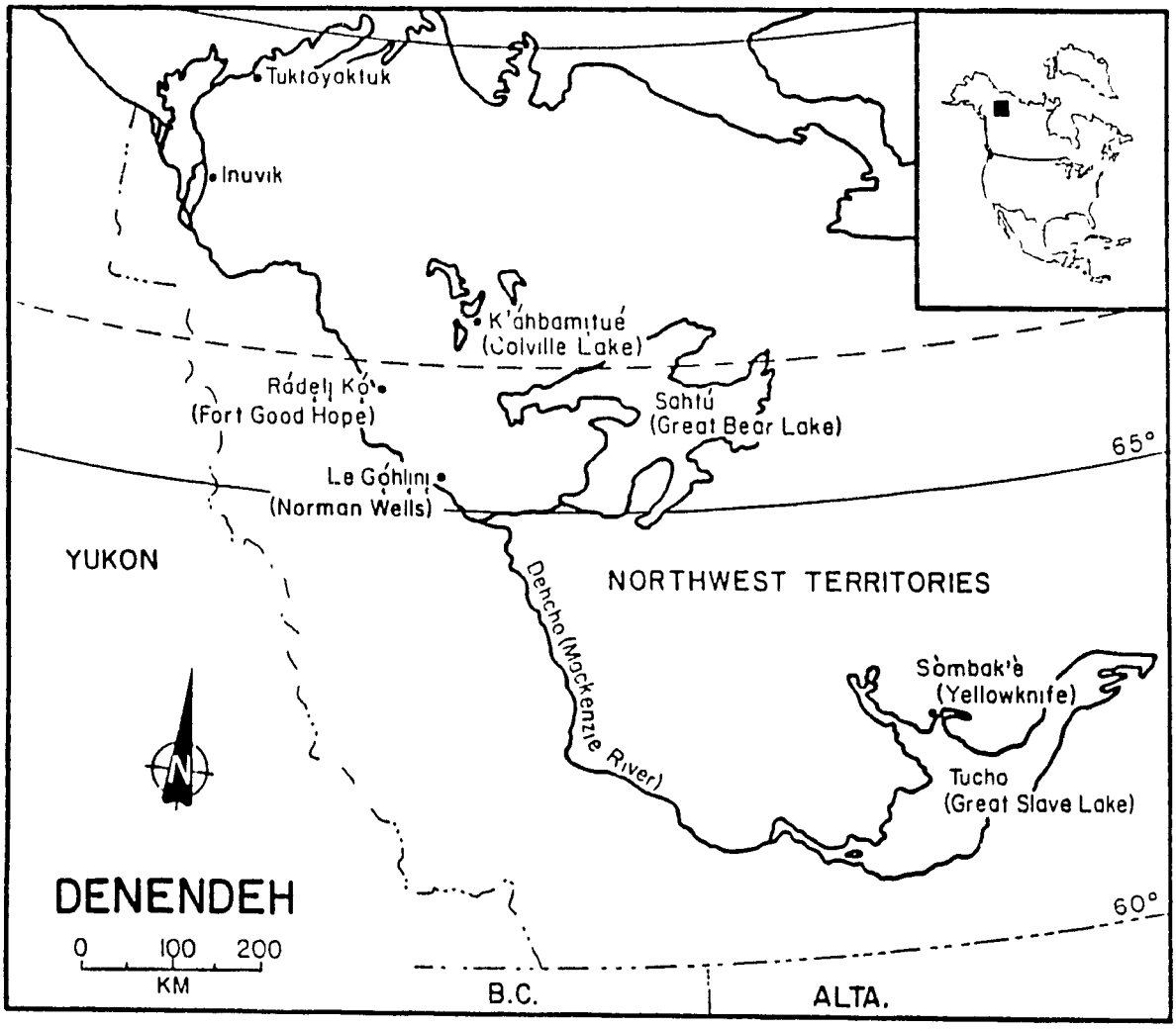
1.3 Study Communities

As previously noted, the two communities involved in the study were FGH and CL. Fort Good Hope is located on the banks of Dehcho 27 km south of the Arctic Circle while CL is situated approximately 170 km northeast of FGH on the southeast shore of Colville Lake (Figure 1.2).

These two communities are the focal settlements for the Sahtú (Hareskin)

Figure 1.2

Location of Fort Good Hope and Colville Lake



(adapted from Holmes and Barnaby, 1989)

Dene/Metis. Culturally, the Sahtú (Hareskin) Dene/Metis belong to the Northern Athapaskans. The contemporary linguistic group affiliation of the FGH area is called Sahtú North Slavey. *K'a so gotine*, or "big willow people" is the name used by many Hareskin to refer to themselves (Savishinsky and Hara, 1984) Sahtú refers to the Great Bear Lake region of the Mackenzie Valley To a large extent, the Dene people live in this valley. Metis is a term used in reference to individuals with mixed Native Indian and White ancestry. In this thesis, the term Hareskin will be used when referring to the Sahtú (Hareskin) Dene/Metis.

In 1959, a winter road was cut from FGH to the game-rich area of CL and a small community was developed. Families migrating from FGH to CL were primarily those who wished to pursue a more traditional way of life

As of June, 1985, the population of FGH was 693 composed of 78% Dene, 12% Metis and 10% other At the same time, the population of CL was 57 (100% Dene) (NWT Data Book, 1986/7).

1.4 **Thesis Format**

One of the functions of the literature review (Chapter 2) was to provide the rationale behind the hypotheses to be tested. In turn, these hypotheses with their concomitant objectives (Chapter 3) determined which design and methods were most appropriate. The methods which were implemented provided an acceptable compromise between the ideal and the practical, as will be discussed in Chapter 4. The results and discussion (Chapter 5) stemming from the data which were collected and analyzed led to the summary and conclusions which will close the thesis (Chapter 6).

2.0 LITERATURE REVIEW

As Billson (1988) noted, one cannot begin to grasp the contemporary situation without first comprehending its historical context. Understanding the determinants of the contemporary situation becomes particularly meaningful if an intervention aimed at promoting significant change is to be introduced. In this case, if advice to alter current Hareskin dietary patterns is ultimately found to be warranted (i.e. if risks of traditional food use outweigh the benefits), then it will become crucial to understand and address any structural constraints (i.e. economic, socio-cultural, or political) to effective change which may exist.

To this end, a brief synopsis of the major stages of cultural and dietary change will be presented. The examination will begin from the time the ancestors of the present-day Native people of the Canadian North are believed to have immigrated to Canada and will culminate the year of Mackenzie's historic voyage down Dehcho. An overview of the lifestyle changes which resulted from early interactions of the Hareskin with White culture will follow. This discussion will provide the pertinent historical backdrop from which to understand the contemporary Hareskin food system.

The focus will then shift to the contemporary food system of the Hareskin People. A review of some of the current determinants of contemporary food use by northern Native Canadians will be the first subsection addressed within this framework. Next, a description of contemporary patterns of food use, followed by a subsection entitled "Seasonal Changes in Food Use and Nutrient Intake", will be presented. The section will end with a brief overview of the benefits and potential risks of the contemporary Hareskin food system.

In the third major section of the literature review, selected benefits and risks of the contemporary Hareskin food system will be discussed. Specifically, the benefits selected to be addressed are the nutrients protein, iron, zinc, and vitamin A while the potential risk to be discussed is that which is derived through the ingestion of foods containing polychlorinated biphenyls, or PCBs.

In each of the previous sections, where data specific to the Hareskin are lacking, qualified data from other northern Native groups will be discussed A summary of the literature which was reviewed will close the chapter.

2.1 **The Pre-Contemporary Hareskin Food System**

2.1.1 Pre-Contact

Approximately 30,000 years ago the ancestors of the indigenous people of Canada migrated from Siberia across the land bridge spanning the Bering Strait. The historical epoch these people lived in was termed "Ice Age Archaic" and lasted from 30000 to 8000 BC. Billson (1988) identifies the culture as the "Big Game Hunting Culture" as mammoths, mastodons, camels, antelopes and giant sloths were the prey of these people. The rapidly advancing ice coupled with the reality of tracking game necessitated a nomadic lifestyle (Billson, 1988)

A dramatic change in climate with a concomitant change in animal species available for consumption led to the second stage, identified as the "Early Hunting and Fishing" age. This stage, lasting from approximately 9000 BC to 1100 AD, acknowledges the differentiation of the Indian and Inuit peoples (Billson, 1988)

The residents of the Mackenzie Delta were known as the "People of the Small Knife" due to the distinctive set of technologies they employed to obtain their food. Fish, caribou, deer and elk were caught and hunted using boats and smaller, more refined tools. As with the more northerly Denbigh people, they maintained the adaptive nomadic lifestyle - living in small bands consisting of a few families which broke up into smaller units when food was scarce. They both hunted and fished in order to ensure a source of food. Reciprocity, sharing, and adoption of one another's children ensured that all of the members were well looked after except in dire situations (Billson, 1988).

From 1100 AD, "Athapaskan" is the term used to refer to the culture of the people of the Mackenzie Delta (Billson, 1988). The Dene belong to the Athapaskan culture which is fundamentally the same as that of the preceding era. The use of hide snares for hunting small game such as hares as well as the onset of the use

of moose for food and hides are two differences between the two stages (Billson, 1988; Yesner, 1989)

Billson (1988) goes on to describe two additional stages of cultural change which took place post-contact with White culture as a result of altered economic activity. For the Hareskin, the first of these stages, the "Transitional Hunting, Fishing and Whaling" era, can be characterized as an early period of non-cash trading of furs obtained by trapping. The second additional stage transpired once trapping became commercialized. At this point the northern Native people became inextricably intertwined with the White system. Before these two stages are discussed, however, it is important to first present a baseline view of the Hareskin diet at the time of contact with White man.

2.1.2 Contact

Various ecological niches were, and still are, utilized by the Dene including mountain, taiga, tundra and transitional zones. The area is characterized by lakes, rivers and other waterways which traverse low-lying plains, the northernmost of which are known as the barrenlands. The forest is composed mainly of jack pine, birch and spruce.

Depending on how far north the location is, the land can remain covered with ice and snow for up to seven months of the year. Although summers are quite short, temperatures can reach the eighties and are often accompanied by sunshine for most of the day. Winter and summer are separated by brief transition periods known as "freeze-up" (when the surface land and waters becomes frozen) and "break-up" (when the ice on the rivers, lakes and surface land melts) (Walker, 1984).

Numerous fish species and small game such as beaver, rabbits, ptarmigan, marten, and lynx were caught, trapped, and hunted. The more southwesterly Dene people focused their subsistence activities on moose with some use of woodland caribou, while those in the northeast used barrenland caribou extensively. During break-up and freeze-up, flocks of migratory birds passing through the region

provided a welcome source of dietary diversity. Some of the delicacies reported to be consumed by the Hareskin include caribou tongue, caribou fetus, muskrat, and beaver tail (Asch, 1984; Savishinsky and Hara, 1984)

The warmer months provide an intense growing season for a wide variety of plant material including wild greens, berries, roots, and edible barks (Walker, 1984). Certain mosses and lichens were boiled to make beverages and medicines Vegetation in the rumens of caribou, moose and other herbivores was consumed as well (Asch, 1984; Savishinsky and Hara, 1984) Liver was an important source of carbohydrate in the form of glycogen, with glycoproteins from intestinal epithelia serving as another source of carbohydrate (Schaefer, 1977)

Cooking was done by roasting and stone-boiling Meat and fish were sometimes pounded with grease and berries to make pemmican Excess foods were preserved by freezing and caching in the winter and by drying and smoking in the summer (Savishinsky and Hara, 1984).

Despite what would seem to be a varied dietary base, the insecurity of Hareskin subsistence was one of the most striking features of their early condition Their dependence on the snowshoe hare (hence their appellation) led to periodic starvation since the hare population is well known to naturally dip, quite dramatically, every seven years or so. Even the western technology of iron, nets and guns which were gradually made accessible to the Hareskin in the 1800's could not ensure enough food (Savishinsky and Hara, 1984)

In summary, it is clear that up to the point of contact with White culture, the foods consumed by the Hareskin and other Native people living in the Mackenzie Valley Region were obtained through the subsistence activities of hunting, fishing, trapping, and harvesting although there may have been some trading, especially for fats and oils. Their diet was heavily reliant on the flesh and organs of both wild game and fish which, over time, may have led to adaptations to a high protein diet (Speth and Spielmann, 1983). Sources of seasonal variation included migratory birds and fresh plant material. While various forms of complex carbohydrate were consumed, it appears that berries were the predominant source of simple

carbohydrates. There is no known report of the use of honey by the Dene, although there is mention of the use of a birch tree-derived syrup once metal boiling pots were made available through trade (Walker, 1984). The average fat content of the Dene diet at the time of contact is unknown although wild animal flesh tends to be lower in total lipid content than does most domesticated meats (Appavoo et al , 1991; Hedican, 1986) The diet consumed at the time of contact was unlikely to lead to chronic malnutrition although acute starvation was likely when hunts failed (Savishinsky and Hara, 1984).

2.1 3 Lifestyle and Food System Changes Post-Contact

> Like their ancestors, they must organize their way of life so as to cope with conditions imposed upon them by their subarctic environment. In addition, they must now cope with conditions increasingly imposed upon them by forces . which originate in socio-cultural systems far from (them)...which, nevertheless, have a tremendous impact upon them and their traditional way of life (Rushforth, 1977:32).

It was almost exactly two centuries ago, in 1789, that Alexander Mackenzie made his celebrated voyage down Dehcho. It was at this point that the Hareskin met "White Man" and took the first step into another world.[1]

That first meeting initiated a chain of events which has, for the Dene, culminated in a shift in lifestyle, for many, from living on the land to living in settlements; from a subsistence-based economy to a consumer economy; and from self-sufficiency to dependence (Billson, 1988). As a consequence of this metamorphosis, the Dene have experienced alterations in their dietary pattern and consequently in their nutritional and health status, as will be discussed later (Young, 1988; Schaefer and Steckle, 1980).

The following chronology, summarized in Table 2.1, recounts the major events in Hareskin history occurring after contact with White culture. The period

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[1] Samuel Hearne travelled to the Great Slave Lake area, NWT in 1771 but apparently met no Hareskin People (Holmes and Barnaby, 1989).

before World War II corresponds to the era Billson (1988) termed the "Transitional Hunting, Fishing and Whaling" stage. Hedican (1986) referred to the same era as that of "ceremonial exchange" in which the traders depended on the goods and services of the Native population, often for survival. Around the time of the second World War, commercialized trade or "non-reciprocal" exchange replaced the preceding, more egalitarian, era (Billson, 1988; Hedican, 1986).

As a result of his historic voyage, Alexander Mackenzie's employer, the Northwest Company, set up its northernmost (at the time) trading post at FGH in 1806. The Hudson Bay Company subsequently absorbed the Northwest Company in 1821. Initially, trapping was encouraged through the provision of trade goods to the Hareskin by direct trading. Later, the institutionalization of a debt system through the use of tokens led to a forced dependence on the Hudson Bay Company (Billson, 1988). The first items introduced were "staple" foods such as tea, flour, and sugar as well as tobacco, alcohol and metal utensils By the late 1800's guns and steel traps were brought in, while the early 1900's heralded the advent of western clothing and cloth.

The traditional nomadic lifestyle was gradually being replaced by a more settled one at this point. White store employees integrated with the Hareskin in family systems, and in the first two decades of the twentieth century some of their children were sent to the Fort Providence Mission Boarding School. Many thus gained a fluency in French while being forbidden to speak their own language (Asch, 1984; Savishinsky and Hara, 1984).

A Roman Catholic Mission, under the direction of Father Grollier, began near FGH in 1859. In 1866, a Roman Catholic Church was built in FGH under the direction of Father Petitot (NWT Data Book, 1986/7). By the early twentieth century all of the Hareskin were nominally Catholic through baptism and confirmation (Savishinsky and Hara, 1984).

In 1921, oil was discovered at Norman Wells (see Figure 1.2). In 1922/23, Treaty 11 was signed with the federal government. The Hareskin in the FGH area were grouped together as Band Number 5 under the treaty. In exchange for their

Table 2.1: Overview of Events in Hareskin History Post-Contact with White Culture

I. Non-cash Trading Stage

1789	- Mackenzie meets Hareskin
1806	- Northwest Company Trading Post set up at FGH
1821	- Hudson Bay Company takes over NorthWest Co. Post
	- trapping encouraged via trade goods/debt system
	- tea, flour, sugar, tobacco, alcohol, metal utensils available
late 1800's	- guns, steel traps available
1866	- Roman Catholic church built at Fort Good Hope
1921	- oil discovered at Norman Wells
1922/23	- Treaty 11 signed: in exchange for title to land Dene retained right to use traditional resources, received $5/year, and obtained a federal promise of medical/ educational facilities
1926	- children of FGH attend residence school in Aklavik, 600 km north
1927	- bad influenza/cholera year
1930	- tuberculosis endemic
	- fur trade flourished even in depression years

II. Commercialized Trading Stage

1940's	- fur prices collapsed, trade good prices high, increased incidence of disease
	- as a result of above, federal government stepped in (many Hareskin had migrated to FGH) and instituted the following: family allowance, pension, welfare, compulsory education, housing, nursing stations, water, electricity
1959	- cultural revitalization; road cut to Colville Lake to increase access to game resources
1975	- Berger Inquiry: increased political activity re. self determination and land claims sparked to some extent by the proposed Mackenzie Valley Pipeline
1980s	- concern about possible contamination of wildlife (fish) as a result of oilfield expansion at Norman Wells (144 km south of FGH); concern about long-range transport of contaminants

title to traditional lands, the Dene retained the right to utilize the natural resources for subsistence and trapping. In addition, they received treaty payments of five dollars a year and had the promise of governmental medical and educational services (Savishinsky and Hara, 1984).

Nineteen twenty-three marked the year of the advent of the Royal Canadian Mounted Police patrol in FGH. In 1926, children from the town began attending the Catholic residence school in Aklavik, 600 kilometres north of FGH Because of this schooling, English superseded French as the "official" language.

With respect to health, 1927 marked a particularly bad season for influenza and cholera while, by 1930, tuberculosis had become endemic. It was not until thirty years later that tuberculosis was under some control (Savishinsky and Hara, 1984).

In economic terms, the fur trade flourished even in the depression years with trappers using steel traps more than deadfalls and snares Outboard motors and firearms were increasingly used. The consumption of home brew, an alcoholic beverage of variant themes but usually consisting of yeast, sugar, and raisins was also common (Savishinsky and Hara, 1984).

Although the government had established its presence in the subarctic in the latter part of the nineteenth century, it was not until after World War Two that it took on a significant role. It was also at this point that the "non-cash trading" economy in FGH gave way to the "commercialized trading" stage. Around this time the price of furs collapsed. Coupled with the high rate of tuberculosis present in the area, the federal government felt a need to step in. People had migrated to the Fort and needed money. Since 1945, the government has introduced family-allowance and old age pension benefits which, together with welfare, have provided major sources of non-wage income to the economy. In the late 1940s, compulsory southern-based education programs were introduced in permanent schools in FGH, among many other settlements in the region. Families who did not send their children to school were liable to be fined, jailed, or to have their family allowance cheques cancelled (Asch, 1977). At the same time, the government

initiated the construction of housing and nursing stations. It also introduced water delivery and electricity in the communities and provided much of the local wage employment. As more people acquired new skills and higher education more of them spent more time at the Fort pursuing wage labour positions (Savishinsky and Hara, 1984). This altered time and energy availability for traditional food harvesting pursuits.

A major cultural and social revitalization occurred among the Hareskin in the late 1950s. This was largely the result of a decision taken by regional administrators to encourage greater use by the Hareskin of the territory's natural resources and to decrease their reliance upon welfare and wage labour. In 1959, a winter road was cut to the fur, caribou and game-rich area of Colville Lake. With the help of local officials, a small community had built up around a store and mission by 1962. Families migrated to, or resettled in, this community where they were able to pursue a hunting, fishing and trapping way of life with only a fraction of the government assistance, drinking, and unemployment problems of the larger fort towns. As a result, the Hareskin were largely redistributed into two permanent settlements less than 100 miles apart. Members of the two communities continue to visit, communicate and intermarry thereby maintaining their sense of common identity (Savishinsky and Hara, 1984).

The 1975 inquiry led by Mr. Justice Thomas Berger into the social and environmental consequences of a natural-gas pipeline through the Mackenzie Valley helped to make the Dene Nation, particularly the membership at FGH, a strong political voice in the Mackenzie Valley and beyond (Goddard, 1985). Later, in the early 1980's, it was principally residents of FGH who reported a deterioration in the quality of fish caught in Dehcho and who lobbied for government support in discerning the cause of the problem (Lockhart et al., 1989; Lutra Associates, 1989).

In summary, the Hareskin developed a dependency on various trade goods for which cash was required: "when the white man first came and brought some things with them, the natives were happy to get what they could to make life a bit

easier" (Holmes and Barnaby, 1989:15). In exchange, the Hareskin had a single commodity with which to obtain cash - furs. When fur prices fell and the price of consumer goods rose around the time of World War Two, the Hareskin found themselves in a bind - how to obtain the cash which they required for the goods on which they had come to depend. At the same time, the incidence of various diseases was rising and people were going to the Fort for assistance (Savishinsky and Hara, 1984). The federal government's institution of transfer payments to "solve" the latter problems decreased Native self-reliance further while weakening traditional leadership (Asch, 1984).

The institution of mandatory schooling contributed to increased settlement since many families chose to settle in town rather than being separated from their children (Goddard, 1985). This led to a decrease in family access to the bush for subsistence activities as well as diminished exposure of children to bush life At the same time as they were being excluded from bush life, children were being taught material which was directed towards the transmission of southern Canadian culture. Thus the formal education process contributed to an alienation of Native children from their traditional culture and food system. Further, the settling of adults who wished to be near their school-age children encouraged an increased reliance on market foods while making access to traditional foods more difficult. This is particularly true since game close to the settlements quickly became depleted with the advent of guns and steel traps (Morris, 1973).

As noted earlier, however, there has been an increasing movement towards cultural revitalization which has grown over the past couple of decades. Thus, there exists among the Hareskin a continuum ranging from primarily a land-based lifestyle to one of virtually exclusive settlement life (Savishinsky and Hara, 1984; Goddard, 1985). Land claims talks, aimed at securing critical hunting and fishing areas, have sensitized people to the vulnerability of the environment which sustains their traditional lifestyle (Goddard, 1985).

The next section provides a description of the contemporary Dene (Hareskin) food system including a more detailed discussion of how the objective

historical events mentioned above influenced contemporary dietary patterns.

2.2 The Contemporary Hareskin Food System

2.2.1 Contemporary Forces of Change

> Basic to health is nutrition; and the nutrition of people who traditionally live by hunting is particularly vulnerable to cultural and social change (Schaefer and Steckle, 1980:i).

Increased availability of market foods and alterations in lifestyle (e.g. participation in the wage economy) are often cited as sources of change in the aboriginal dietary pattern (Raymond, Drury, and Szabadka, 1985; Kuhnlein, 1989a). However, the initial determining factor, based in history, is rarely addressed. Essentially, this factor is the condition of internal colonialism[2] which continues to exist in the Canadian North (Griffiths et al., 1987; Billson, 1988). While this relationship has the potential to improve, it has contributed to the historical events described earlier which, in turn, have had significant effects on certain elements of Hareskin lifestyle and consequently on dietary patterns.

As noted earlier, settlement, formal education, and the need for money decreased access to, and experience with, bush life which, in turn, increased reliance on store foods (Thouez et al., 1989). Instead of venturing into town a few times per year to obtain trade goods, many now venture into the bush a few times a year to obtain wild foods.

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[2] [Internal colonialism] refers to situations where the original inhabitants of remote regions have been disenfranchised economically and politically by the nation states which surround them. Commodities are valued according to the national and international economic priorities which have little to do with economic conditions in hinterland regions. Populations are maintained as cheap and mobile labour forces for the shifting priorities of resource extraction industries. The dominant (and usually White) minority also allocates social roles and thereby creates a cultural division of labour where indigenous peoples occupy the lower rungs of institutional ladders (O'Neil, 1986:251).

Culture, however, is very resilient and, ironically, one of the consequences of Euro-Canadian influence in the north has been the development of a much more clearly defined sense of identity and purpose among the northern Native People since destruction of the environment and of their cultures is universally feared (Savishinsky and Hara, 1984; Hultkrantz, 1973). It is interesting to speculate that, as a result of the relatively rapid changes which have occurred, the current dietary pattern is transitory until such a time as a more culturally acceptable and adaptive diet is adopted.

Ritenbaugh et al. (in prep.), suggest that dietary "acculturation" in a Dene community is a function of age and community. Younger individuals consume the greatest diversity of foods and have the lowest energy intake from traditional foods. Individuals living in communities with easy access to stores and transportation axes have diets characterized by relatively high market food consumption as well as decreased protein intakes (Ritenbaugh et al , in prep)

Kuhnlein (1989a,b) notes numerous factors which are believed to directly contribute to the observed decrease in the use of traditional foods. These include:

a) legislation restricting use of traditional food resources
b) reduced density of traditional food species per unit of harvest area
c) availability of new foods
d) acceptability of new foods as a result of media, social contact, and education, and
e) limitations of time and energy for traditional harvesting
f) interruption of knowledge transfer to younger generations.

Increased financial resources, can serve to either diminish or enhance traditional food use. If money is used to purchase market foods, a decrease in traditional food consumption may potentially result. Contrarily, if it is used to purchase hunting technology or to finance excursions to less utilized areas, money can serve to increase the availability of traditional food resources (Hedican, 1986; Rushforth, 1977).

Together with legal, practical (time, energy), and ecological considerations, individual preferences and health beliefs are important determinants of food

choices (Wein et al., 1989; Kuhnlein, 1989b). Bone (1985) suggested that exposure to market foods through work camps can change food preferences. On the other hand, exposure of children to traditional foods through participation in bush life may increase their appreciation of, and preference for, traditional foods (Goddard, 1985).

Recent concerns about the contaminant content of wild foods, particularly with respect to methylmercury and PCBs, are contributing to a decreased use of traditional foods (Schaefer and Steckle, 1980; Kuhnlein, 1989b). Thouez et al. (1989) note that the future of the hunting and trapping regime is linked to current environmental management.

In contrast to the increasing delocalization of the northern food system, Herrin and Gussow (1989) make a plea for increased local autonomy in food production to aid in the development of sustainable food systems. However, it is not feasible to encourage a return to the bush with a complete severance from the market goods which have become a part of their lives. Individuals understandably do not wish to give up items which make life more enjoyable, many may not know how to live off of the land, and the possibility exists that the land could not support the increased number of people (Fernandes-Costa, 1984).

2.2.2 Current Food Use Patterns

The Nutrition Canada Food Consumption Patterns Report notes that Native Indian adults consumed a daily average of 7 to 30 grams of wild game (not including fish of which the Native Indian population consumed slightly greater than the national average) depending on sex and age (HWC, 1977). However, only a small fraction of the individuals surveyed came from the subarctic Mackenzie Valley Region. Data from Ritenbaugh et al. (in prep.) show that fully 25% of the energy consumed by the Dogrib was derived from traditional foods. Similarly, Appavoo (1990) calculated that the adult Hareskin population in FGH consumed approximately 30% of their energy from traditional foods, while individuals in CL obtained closer to 55% of their energy from traditional foods. Young (1988)

reported that active subarctic hunters may consume over 2 kg of flesh food daily, a value significantly different from the 30 g average noted by Nutrition Canada.

The average Canadian consumes approximately 140 g of red meat[3] /person/day of which beef constitutes 50-60%, pork 30-40%, and other meats <5%. Muscle comprises approximately 75% of the red meat consumed with processed meats making up the remaining 25%. Ground beef is the largest single item purchased while less than 1/50 of the red meat consumed is in the form of organ meats. However, it has been determined that while organ meats contribute only 0.3% dietary protein and 0.8% of dietary iron, they contribute approximately 12% of the vitamin A (Sabry, 1988).

Lutra Associates (1989) reported that almost all FGH and CL households interviewed participated in the domestic fishery Even those who did not participate consumed up to 10 fish per week. However, the intensity of fishing is less than it was previously due in part to a reduction in the number of dogs kept and hence the number requiring feeding. Some households implicated increased age and less time on the land for a diminished use of fish. A small proportion of households also reported a decreased fish consumption secondary to questions regarding their safety for human consumption (Lutra Associates, 1989).

Whitefish, cisco and inconnu are the major species consumed in FGH, while trout and whitefish predominate in CL. The flesh and eggs of most species harvested are consumed as are the livers of loche, whitefish and inconnu. Other information collected indicate that while fish plays an important part in the household diet, fish is not depended upon as the main food source in FGH. Fish plays a more important role in the diet of CL residents (Lutra Associates, 1989). In comparison, the average Canadian consumed only 135 g of fish per week (raw edible portion) in 1988. The vast majority of this weight was muscle tissue (NIN, 1991).

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[3] red meat is defined as beef, pork, veal, lamb, mutton; organs of the above; and processed meats containing the above (Sabry, 1988).

Wein and Sabry (1988) found that 120 Native Canadian households near Wood Buffalo National Park in northern Alberta consumed traditional foods an average of 319 times per year. Large animals, particularly moose and caribou were used on an average of 128 occasions while fish, predominantly whitefish, were used on an average of 62 times per household per year. With the exception of berries which were used on an average of 63 occasions per household per year, plant foods were infrequently used. Small mammals, birds, and waterfowl were also used (Wein and Sabry, 1988). Although populations of rabbit, beaver, and muskrat fluctuate, they are especially important when big game fail (Schaefer and Steckle, 1980).

For use in a PhD thesis regarding the food use and nutrient intakes of Native Canadians living near Wood Buffalo National Park, Alberta, Wein (1989) classified individuals in households in the upper third of a household traditional food frequency distribution (n=58) as frequent users of traditional foods. Residents of households in the lower third (n=55) were classified as infrequent users. Wein (1989) found that frequent users of traditional foods obtained significantly more protein, iron, phosphorus, riboflavin, and niacin and significantly less fat and calcium per 1000 kcal than infrequent users. Zinc intake was not assessed.

In 1985, households in four communities along Dehcho ranging from Norman Wells (the most urban with the most non-Natives) to Wrigley (the most remote with the highest proportion of Native residents) were questioned regarding their use of traditional foods. Using answers to the question "How much of your household food is country food", Bone (1985) classified households as "low" with respect to traditional food use if less than or equal to 15% of the foods used were wild foods, "medium" if between 16 and 60% of their foods were wild foods, and "high" if over 60% of the foods they used were wild foods. The results indicated that 41.7% of households were "low" consumers, 40.6% were "medium" consumers, and 17.7% were "high" consumers. The author stated that "all" (Native and non-Native) households were surveyed with an overall response from 423 households. No indication regarding non-response or possible bias is given. A

further question arising from the lack of detail regarding methods used is how valid and reliable the answers are.

Muller-Wille (1974) noted that large quantities of meat are consumed in the bush. This meat is supplemented with tea, sugar, bannock, and some canned foods. Less meat is consumed in the settlements due to the availability of store foods and the difficulty in transporting meat from the bush to the settlement.

From the time of ice break-up until late September, market foods are brought into FGH by barge (Smith, 1986). All dairy products and staples must be shipped into the NWT. In the NWT, approximately 40% of stores sell fresh meats while less than 26% sell any traditional foods. Of the traditional foods sold, most is fish (Green and Green, 1987). Some families keep their own chickens and grow vegetable gardens. Market foods are used extensively to supplement traditional foods which are the primary dietary sources of meat and fish (Bone, 1985, Hedican, 1986).

Current dietary change among the Dogrib has been proposed to involve more addition than substitution (Ritenbaugh et al., in prep.) In particular, refined sugar products are being increasingly utilized (Schaefer and Steckle, 1980). Energy intakes have consequently increased. Proportion wise, the change is seen in higher energy intakes from carbohydrate and less from protein. However, average protein intakes remain approximately twice that of the American average thereby supporting the continued existence of an influence of a hunting-based diet (Ritenbaugh et al., in prep.).

Age-related patterns in food consumption include a higher percentage of energy from meat with increasing age and a higher percentage of energy from carbohydrate with decreasing age. Energy intake from bread remains consistent throughout the age groups (Ritenbaugh et al., in prep.). Younger age groups show a decreased intake of organs and bones with a concomitant increase in the consumption of muscle tissue (Schaefer and Steckle, 1980).

In 1986, the average Canadian derived approximately 12-14% of dietary energy from protein, 38-40% from fat, and 46-50% from carbohydrate (Sabry,

1988). In contrast, Ritenbaugh et al. (in prep.) in their study of the Dogrib, found that approximately 31% of energy came from protein, with an approximately equal contribution from fat, and slightly more energy (approximately 39%) from carbohydrate.

2.2.3 Seasonal Changes in Food Use and Nutrient Intake

In the natural environment, seasonal changes influence the availability of various traditional food species for harvesting. Harvest patterns also vary according to community and year as influenced by the availability of wage employment, fur prices, and the distribution of animal populations (Delancey, 1985). Consequently, the nutrient density of the diet may be expected to vary according to season, community, and year (Mackey and Orr, 1988).

The consumption of "out-of-season" food species is made possible through traditional preservation techniques such as smoking and drying, as well as by more modern methods such as freezing (Wein and Sabry, 1988). Dried fish and meat also serve as a durable source of food which can be cached as protection against times of food shortage (e.g. during "failure" on the trapline) (Hanks and Winter, 1991; Maracle, 1985).

From archaeological data, ethnographic analogy, and historic sources, Hanks and Winter (1991) supported the conclusion that the use of land and river resources by the Dene has not changed drastically since European contact. Most groups are still involved in a seasonally-determined mixed hunting, fishing, and gathering strategy which emphasizes the production of dry fish for fall and winter use (Smith, 1986; Hanks et al., 1991).

Early summer fishing is looked forward to with anticipation after a meat-dominated winter and spring. In particular, any cisco, whitefish, and inconnu which is caught is regarded as a special treat (Lutra Associates, 1989). Food procurement from July to just prior to freeze-up is characterized by an intensive domestic fishery in which many fish species, including inconnu, lake trout, cisco, and whitefish, are consumed (Smith, 1986; Rushforth, 1977; Lutra Associates,

1989). Large quantities of fish are dried for use year-round (Maracle, 1985). Mackey and Orr (1988) found that summer fish consumption on the northern Labrador coast contributed to the highest seasonal intake of calcium, likely due to the intake of bones. Big game such as moose are also hunted at this time and, towards the end of summer, caribou hunting begins (Smith, 1986)

Fall and winter subsistence activities revolve around hunting and trapping. Fur animals (particularly when working on the trapline), moose, caribou, rabbit, and fish are important sources of food (Smith, 1986; Maracle, 1985; Wein and Sabry, 1988). Moose and caribou are often dried or boned in order to lighten the load for the return to the settlement (Yesner, 1989; Maracle, 1985) In the Great Bear Lake area, October fare consists of late runs of whitefish, loche, and pike, rabbits, ptarmigan, and an occasional woodland caribou. Freeze-up marks the cessation of river fishing and an increase in lake-fishing (Rushforth, 1977, Lutra Associates, 1989).

Fort Good Hope residents are reported to look forward to the winter fishery '"...because lake fish taste different than river fish"' and because they generally '...no longer "trust" (i.e. the safety) of river fish' (Lutra Associates, 1989:56). In particular, the highly valued loche livers are reported to be at their tastiest (i.e. fattiest) in the early winter (Hunter, 1986).

September duck migrations provide a break from the seasonal diet of fish, caribou, and market food. Tea, flour, sugar, lard, and oatmeal are the most widely used market foods during the trapping season (Rushforth, 1977; Appavoo, 1990) The importance of lard and sugar may lie in the fact that subsistence on lean fish and hare is often only a step above starvation, as will be discussed in section 2.3.1. For the Inuit living on the northern coast of Labrador, Mackey and Orr (1988) note that dietary iron density in the early fall is the lowest of the year, while the winter diet has twice the iron density of the other seasons. This may be partially attributed to elevated intake of seal.

In addition to natural cyclic fluctuations in animal populations, winter weather conditions have the capability of altering the relative importance of various

food species in the next season. For example, deep snow can decrease the moose population through starvation while shallow snow may cause the death of small mammals through exposure (Yesner, 1989).

Traditionally, the (late) spring hunt meant diversity and a renewal of fatty meat consumption after a late winter and early spring of high lean meat consumption (Speth and Spielmann, 1983; Wein and Sabry, 1988). Mackey and Orr (1988) report that on the northern coast of Labrador, protein intake is at its peak in early spring (Mackey and Orr, 1988).

The spring hunt begins in late April to early May and involves the hunting of beaver, muskrat, ducks, geese, and any large game present (Smith, 1986). Meat which is not consumed is dried and brought back to the settlement (Rushforth, 1977). Hunter (1986) claims that spring is the best time to dry meat since there are few insects and the air is cool enough to give the meat its 'proper texture'. Like trapping, spring beaver hunts are often conducted by men, while the women stay in town with school-age children (Rushforth, 1977).

2.2.4 Benefits and Risks of the Contemporary Hareskin Food System

> You know, cows were made for white people - moose for Indians. An Indian eats cows and pigs, and dies (Hedican, 1986:73).

The concept of food safety provides a useful framework for addressing the issue of benefits and risks with respect to a food system. An integral part of the concept of food safety involves recognizing the popular phrase "the dose makes the poison". In other words, the mere presence of a compound does not imply that toxicity or physiological disruption will necessarily follow. Rather, it is important to quantify the length of time and level of exposure to the compound and to compare this amount against an appropriate standard. In addition to determining the magnitude of the risk, it is also important to consider: the ease of modification of the food behaviour; the strength of the evidence that the risk is real; and the size of the population at risk (Forbes et al., 1989). Further, it is important to weigh

the risks of a given food practice with its benefits (Institute of Food Technologists, 1988).

Benefits may be construed as anything which contributes to an improvement in condition, while risks pertain to such considerations as injury, increased cost, decreased satisfaction, or loss of convenience (Institute of Food Technologists, 1988).

The benefits of traditional food use are holistic in nature, involving such dimensions as nutrition, economics, and socio-cultural value. First of all, traditional foods are generally more nutrient dense than their marketed counterparts as will be explicated in subsequent sections (e.g. Schaefer and Steckle, 1980) In the past decade, there has been heightened interest in the fish component of the diet due to health implications of its nutritional properties (see Appavoo, 1990 for a review of the health implications of fish oils). Secondly, traditional food use serves as a buffer against economic dependence which can result from high use of costly imported foods (Hedican, 1986; Young, 1988). It is important to note that the Native people of northern Canada are among the only relatively poor populations in the world with a larder well-stocked with animal protein (Usher, 1976, Asch, 1984). Thirdly, the processes involved in obtaining and utilizing traditional foods incorporates values integral to Hareskin culture including hard work and sharing (Bone, 1985; Usher, 1976; Rushforth, 1977). In addition, feelings of pride and confidence at being successful at a useful endeavour are important to consider (Bone, 1985). In contrast with the sharing and reciprocity surrounding traditional food use, the use of market foods promotes individualism (Messer, 1984). A fourth benefit of traditional food use is self-evident and involves the fact that the lifestyle associated with harvesting wild foods promotes physical activity which is generally associated with positive health outcomes. Finally, the consumption of locally available foods, if they are judiciously harvested, utilizes principles of ecological sustainability (Herrin and Gussow, 1989).

Thus, the use of wild foods by the Dene is more than the use of an alternative source of food - it is a central tradition in Dene culture (Usher, 1976).

It is important to remember that the use of market foods also has positive attributes. First of all, imported foods are currently important sources of carbohydrate and calcium (Young, 1988). Further, while chronic malnutrition does not appear to have been a concern in the pre-contact period, occasional acute starvation was (Savishinsky and Hara, 1984). Food security is currently satisfactory due in large measure to the availability of a predictable and diverse supply of market foods.

While market foods have been shown to complement traditional foods in the contemporary food system, inappropriate choices can lead to health related risks. Indeed, coincident with the dietary changes noted above has been a change in health and nutritional status.

The diminished use of organs and bones noted earlier has contributed to an increased need for alternative sources of vitamins, minerals and trace elements. As discussed earlier, use of market foods is largely restricted to high carbohydrate foods which are often low in vitamins, minerals, and trace elements. Thus, evidence of risk with respect to certain nutrients in the contemporary diets of northern Native people is not unexpected. In particular, these nutrients include vitamin A, calcium, folate, and to some extent, iron (Young, 1988; Schaefer and Steckle, 1980; Kuhnlein, 1989b; Wein et al., 1991; Sevenhuysen and Bogert-O'Brien, 1987). Under-utilized traditional food sources rich in each of these nutrients exist (Kuhnlein, 1989b; Schaefer and Steckle, 1980).

Health concerns attributed to the recent change in diet of the Northern Native people have been collectively termed "New World Syndrome" and involve conditions such as dental caries, obesity, hypertension, iron deficiency anemia, diabetes, and gall bladder disease (Draper, 1977; Schaefer and Steckle, 1980; Young, 1988). O'Neil (1986) has noted that the health effects of nutritional changes may be aggravated by psychosocial stress.

The presence of contaminants, including PCBs, in food constitutes a more complex risk as "risk embodies not only probabilistic estimates of hazard, but also a dimension of outrage" (Scott, 1988:267). While the media has undoubtedly

played a role in recent attention given to the presence of PCBs in the northern food system, heightened concern may also be attributed to uncertainty regarding the actual risk PCBs pose to the northern Native people as well as to the environment (e.g. Globe and Mail, Sept.6, 1989:A8). A discussion of the current state of knowledge regarding the physiological implications of PCB consumption will be presented in section 2.3.5.6.

2.3 Selected Nutrients and PCBs in the Contemporary Hareskin Food System

As will become evident by the end of the literature review, the nutrients to be investigated were chosen for a number of reasons. Similarly, the choice to investigate polychlorinated biphenyls was made for a number of reasons which will, likewise, become evident by the end of the literature review.

2.3.1 Protein

2.3.1.1 General Description

Dietary proteins are composed of approximately 20 common amino acids, eight of which are currently considered essential for adult humans (HWC, 1990). Essential amino acids (e.a.a.) cannot be synthesized endogenously and must therefore be consumed, preformed, in the diet.

The protein "quality" of a food is judged both by its amino acid profile and by its digestibility (Linder, 1985). In general, proteins from animals, fowl, and fish have e.a.a. patterns closely resembling that required for synthesis of human tissues and are highly digestible (Linder, 1985; Sabry, 1988). With the exception of soybeans, vegetable proteins are usually less than adequate in one or two e.a.a. and have variable digestibilities (Linder, 1985).

2.3.1.2 Food Sources

Protein is found in a wide variety of foods. The "average" Canadian diet

derives 11% of its dietary energy and approximately 26% of its protein from red meats (beef, pork, veal, mutton, lamb, organs of above, and processed meats from above). Actual values vary with income, age, and sex (Sabry, 1988). Game meats were intentionally omitted from the latter study. For the "average" Canadian, milk and milk products, poultry, fish, eggs, legumes, grain and grain products, and, to a lesser extent, fruits and vegetables, make up the remainder.

Generally, the protein content of animal, fowl, and fish flesh is about 13 to 24% of the raw edible portion (NIN, 1991; Speth and Spielmann, 1983; Farmer and Neilson, 1967). This range is quite consistent for both farmed and wild species (NIN, 1991; Speth and Spielmann, 1983) (refer to Table 2.2 for protein content of traditional Dene food species). In contrast, the fat content of wild fish, animals, and birds varies both within and among species, particularly according to season (Appavoo, 1990; NIN, 1991).

Cooking and drying animal meats, fish, and birds results in higher protein contents due to moisture loss (Mann et al., 1962; Hoppner et al., 1978). The processing of fish by smoke-drying at 60-65°C leads to the denaturation of approximately 90% of fish proteins while the remaining 10% (tropomyosin) may be held at 100°C for a prolonged time without denaturation (Opstvedt, 1988). While protein utilization does not appear to be influenced significantly by the denaturation, protein aggregation which may occur subsequent to the denaturation could involve the formation of disulphide bonds which may reduce digestibility (Opstvedt, 1988). Aldehydes contained in the smoke may decrease both protein quality and lysine availability (Opstvedt, 1988).

2.3.1.3 Metabolism

The process of protein digestion begins in the stomach with acid denaturation and partial pepsin-mediated degradation. Further proteolysis in the upper small intestine frees amino acids and small peptides. Absorption is energy and carrier-dependent with further digestion of the peptides occurring in the epithelial cells and subsequently in the liver or peripheral tissue. Occasionally,

Table 2.2A: Range of Published Literature Values for Proximate Composition, Vitamin A, Iron, Zinc, and PCBs in Foods Traditional to the Hareskin (/100g)[a]

Common Name, Process	%H_2O	%Pro	%Fat	%CHO	%Ash
MAMMALS					
Beaver,raw	46.2	14.3	39.0	-[b]	0 6
Beaver,cooked	56.0	28.9	13.3	0	-
Caribou,raw	68.7-74.8	22.0-28.9	1.1-2.9	-	1 1-1 5
Caribou,cooked	-	37.8	1.1	0	-
Moose,raw	72.4	25.5	1.1	-	1 0
Moose,cooked	-	33.3-34.4	3.3	0	-
Muskrat,raw	73.4	22.4	1.3	-	1 1
Muskrat,cooked	-	26.7	3.3	0	-
Rabbit,raw	73.3-74.8	21.6-24.0	1.8-2.7	-	-
Rabbit,cooked	-	28.9	10	0	-
BIRDS					
Duck,raw	71.0	21.1-24.3	1 1-3 6	0	-
Ptarmigan,raw	70.4-71.2	25.7-26.5	1.4-2.1	-	1 7
Ptarmigan,cooked	62	31.1	5.6	0	-
FISH					
Cisco,raw	-	-	-	-	-
Cisco,cooked	-	23.3	15.6	tr[c]	-
Inconnu,raw	74.4	22.2	4.1	-	-
Loche,raw	74.2-82.5	14.8-24.2	0.3-1.5	-	1.0-1 1
Loche Liver,raw	38.9-58.5	5.6-9.1	27.2-42.0	-	0 5-0.8
Pike,raw	77.7-80.1	17.5-18.7	0.2-0.7	-	1 1-2.4
Pike,cooked	-	22.2	tr	0	
Trout,raw	75.4	22.4	2.1	-	-
Trout,cooked	71.0	22.6-23.3	14.0-14.4	tr	-
Whitefish,raw	70.0-79.2	13.6-25.8	1.2-4 9	-	1 3-2 0
Whitefish,cooked	-	23.3	11 1	tr	-
Whitefish,dried	18	69	3.2	-	5 7
BERRIES					
Blackberries	86	0.7-1.3	tr	12 5-13.2	-
Blueberries	85	tr-0.7	tr	14.4-15 6	-
Cranberries	87	tr	tr	13	-
Cloudberries	-	2	tr	8.6	-
Gooseberries	-	tr	tr	10 0	-
Raspberries	87	0.8-1.5	tr	11.5-13.8	-

see footnotes at end of Table 2.2 cont.

Table 2.2B: Range of Published Literature Values for Proximate Composition, Vitamin A, Iron, Zinc, and PCBs in Foods Traditional to the Hareskin (/100g)[a]

Common Name, Process	Energy (kcal)	Vit.A (RE)	Iron (mg)	Zinc (mg)	PCB (ug)	Ref[d]
MAMMALS						
Beaver,raw	-	-	-	-	-	5
Beaver,cooked	248	0	1.4-1.6	-	-	2,7
Caribou,raw	96	tr	4.2	3.2	0.9	5,8-10
Caribou,cooked	174	7	3.4	3.0	-	2,7
Moose,raw	-	tr	-	-	-	5
Moose,cooked	176	52-58	3.3	-	-	2,7
Muskrat,raw	-	847	-	-	-	5
Muskrat,cooked	146	30	1.6	-	-	2
Rabbit,raw	96-120	-	3.6	-	-	3,9
Rabbit,cooked	216	0	1.6	-	-	2,7
BIRDS						
Duck,raw	124-129	-	3.3	-	-	2,3
Ptarmigan,raw	125	tr	-	-	-	3,5
Ptarmigan,cooked	173	-	7.6	-	-	7
FISH						
Cisco,raw	-	-	-	-	0.41	1
Cisco,cooked	241	52	1.4	-	-	2
Inconnu,raw	125	-	-	-	0.35	1,3
Loche,raw	-	30	-	-	-	4,5
Loche Liver,raw	280-368	1183	-	-	13.9-34.4	4-6
Pike,raw	-	270	-	-	-	5
Pike,cooked	99	132	0.4	-	-	2
Trout,raw	109	-	-	-	-	3
Trout,cooked	216	96	5.0-5.1	-	-	5,8
Whitefish,raw	135	32	-	-	0.2-0.9	1,3-5
Whitefish,cooked	196	107	1.1	-	-	2
Whitefish,dried	-	-	-	-	-	5
BERRIES						
Blackberries	52-58	16-20	0.6-0.9	-	-	2,7
Blueberries	56-62	10	0.2-1.3	-	-	2,7
Cranberries	49	5	0.2	-	-	7
Cloudberries	51	21-71	0.7	-	-	2,11
Gooseberries	40	30	0.6	-	-	2
Raspberries	49-57	13-14	0.5-1.4	-	-	2,7

[a] apart from PCB values, values are generally derived from foods harvested in regions other than the Mackenzie Delta
[b] no data available
[c] trace amounts
[d] references: (1) Wong, 1985; (2) HWC, 1985; (3)Farmer and Neilson, 1967; (4) Lockhart et al., 1989; (5) Mann et al., 1962; (6) Muir et al., 1990; (7) HWC, 1988; (8) Hoppner et al., 1978; (9) Farmer et al., 1971; (10) Kuhnlein and Kinloch, 1988; (11) Schaefer, 1977.

whole proteins may be absorbed which can be associated with food allergies (Linder, 1985). Animal proteins are generally 85-100% absorbed while plant proteins may be 70-95% absorbed. Upon entering the portal system, the amino acids are taken up by the liver and muscles. Free nitrogen resulting from the catabolism of nitrogenous compounds in various body tissues is converted to either ammonia, urea, or creatinine and subsequently eliminated from the body primarily through the urine (Linder, 1985).

2.3.1.4 Dietary and Biochemical Assessment

Current dietary recommendations for protein are based on a mixed diet, thereby recognizing the variable qualities of dietary protein (HWC, 1990; Sabry, 1988). For adult women, the RNI for protein ranges between 57 and 61g depending on age. The RNI for men is higher, reflecting the difference in body weight. The "average" North American consumes approximately 80-125g of protein daily (Linder, 1985). This is approximately twice the average adult requirement of 0.8 g/kg body wt/day and provides 12-15% of the total energy intake (HWC, 1990, Sabry, 1988).

At the upper extreme, Speth and Spielmann (1983) note that up to 3 6 kg of lean meat may have been consumed by the Dene in times of carbohydrate and fat scarcity. Using a value of 38g protein/100g cooked caribou (1.1% fat) from HWC (1988a), 1368g of protein may periodically have been consumed by an active hunter with limited food resources.

The Nutrition Canada Indian Survey found that median protein intakes of adult men and women were higher than the standard of adequacy (>0.7g/kg body wt/day) and similar to that of the national survey (HWC, 1975). The majority of adult women consumed between 40 and 100 g protein per day (median of 59g for 20-54 yr old women and 50g for 55+ yrs) although 1.2% of women aged 20-39 years reported consuming over 400 g protein. An "inadequate" intake of protein (<0.5g/kg body wt/day) was determined for 10% of Indian women aged 20-39 in comparison to 9% for the national population of women aged 20-39 (HWC, 1975).

In apparent contradiction, however, none of the Indian women aged 20-39 were at moderate or high risk with respect to serum protein levels while 0.6% and 1.9% of the national population of women 20-39 years of age were at high and moderate risk respectively. A discussion of the relevance of serum protein levels to the evaluation of protein status is given below.

Risk of dietary and biochemical inadequacy of protein increased for both the Indian and national populations with age (HWC, 1975). In general, Indian men were found to be at less risk of dietary and biochemical protein inadequacy than Indian women.

In a study of the Nuxalk people of Bella Coola, British Columbia by Kuhnlein (1984), 40 women aged 19-49 years were found to have a mean protein intake of 52 ± 12 g/1000 kcal. Ten percent of the women had protein intakes less than 2/3 of the RNI while none consumed less than 1/3 of the RNI. While this Native group consumes little wild game, their fish intake is considerable (Kuhnlein, 1984).

Native women from Wood Buffalo National Park, Alberta had mean protein intakes of 69 ± 23g (n=38, 25-49yrs) and 64 ± 23g (n=27, 50-86yrs) (Wein et al., 1991). Men had considerably higher intakes at 116 ± 35g (n=26, 25-49yrs) and 97 ± 42g (n=18, 50-86yrs). The contribution of protein to energy intake was found to be between 16 and 18%.

As noted in the 1986 NRC report, Nutrient Adequacy, the probability approach acknowledges that the recommended intake levels exceed the requirements of almost all individuals. Using this approach, Wein et al. (1991) found that 5% of the 107 adult women studied were probably consuming inadequate levels of protein.

Sevenhuysen and Bogert-O'Brien (1987) found a mean intake of 71 ± 4g of protein for 85 Native women (≥18yrs) from northern Manitoba. Intakes of 12 pregnant women were included in the calculation of the mean intake although they were not included in determinations of %RNI intakes. Two individuals were found to have consumed less than 40% of the RNI while 57 (78%) consumed over 100% of the RNI. Despite a higher mean protein intake than was observed by Wein et

al. (1991), more of the women (9%) were found to have a high probability of inadequate intakes using the probability approach (Sevenhuysen and Bogert-O'Brien, 1987). This suggests that there may have been a few high intakes skewing the mean upwards in the study by Sevenhuysen and Bogert-O'Brien (1987). Ranges were not provided.

As with the other studies noted above, Kuhnlein (1989b) reported a low prevalence (3/69) of adult women 20-40yrs consuming less than 1/2 of the RNI for protein. The mean protein intake of this group of Inuit women, 136±64g, was higher than that of the Indian groups previously mentioned as well as of the North American average range also noted earlier. The mean intake rose to 147±40g for women aged 41-60yrs (n=26) and fell to 125±37g for women ≥60yrs (n=11) (Kuhnlein, 1989b). As observed by Wein et al. (1991), the intake of protein by men was found to exceed that of women on a total gram basis (Kuhnlein, 1989b)

Caribou and ringed seal meat are the primary sources of dietary protein for Inuit women aged 20-40yrs. Narwhal mattak, chicken meat, and hamburger, ranking third to fifth in contribution to protein intake respectively, are relatively less important (Kuhnlein, 1989b). As would be expected from the preceding, the contribution of traditional Inuit foods to the protein intake of women 20-40yrs is significantly greater ($p<0.001$) than that of market foods (Kuhnlein, in prep).

While not noting precise amounts ingested, Ritenbaugh et al. (in prep) found that the average intake of protein by the Dogrib people of the N.W.T. was about twice that of the U.S. average (therefore approximately 160-250g based on Linder, 1985). The percent energy contribution from protein was about 32% for women and 31% for men (Ritenbaugh et al., in prep.).

While no numbers were presented, Verdier et al. (1987a) found that <1% of the Inuit population they studied was at risk from low serum protein levels. Desai and Lee (1974) similarly reported that none of the 310 Native Indian participants from the Yukon had serum protein levels less than 6 g/dl (i.e. high risk) and very few had levels lower than 6.4 g/dl (i.e. >6.4 g/dl = low risk).

Despite the fact that only 30% of the sample originally selected for the

Nutrition Canada Survey participated resulting in a potential bias, Hoffer et al. (1981) found no noteworthy differences in serum protein levels between their sample of northern Quebec Cree (82% participation) and the Nutrition Canada Indian sample.

2.3.1.5 Physiological Significance

Dietary requirements for protein are based on needs for both total amino nitrogen and e.a.a. which serve: a) structural (collagen and elastin); b) regulatory (neurotransmitters, enzymes and hormones); and c) other (milk protein, nucleic acid and carrier protein production, vitamin precursors, gluconeogenesis, and mediators of immune response) functions (Sabry, 1988; Gibson, 1990; HWC, 1990; Linder, 1985). Primarily a function of its structural role, protein requirements are increased during periods of anabolism such as pregnancy and childhood.

Unlike many other nutrients, including iron and vitamin A as will be discussed, there are no dispensable "stores" of protein in the human body (Gibson, 1990). Generally, the majority of the body's protein is in the form of somatic protein (skeletal muscle) with a smaller visceral pool (serum proteins, erythrocytes, lymphocytes, granulocytes, and organs such as the liver, pancreas, kidneys and heart) (Gibson, 1990).

Serum proteins are commonly used to assess protein status due to the ease with which they can be determined. However, the lack of sensitivity and specificity of these visceral proteins is well known. Protein restriction must be severe and prolonged to lead to a decrease in serum albumin since, concomitant to a decrease in its synthesis, is a decrease in its breakdown and a redistribution to the intravascular space from the interstitial space (Golden, 1982). Infection, hepatic disease, trauma, and energy, zinc, iron or vitamin A deficiency can all lead to a diminishment of serum transport protein status (Golden, 1982; Gibson, 1990). In fact, it appears that hypoalbuminemia may be more a function of zinc deficiency than of protein deficiency since supplementation with zinc alone resulted in an elevation of serum albumin concentration (Golden, 1982). Despite their lack of

value as sensitive indices of protein status, serum proteins do indicate patients at the highest risk of morbidity or mortality whatever the cause of their illness (Golden, 1982). Thus, the use of total serum protein levels does not permit conclusions regarding the protein status of the Native people participating in the studies noted earlier.

Negative nitrogen balance (i.e. nitrogen loss is greater than intake) occurs in situations of starvation, physical or mental trauma, infection, or if the diet is lacking an e.a.a. (Linder, 1985). In these cases, body protein is degraded for use as an energy source (gluconeogenesis) or as a source of e.a.a. for tissue maintenance. On the other hand, if the diet is low in carbohydrate but high in protein, dietary protein (in contrast to body protein) is used as the primary substrate for gluconeogenesis (Linder, 1985).

The interaction between energy intake and the amount of protein required to maintain nitrogen-balance is interesting with respect to the nutrition of Native people consuming high protein diets. If the diet contains 50-60% of its energy as protein, an initial short-lived anorexia can be expected (HWC, 1990) As hepatic amino-acid catabolizing enzymes are induced, food intake returns to normal and no difference in growth rates are observed (HWC, 1990). In contrast, Speth and Spielmann (1983) reported observations by the northern ethnographer, Vilhjalmur Stefansson, regarding "rabbit starvation" in which a diet containing 85-90% of its energy as protein may be consumed:

> If you are transferred suddenly from a diet normal in fat to one consisting wholly of rabbit you eat bigger and bigger meals for the first few days until at the end of about a week you are eating in pounds three or four times as much as you were at the beginning of the week. By that time you are showing both signs of starvation and of protein poisoning. You eat numerous meals; you feel hungry at the end of each; you are in discomfort through distention of the stomach with much food and you begin to feel a vague restlessness. Diarrhoea will start in from a week to ten days and will not be relieved unless you secure fat. Death will result after several weeks (Stefansson, 1944:234).

Similar observations have been reported by others in the ethnohistoric literature

(see Speth and Spielmann, 1983).

The specific dynamic action (diet-induced thermogenesis) of protein ingestion is about 30% (i.e. for every 100 kcal of protein ingested, 30 are needed to compensate for increased metabolic needs) while that of fat is 6-14% and that of carbohydrate is 6% (Speth et al., 1983). This explains the consumption of increasingly larger meals as an attempt to meet energy needs. If the meat contained 2-3% fat, approximately 1.6 kgs would be required by an adult woman just to satisfy basic metabolic needs (Speth and Spielmann, 1983).

An optimal protein to energy ratio cannot be generalized since an individual's need for both must be known (HWC, 1990). The upper limit of safe protein intake appears to be a function of the body's ability to excrete the end products of metabolism, primarily urea, which is determined by water consumption, and renal and hepatic function (HWC, 1990). Draper (1977) notes reports of high water intakes by the Inuit whose pre-contact diets are thought to have consisted of 2% energy from carbohydrate, 32% from protein, and 66% from fat. Schaefer (1977) reports a relatively high prevalence of hepatomegaly in the Inuit, presumably from increased gluconeogenesis. This capacity for efficient gluconeogenesis may be a biological adaptation resulting from a long history of high protein, low carbohydrate diets in the context of a physiological requirement for glucose as a metabolic substrate (Haas and Harrison, 1977). In general, the traditional Dene diet had more carbohydrate sources available (Schaefer and Steckle, 1980).

A concern for a possible increased risk of osteoporosis in individuals consuming a high protein diet has been raised (Draper, 1977). Osteoporosis is an age-related disease in which bone mass is decreased. The interest in the role of dietary protein in osteoporosis began as a result of a study which noted a relationship between high levels of purified protein and hypercalciuria (Sabry, 1988). Normally, a high protein intake is accompanied by a high phosphorus intake, the latter of which has a hypocalciuric effect which offsets, to some degree, the hypercalciuric effect of the protein (Sabry, 1988; HWC, 1990). There is

currently no evidence suggesting that a high protein intake in the context of a normal diet is a risk factor in osteoporosis.

2.3.2 Iron

2.3.2.1 General Description

Iron (Fe) is the most abundant trace element in the human body (Linder, 1985). Two basic classifications of iron consist of heme and non-heme iron with both forms being found in humans and other animals As heme iron is present in hemoglobin and myoglobin, it is found only in animal tissues (Sabry, 1988). Non-heme iron is the remaining tissue iron (e.g. ferritin) as well as the form of iron found in plants (Sabry, 1988).

2.3.2.2 Food Sources

Canadian beef and pork in the current Canadian Nutrient File (1988) have iron contents which are approximately 25-50% lower than in previous editions. This may be attributable to recent alterations in beef and pork production (Sabry, 1988). When comparing iron intake data, it becomes important to know which nutrient file was in use.

Ruminant flesh (e.g. beef) appears to have higher iron levels than does pork. With few exceptions, the iron content of organ and processed meats are higher than those of flesh (Sabry, 1988).

The iron content of fish varies among species This variability is enhanced in fish harvested from natural populations in comparison to those from domestic fish farms. In general, the iron content varies from 0.3 to 2.0 mg/100g raw edible portion (NIN, 1991). These levels are comparable to current values for beef and pork. Iron values for poultry fall between 1 and 2 mg/100g cooked flesh (HWC, 1988a).

In contrast to domestic species, cooked caribou and moose have iron levels over 3 mg/100g. Animal blood and liver have considerably higher levels (HWC, 1985) (see Table 2.2 for iron content of traditional Dene foods).

In North American diets, grain products are a major source of non-heme iron as a result of their fortification (Gibson, 1990; HWC, 1975). Mandatory iron enrichment is prescribed for infant formulas, meal replacements, flour, and bread. Flour is fortified at a level of 2.9-4.3mg Fe/100g while 100g of bread made from the enriched flour must have ≥1.76mg Fe. Enrichment of breakfast cereals is optional at 13.3mg Fe/100g (HWC, 1988b).

2.3.2.3 Metabolism

Iron homeostasis is maintained through absorption (Linder, 1985). The amount of dietary iron which is absorbed is regulated by iron status and is influenced by the chemical form of the iron and the presence of dietary factors which may inhibit or enhance absorption (Monsen, 1978; Sabry, 1988). In contrast to non-heme iron, heme iron has a high bioavailability with a rate of absorption (17-31%) not highly influenced by iron status or other dietary components. Prolonged heating, however, decreases the absorption of iron from heme (Sabry, 1988).

The absorption of non-heme iron is approximately 2-17% if no meat is ingested. Phytates, fibre, tannins, egg yolk (phosvitin), and a replete iron status inhibit non-heme iron absorption while ascorbic acid and animal flesh (in the latter case, possibly through the binding of iron to the thiol group of cysteine) stimulate its absorption (Monsen, 1978; Latunde-Dada and Neale, 1986; Hallberg and Rossander, 1984; Sabry, 1988; HWC, 1990; Linder, 1985). Farb and Armelagos (1980) suggest that the inhibitory effect of tannins in tea may be offset to some degree if milk is added to the tea as milk proteins may bind the tannins.

Iron is stored primarily in the liver, spleen, and bone marrow in the form of ferritin and hemosiderin (HWC, 1990). Ascorbic acid and possibly vitamin E are involved in the mobilization of iron from ferritin, thus a high ascorbate intake in an individual with iron-overload can lead to severe toxicity. Iron is lost from the body

epithelial cells, and through the bile (Linder, 1985).

2.3.2.4 Dietary and Biochemical Assessment

The requirement for iron is highest in growth and pregnancy (Sabry, 1988) Pre-menopausal menstruating women also have a high need for iron. In the general Canadian population, biochemical data support the conclusion that iron-deficiency is a widespread problem in Canada, particularly among children, adolescents and young adult women (Sabry, 1988; HWC, 1975; Gibson, 1990). This may result from inadequate intakes, poor absorption, and/or increased loss from the body (Gibson, 1990).

In the Nutrition Canada Indian Survey, more women than men were at risk for low iron intakes, with women over the age of 40 being at greatest risk With the exception of Indian women over the age of 40, levels of risk for inadequate iron intake of the national and Indian populations were similar. The distribution of intakes was wide with 2% of the Indian women aged 20-39 consuming ≥ 44mg iron Over 50% of the same group of women consumed >10mg iron (HWC, 1975)

Biochemically, transferrin saturation levels of Indian women were lower than those of the national population of women. Approximately 50% of the Indian women were at high or moderate risk based on this index in comparison to 20-30% of the national population of women. In contrast to iron intake for which risk of inadequacy increased with age in women, risk of low transferrin saturation decreased with age (HWC, 1975).

Hemoglobin levels were somewhat lower for the Indian women surveyed than for the national population. While approximately 12% of Indian women were at moderate or high risk for iron deficiency based on hemoglobin levels, only 7% of women in the national population fell into this category. Percentages of women in the various risk categories was relatively consistent with age (HWC, 1975). Considering the two biochemical indices together, it appears that a compromised iron status may exist in some Native women. The high level of risk of dietary iron inadequacy is somewhat anomalous to the lower incidence of biochemical risk

inadequacy is somewhat anomalous to the lower incidence of biochemical risk observed. Variations in requirement and bioavailability may be implicated. The use of hemoglobin and transferrin saturation as indices of iron status is discussed below.

As a result of concerns about the potentially serious findings with respect to the iron status of Native Indians, a study was conducted with a more sensitive and specific indicator of iron status (i.e. serum ferritin). Valberg et al. (1979) reported that if an adequate iron status was defined as having stores in excess of immediate needs, then 34% of 314 non-pregnant women of reproductive age were at risk of inadequacy. Similarly, 11% of 90 older women and 5% of 330 adult men could be categorized as being at risk using this criteria. However, if adequate iron status implies adequate iron availability for erythropoiesis, then 3-4% of adult women and $<1\%$ of adult men were at risk of inadequacy. This study served to confirm the existence of compromised iron status in about 1/3 of the Indian women surveyed. It is important to note that the authors stated that their results were representative only of the sample studied due to the high non-response rate (Valberg et al., 1979).

In a study of 40 adult Nuxalk women from British Columbia, Kuhnlein (1984) found that the mean iron intake was about half of the RNI at 7 ± 2mg. Sixty-four percent of the women consumed $\leq 2/3$ RNI while 21% consumed $\leq 1/3$ RNI. A similar low mean intake and high risk of dietary inadequacy as judged by comparisons with proportions of the RNI was found by Sevenhuysen and Bogert-O'Brien (1987). For 85 northern Manitoba Native Indian women (including 12 pregnant women) a mean iron intake of 11.0 ± 0.1mg was calculated. The researchers used the standard error of the mean versus using standard deviation. While 10% of the women consumed $<40\%$ RNI, 27% consumed $\geq 100\%$ RNI. Using the probability approach, 47% of the population was judged to have a high probability of not meeting their personal requirements (Sevenhuysen and Bogert-O'Brien, 1987).

Wein et al. (1991) found that mean iron intakes of Native Canadians near

Wood Buffalo National Park, Alberta met the RNI for all groups studied except women aged 25-49. The iron intake of the latter group was 11.6±3.4mg. In contrast to the high probability of inadequate iron intake observed by Sevenhuysen and Bogert-O'Brien (1987) for adult women, Wein et al. (1991) found that only 13% of the 107 adult women studied had an iron intake which was probably inadequate. The fact that over 25% of the sample studied by Sevenhuysen and Bogert-O'Brien (1987) had intakes greater than 100% of the RNI may be responsible for the high mean iron intake observed. It is likely that the distribution of iron intakes of the sample studied by Wein et al. (1991) was less skewed.

In contrast to the mean intakes noted for the Native Indian populations, Kuhnlein (1989b) found that the mean iron intake of Inuit women from Broughton Island was over 50mg. Indeed, 26 women aged 41-60 were found to have a mean iron intake of 75±45mg. While 2 of 69 women 20-40 years of age consumed < 1/2 RNI, 91% were found to consume ≥100% RNI. Ringed seal meat, dry narwhal meat, and caribou meat were the top three contributors to iron intake Ringed seal liver ranked eighth (Kuhnlein, 1989b). As would be anticipated, traditional foods were found to contribute significantly more ($p<0.001$) iron to the diets of women aged 20-40 than were market foods (Kuhnlein, in prep). Both the iron content and quantity of traditional food consumed contributed to these high intakes (Kuhnlein, 1989b).

In a blood assay for hemoglobin and transferrin saturation in the Inuit, Verdier et al. (1987a) found that 2/287 subjects were at high risk for iron deficiency based on hemoglobin values. However, the transferrin saturation levels for the same two individuals were normal. It is unknown whether these two individuals were pregnant such that hemodilution could result in low hemoglobin levels but, since transferrin saturation is a ratio of serum iron to transferrin, transferrin saturation would be normal. Otherwise, any of the numerous factors listed below could have led to abnormal hemoglobin values.

While no dietary data were available to support their findings, Desai and Lee (1974) found that hemoglobin levels (47%) and transferrin saturation levels (59%)

were unsatisfactory in the adult Indian men studied at Upper Liard, Yukon Territory. Results for Indian women at Upper Liard were somewhat more favourable than those for the men although 42% had low transferrin saturation levels (< 16%). At Ross River, a more isolated area, only 3 of 45 adults and no children had unsatisfactory hemoglobin levels. Transferrin saturation levels for 74% of the children at Ross River, however, were low. This suggests that while overt anemia was probably rare, iron deficient erythropoiesis may have been in evidence for men, women and children at both Upper Liard and Ross River, although the situation at the former may have been more serious (Desai and Lee, 1974).

2.3.2.5 Physiological Significance

Iron is involved in the transportation and storage of oxygen through the action of the iron-containing compounds hemoglobin and myoglobin. It is also involved in numerous enzyme systems including cytochrome oxidase, catalase, ribonucleotide reductase, and xanthine oxidase (HWC, 1990).

A deficiency of iron can lead to anemia, pagophagia (ice-eating), koilonychia (spoon nails), hypochlorhydria, abnormal cell-mediated immune function, decreased work performance, and altered neurological function (HWC, 1990; Gibson, 1990).

There are three stages in the development of iron-deficiency anemia:

a) iron depletion
b) iron-deficient erythropoiesis
c) iron-deficiency anemia

The first stage is characterized by a diminished store of iron in the liver with a concomitant decrease in serum ferritin levels. There are, however, normal levels of iron on the iron transport protein transferrin (i.e. transferrin saturation) and normal levels of hemoglobin.

In the second stage, iron stores have been depleted. Transferrin saturation is decreased and there is an increase in the heme precursor, erythrocyte protoporphyrin. Hemoglobin levels may decrease slightly but are within the normal

range. Physical activity may decrease. Microcytic hypochromic anemia characterizes the third stage. It is at this point that hemoglobin concentration falls.

The use of hemoglobin alone as an indicator of iron status is fraught with difficulties. First of all, it is an insensitive indicator as illustrated by the fact that it falls only in frank anemia. Further, racial, sex, and age differences exist which must be acknowledged (no data specific to the Native Indian population were found); there are diurnal variations in hemoglobin concentration; and specificity is low (smoking and dehydration increase hemoglobin concentration while infection, protein-energy malnutrition, pregnancy, or B12 or folate deficiency decrease it) (Gibson, 1990). Kimber et al. (1983) found that serum ferritin is a more sensitive and specific indicator of iron status, particularly when combined with hemoglobin and transferrin saturation measurements. Serum ferritin levels may be elevated in leukemia, liver necrosis, and inflammatory conditions (Kimber et al , 1983, Gibson, 1990).

The physiological regulation of iron absorption provides a high degree of protection against excess iron absorption except in the case of idiopathic hemochromatosis, a genetic disease, in which iron accumulates in parenchymal tissue (Gibson, 1990).

Iron overload due to chronic excessive dietary intake has, however, been documented in the South African Bantu who consume an alcoholic beverage brewed in iron pots. This beverage can provide up to 100mg/day of bioavailable iron in addition to that contained in food. The influence of the alcoholic medium on iron absorption is unknown (HWC, 1990).

Toxic levels may also be consumed through the abuse of dietary iron supplements. The excess iron is stored in tissues as hemosiderin. Eventually, the excess iron can damage the liver, heart, pancreas, and possibly other organs leading to functional impairment and possibly early death (Linder, 1985). High dietary iron levels can cause decreased zinc and copper bioavailability (HWC, 1990).

2.3.3 Zinc

2.3.3.1 General Description

While zinc is the third most common trace element in the human body (after iron and fluorine), relatively little emphasis has been placed on it in the assessment of nutritional status, particularly with respect to Native Canadians (Sabry, 1988; Linder, 1985).

2.3.3.2 Food Sources

The richest food sources of zinc are red meats, poultry, liver, eggs, and seafood. Whole grains have a significant level of zinc in their germs. The latter zinc, however, has a low bioavailability due to the accompanying fiber and phytic acid (Solomons, 1982).

As with iron, beef is a richer source of zinc than pork. Zinc levels in both meats are approximately twice those of iron (Sabry, 1988). In contrast, the zinc content of cooked caribou is approximately half that of iron (Hoppner et al., 1978). This anomaly may reflect the genetic manipulation of domestic meat animals. Zinc levels in fish are equivalent to, or somewhat higher than, those of iron (refer to Table 2.2 for zinc levels in traditional Dene foods) (NIN, 1991; Nettleton, 1985).

Zinc enrichment is generally not a major source of dietary zinc since mandatory zinc enrichment applies only to infant formulas and meal replacements (HWC, 1988b).

2.3.3.3 Metabolism

Like iron, the absorption of zinc is homeostatically regulated. Bioavailability varies with zinc status, the amount of zinc in the diet, and the presence of inhibitory factors such as iron, copper, calcium, phytates, and fiber (Solomons, 1982). Unlike iron, the absorption of zinc is not enhanced by the presence of ascorbic acid or flesh, although Sandstrom et al. (1989) suggest that dietary protein levels influence zinc bioavailability. Estimates of absorption vary from 20 to 30% of the total zinc ingested (Linder, 1985).

In contrast to iron, zinc is not stored by the body although in instances of excessive intakes, zinc will bind to the metallothioneins present in most cells (Linder, 1985).

2.3.3.4 Dietary and Biochemical Assessment

Very little data exist on the zinc status of Native Canadians. The two existing reports on dietary zinc intake and one report of a biochemical survey of zinc status will be discussed.

Kuhnlein (1984) reported that the mean zinc intake of 40 Nuxalk women aged 19-49 was 6 ± 2 mg. Thirty-three percent of the women consumed $\leq 2/3$ of the RNI for zinc (the RNI for zinc was 8 mg at the time of the study versus the current 9 mg) while 8% consumed $\leq 1/3$ RNI.

In contrast, the mean zinc intake of Inuit women ≥ 20 years of age from Broughton Island was approximately three times that of the Nuxalk women Four of sixty-nine Inuit women aged 20-40 years consumed $< 1/2$ RNI (8 mg zinc) while 94% consumed over the RNI. Caribou, ringed seal, narwhal mattak, and hamburger contributed the most zinc to the diet of the latter group of women (Kuhnlein, 1989b). Traditional foods contributed significantly more ($p < 0.001$) zinc to the diets of Inuit women aged 20-40 than did market foods (Kuhnlein, in prep.). Inuit men aged 20-40 years consumed an average of 28 ± 18 mg zinc, while those aged 60 and over consumed a relatively consistent mean of 20 ± 1 mg (Kuhnlein, 1989b). The RNI for zinc for adult men is currently 12 mg in comparison to the previous recommendation of 9 mg (HWC, 1983; HWC, 1990).

Using ≤ 80 mg/dl as the cut-off point for risk of low plasma zinc, Thouez et al. (1989) found that more women (16.1% and 28.4% for the Cree and Inuit respectively) than men (9.2% and 25.9% for the Cree and Inuit respectively) were at risk of low plasma zinc levels and that the Cree were at lower risk than the Inuit. No explanations were forwarded regarding these findings which seem to contradict the dietary findings of Kuhnlein (1984, 1989b) for the Nuxalk Indians and Broughton Island Inuit, although food use was not noted by Thouez et al. (1984).

Further, a relationship with sample selection and response rates cannot be excluded since these were not reported by Thouez et al. (1984).

2.3.3.5 Physiological Significance

Zinc is a constituent of over 200 metalloenzymes involved in protein, lipid, carbohydrate, alcohol, and nucleic acid metabolism. Zinc also functions in the stabilization of membranes, growth, reproduction, immune and sensory functions, and wound healing (Bach, 1981; Cousins et al., 1986; Henkin, 1984; Hicks and Wallwork, 1987; Oner et al., 1984; Sabry, 1988; Gibson, 1990).

Zinc deficiency can occur in situations of cystic fibrosis, renal or liver disease, in association with burns or alcoholism, inadequate intake, or low availability. The first report of dietary zinc deficiency was by Prasad et al. (1963) regarding male dwarfs from the Middle East. These men suffered from growth retardation, hypogonadism, anorexia, mental lethargy, and skin changes all of which were corrected by zinc supplementation. Marginal zinc deficiency is characterized by slowing of physical growth, poor appetite, and diminished taste acuity (HWC, 1990; Gibson, 1990).

The most reliable indicator of zinc status is response to zinc supplementation. The time and level of compliance required, however, make this impractical. Since serum zinc is homeostatically regulated, levels only fall in severe depletion. Infection also causes a fall in serum levels as zinc is redistributed to the liver (Gibson, 1990).

No toxicity has been reported in humans as a result of excess zinc intake although excessive intakes can compromise copper status and may impair immune function (HWC, 1990).

2.3.4 Vitamin A

2.3.4.1 General Description

Vitamin A active compounds can be categorized as being either preformed or as having provitamin A activity. In 1915, preformed "fat-soluble A" was isolated

and described by McCollum and Davis (Schwieter and Isler, 1967; Ball, 1988) Preformed vitamin A exists in three oxidation states (alcohol, aldehyde, and acid) with all-trans retinol (retinol) being the most common and most biologically active form. In nature, retinol is found primarily as esters of long chain fatty acids, particularly palmitic acid (Ball, 1988).

First detected in 1931, all-trans dehydroretinol, formerly called vitamin A_2, is reported to be the predominant form of vitamin A in the liver and flesh of freshwater fish. Based on growth studies, all-trans dehydroretinol has approximately 40% of the activity of retinol (Ball, 1988). This form of the vitamin has also been observed to a limited extent in marine fish (usually less than 10% of the total vitamin A) (Schwieter and Isler, 1967).

Due to the double-bonded nature of vitamin A, sixteen isomers of preformed vitamin A are possible; however, only three are free from steric hindrance and are thus 'preferred' in nature (Parrish et al., 1985; Ball, 1988) Formerly known as neovitamin A, 13-cis retinol is the most common isomer of retinol and possesses 75% of the biological activity of the all-trans isomer. The other two isomers are 9-cis-retinol and 9,13-di-cis-retinol with 22% and 24% of retinol's bioactivity respectively. The same isomers are proposed to exist for dehydroretinol (Schwieter and Isler, 1967; Ball, 1988). Cis-isomers can comprise as much as 35% of the vitamin A in fish liver oils (Ball, 1988).

In 1930, Moore demonstrated the provitamin A activity of B-carotene (Schwieter and Isler, 1967). Of approximately 80 naturally occurring carotenoids, only ten appear to have provitamin A activity (Roels, 1967). Of these, B-carotene is the most biologically active with approximately one-sixth the activity of retinol (Ball, 1988). The use of retinol equivalents (RE) to define the vitamin A activity of foods considers the latter fact. By definition, 1 RE is equivalent to 1 ug all-trans retinol, 6 ug B-carotene, and 12 ug of other provitamin A carotenoids (Parrish et al., 1985). Provitamin A carotenoids, present in plants and in lower forms of animal life, are the source of all preformed vitamin A in nature (Ball, 1988).

2.3.4.2 Food Sources

As will be discussed, vitamin A is stored in the liver. Consequently, this organ is an important food source of the vitamin. Beef liver contains approximately 11000 RE/100g, although Roels (1967) notes that liver retinol values vary widely even within species (HWC, 1988a). Using spectrophotometric techniques following saponification, Flores et al. (1988) found that, despite a high degree of unpredictable heterogeneity in vitamin A distribution within the liver, there was no significant difference between the mean (n = 10 regions of the liver) level of vitamin A in the liver and that of any one region.

Kidney, egg yolk, whole milk, butter, and cheese are other relatively high natural sources of vitamin A. Meat is a poor source of retinol with beef and pork containing 0-4 RE of the vitamin (Ball, 1988; HWC, 1988a). At approximately 58 RE/100g the vitamin A content of cooked moose is substantially higher than that observed for beef or pork (HWC, 1988a).

While the livers of many fish species are rich with vitamin A, the flesh of most fish, with the exception of halibut and fatty fish, have only trace amounts of the vitamin (Roels, 1967; Ball, 1988). Some fish have higher levels of vitamin A in their intestinal walls than in their livers (Roels, 1967).

In most foods, vitamin A occurs primarily as mixed esters of retinol which are typically dissolved in the fat matrix and protected from oxidation by vitamin E and other antioxidants, until the antioxidant is depleted (Ball, 1988).

With respect to provitamin A, fruits are generally unimportant sources while levels in vegetables vary widely between species (Roels, 1967; Ball, 1988; Linder, 1985). Red palm oil has the highest reported levels (30,000 RE), with carrots (2000 RE), cantaloupe (860 RE), winter squashes (850 RE), and spinach (1500 RE) being important sources in North America (Linder, 1985; Ball, 1988; HWC, 1988a). Cereals have no provitamin A carotenoids with the exception of trace levels in soybeans (Roels, 1967).

In Canada there is a mandatory vitamin A enrichment of skimmed milks, evaporated skimmed milks, margarine and similar butter-substitutes, prepared

infant formulas, and meal replacements (HWC, 1988b). For example, 100 g of margarine must not contain less than 990 RE of vitamin A while skimmed milks must contain between 360 and 750 RE (HWC, 1988b).

Boiling can lead to a 25-40% loss of vitamin A while broiling results in a vitamin A loss of less than 20%. Due to its unsaturated nature, vitamin A is prone to oxidation when heated in the presence of oxygen, or when exposed to ultraviolet light or oxidized oils. Vitamin A oxidation is catalyzed by copper and iron ions (Burt, 1988).

While the sources of vitamin A in the diet of the Dene before contact are unknown, particularly with respect to sources of provitamin A, it is evident that fish and the livers of various animals and fish were consumed (Schaefer, 1977; Hanks and Winter, 1991; HWC, 1985) (see Table 2.2 for vitamin A levels in traditional Dene foods).

Fruit, vegetables, and milk, the primary sources of vitamin A in the south, are not dependable commodities in much of the north due to the necessities of importation and adequate storage conditions (Kuhnlein, 1989b, Verdier et al., 1987b). When available, these foods are highly priced - an important consideration in a population whose average income is considered meagre (Bone, 1985).

2.3.4.3 Metabolism

Pancreatic enzymes hydrolyse dietary vitamin A esters in the small intestine (Ball, 1988). Cooking practices, dietary levels of fats, and antioxidants, as well as digestive disorders such as fat malabsorption all influence the absorption of both provitamin A and retinol (HWC, 1990; Roels, 1967). The free retinol crosses the mucosal membrane and is re-esterified, primarily with palmitate, inside the mucosal cell. In association with chylomicrons, the retinol esters are transported first in the lymph and then in the bloodstream to the liver where retinol in excess of immediate needs is stored in the parenchymal cells and non-parenchymal fat-storing cells until required (Goodman, 1984). Approximately 90-95% of the body's retinol is stored in the liver (Flores et al., 1988; Ball, 1988). Liver disease, including

alcoholic conditions, can decrease vitamin A storage (de Leenheer et al., 1988). Unlike retinol, B-carotene cannot be mobilized from the liver or other deposit sites in response to body needs for vitamin A (Ball, 1988). Mobilized retinol is bound by retinol-binding protein (RBP) which is subsequently circulated as a transthyretin-RBP complex to prevent renal filtration (Goodman, 1984; Parrish et al., 1985; Ball, 1988). Hepatic synthesis and secretion of RBP is thought to be a regulator of retinol mobilization (Goodman, 1984). Both adequate protein and zinc stores are required for retinol mobilization through their role in RBP synthesis (Linder, 1985; Gibson, 1990).

Age, sex, and race influence serum retinol levels although only age-specific interpretive criteria are currently used (Gibson, 1990).

2.3.4.4 Dietary and Biochemical Assessment

Dietary vitamin A assessment of the Dene has not yet been conducted. Of a total of 494 adult women (≥20 years) who participated in the 1975 Indian Nutrition Canada Survey, only 26 were from the Mackenzie Valley. Results of this survey noted that the dietary intakes of vitamin A by native Indians was less than those observed in the national population (HWC, 1975). The median intakes were "marginal" (500-750 RE) for all women, elderly men, children, and teenagers. Elderly women (≥55) had "inadequate" median vitamin A intakes (<500 RE). The distribution of vitamin A intakes was wide, however, with 2% of the women reporting consumptions of >5000 RE. Based on dietary data alone, Nutrition Canada concluded that the liver reserves of Indians were poor (HWC, 1975). This conclusion was premature as biochemical or clinical evidence was lacking; an additional concern with this survey was the possible bias resulting from the fact that only 30% of those initially selected participated in the survey (Hoffer et al., 1981). Further, usual intake data was not obtained.

Dietary data for Native women living in northern Manitoba (Sevenhuysen and Bogert-O'Brien, 1987), the Cree and Chipewyan people of Wood Buffalo National Park in northern Alberta (Wein et al., 1991), and for the Inuit (Verdier et

al., 1987b; Kuhnlein, 1989b) all indicate that vitamin A is one of the nutrients at highest risk for dietary inadequacy.

Sevenhuysen and Bogert-O'Brien (1987) conducted single 24 hour recalls of 73 non-pregnant, non-lactating Indian women in September and October of 1981. The mean vitamin A intake was 968 ± 129 RE with approximately half of the women consuming less than 70% of the RNI for vitamin A. Using the probability approach of Anderson et al. (1982) which recognizes that the RNI overestimates the individual requirements of most people, approximately 56% of the women were found to have vitamin A intakes which were probably inadequate. It is important to note that since vitamin A intakes exhibit very large day-to-day variations, an inadequate number of replications can lead to an overestimation of inadequate intakes even with the probability approach. This limitation is not overcome by increasing group size (Anderson et al., 1982).

The probability of inadequate vitamin A intake of 107 adult Indian women averaged over two seasons (spring and fall) was calculated to be 52% using the probability approach of Anderson et al. (1982) (Wein et al., 1991) This finding is similar to that observed by Sevenhuysen and Bogert-O'Brian (1987) despite the fact that Wein et al. (1991) conducted four 24-Hr recalls per individual. Mean vitamin A intakes ranged from a low of 561 ± 258 RE for women aged 25-49 years of age (n=38) to a high of 911 ± 1032 RE for women aged 13-24 (n=42) (Wein et al., 1991). Women aged 50 and over (n=27) had mean vitamin A intakes of 610±245 RE. These values are somewhat lower than that calculated by Sevenhuysen and Bogert-O'Brien (1987). Food usage was not reported in either study making an evaluation of possible determinants of the observed differences in mean intakes impossible.

Using food frequency data (excluding liver, kidney, meat, and fish) Verdier et al. (1987b) calculated that 24% of the vitamin A intake of Inuit from Arctic Bay was from margarine. This contrasts with 9% of vitamin A from margarine in the general Canadian population as calculated from food disappearance data. Dairy products, on the other hand, provided more vitamin A to the general population

(41%) than to the Inuit (27%) (Verdier et al., 1987b). Surprisingly, fruits and vegetables made approximately equal vitamin A contributions to the diets of both the general population and the Inuit; however, if meat, fish, kidney, and liver had been accounted for, the proportions may have been different.

A year-long series of 6 cross-sectional surveys conducted by Kuhnlein and coworkers in the Eastern Arctic revealed that Inuit women aged 20-40 consumed a mean of 653±993 RE of vitamin A (n=69) (Kuhnlein, 1989b). Women aged 41-60 ingested 925±1340 RE (n=26) while women over the age of 60 consumed 664±1197 RE of vitamin A (n=11). According to 24-HR recall data, approximately 50% of the women aged 20-40 consumed less than half of the RNI (800 RE) for women while 14% of the same group of women consumed over 100% of the RNI. Ringed seal liver and macaroni and cheese were the top two food sources of vitamin A for this group of women (Kuhnlein, 1989b). The latter finding supports the suggestion that if liver had been considered in the proportions of vitamin A derived from various sources in the study by Verdier et al. (1987b), comparisons with the general population may have had different results.

Variability in age-grouping makes comparisons of the previously noted studies difficult. However, it is evident that standard deviations in mean intakes are large and that mean intakes tend to fall below the RNI of 800 RE for women.

Gibson (1990) notes that poor agreement is often observed between the usual intake of vitamin A and the mean intake calculated from recalled intakes due to a high intra-individual variation in vitamin A intake (HWC, 1990). Further, it is important to consider that an evaluation of dietary inadequacy does not equate with physiological deficiency.

Despite indications of dietary inadequacy, no serum vitamin A levels were indicative of a high risk of deficiency (<10 ug/dl; >30 ug/dl is considered low risk) and very few were at moderate risk in the Indian Nutrition Canada Survey (HWC, 1975). Even in elderly women considered the most at risk, 90% (n=109) had serum vitamin A levels >30 ug/dl. It is known, however, that blood levels fall only after liver stores have been depleted or when protein deficiency prevents the

synthesis of RBP (HWC, 1975; Roels, 1967). The latter is not a consideration in the case of the native Indians whose serum protein levels were higher than the general population (Hoffer et al., 1981).

In a study of the James Bay Cree conducted by Hoffer et al. (1981), 10.2% of the sample had serum vitamin A levels between 10 and 30 ug/dl ("moderate" risk) while only 1.6% of the national Nutrition Canada population fell into this category. The figure of 10.2% for this sample ($n=478$, age≥ 30) is higher than that of 7.9% observed for remote-living Native Indian adults ($n=402$, age≥ 20) in the Nutrition Canada survey. Of Indians living closer to cities ($n=450$, age≥ 20) only 1.3% fell into the moderate risk category. This may reflect a greater use of milk, fruits, vegetables, and/or margarine by the latter group versus the former

In contrast, Desai and Lee (1974) found that plasma vitamin A levels of approximately 300 native Indians in the Yukon were almost all above 19 5 ug/dl, the lower acceptable limit established by the U.S. Interdepartmental Committee on Nutrition for National Defence. Their analytical technique and use of standards was not described.

A study conducted in 1949 in Sheffield, England noted that plasma retinol levels of individuals fed vitamin A deficient diets did not fall until 8 months on the diet (HWC, 1990). Even after 18 months, only 3 of the 16 participants had markedly abnormal vision. This reflects storage and mobilization of vitamin A from the liver (Moore, 1967).

It has been found that adults require approximately 400 RE of vitamin A to prevent deficiency signs; although it is imprudent to limit vitamin A intakes to such marginal levels (HWC, 1990). Occasional vitamin A intake is probably sufficient to prevent deficiency signs except in the case of disease, chlorinated hydrocarbon poisoning, or other stresses at which time marginal intakes become grossly inadequate (HWC, 1990; Zile and Malford, 1983; Moore, 1967). Maintaining adequate liver stores of retinol is thus important.

2.3.4.5 Physiological Significance

Vitamin A is most often associated with its role in vision. Other functions, not so well understood, include growth, reproduction, cellular differentiation, glycoprotein synthesis, membrane stabilization, and immune response (Gibson, 1990).

A deficiency of vitamin A results in an increased susceptibility to infection (Sommer et al., 1984; Smith and Brown, 1987), respiratory disease (Sommer et al., 1984; Thouez, 1989), and anemia (Mejia, 1985; Sommer, 1989), while eventually leading to well-established impairments of vision, reproduction, and growth.

Many vitamin A deficiency signs can be attributed to the lack of differentiation of mucous-secreting cells in membranes lining the eyes, respiratory tract, alimentary tract and urogenital tract which lose their secretory functions and become keratinized and susceptible to infection (Ball, 1988). It is thought that vitamin A has a steroid-like action on the gene expression of target cells, potentially altering the glycosylation of membrane-associated proteins which may be important to cellular differentiation, cell adhesion, and inter-cellular communication (Goodman, 1984; Zile and Malford, 1983). Vitamin A is also believed to directly influence cell-mediated immunity (Sommer et al., 1984).

Although data specific to the Dene are not available, data for the registered Indian population of Canada suggest that while morbidity and mortality due to infection and respiratory diseases are decreasing, they remain higher than for the general Canadian population (Muir et al., 1988). The five year average death rate (per 1000 population) from infectious and parasitic diseases is 0.11 for registered Indians versus 0 04 for the Canadian population (1980-1984) while the age-standardized rate for respiratory diseases is 2.2 times higher for the Indian population than the general Canadian population (Muir et al., 1988). Interestingly, despite high mean intakes of iron, anemia is a concern in some northern communities (HWC, 1975; Verdier et al., 1987a). It has been suggested that low vitamin C and folacin intakes may be implicated in this finding as might the use of group versus individual data (HWC, 1975). Another possibility, however, reflects

the finding that anemia can persevere despite adequate iron intakes if vitamin A status is deficient (Mejia, 1985; Sommer, 1989). No reports of impairments of growth, vision, or reproduction were found. While these findings do not implicate vitamin A, they do suggest an interesting line of investigation when considered together with data suggesting that vitamin A intakes and serum levels of native Indians are lower than the national average.

On the other hand, the potential for vitamin A toxicity exists once liver stores are replete since unbound retinol disrupts cell membrane integrity (Goodman, 1984). Toxicity usually only occurs with the abuse of vitamin supplements or through the consumption of the livers of animals at the top of the food chain (e g polar bear). Anorexia, blurred vision, headache, cracked and peeling skin, and bleeding lips and nose is associated with the consumption of 30,000 RE/day for several months. Rapid recovery accompanies the discontinuation of dosing Prolonged hypervitaminosis A can lead to cirrhosis of the liver and can be teratogenic (Ball, 1988).

2.3.4.6 Analytical Considerations

While HWC (1990) correctly notes that uncertainties regarding the levels of vitamin A in foods exist which make conclusions about intake difficult, certain steps can be taken to ensure the highest quality of results possible. These include the use of high performance liquid chromatography which permits the ready resolution and quantification of the majority of isomers whose vitamin A activity, even if calculated approximately, should not be overlooked (Thompson, 1986, Woolard and Indyk, 1986; Lawn et al., 1983; Parrish et al., 1985), the use of gold lights (λ >500nm), nitrogen gas, and antioxidants which can help avoid isomerization and the destruction of vitamin A (Ball, 1988; Thompson and Duval, 1990), the avoidance of acids which rearrange double bonds and lead to dehydration of the vitamin (Schwieter and Isler, 1967); and the avoidance of copper and iron which accelerate oxidative rancidity, thereby contributing to vitamin A destruction (Ball,

1988). If the form of vitamin A present in a food is unknown, or if there is more than one form present, alkaline hydrolysis is recommended. Alkaline hydrolysis is used both to break down the lipid or protein matrices stabilizing the retinol esters, and to convert the retinol esters to retinol so that saponifiable material can be discarded in the aqueous fraction (Parrish et al., 1985). The use of accurate standards is also important (Thompson and Duval, 1989). Analyses incorporating the latter factors can contribute to increased confidence in the vitamin A values used in the calculation of vitamin A intakes.

2.3 5 Polychlorinated Biphenyls

2.3.5 1 General Description

Polychlorinated biphenyls are a class of synthetic chlorinated compounds which have biphenyls as their basic structural unit (Sawhney, 1986) There are a total of 209 possible PCB isomers (congeners) which result from various chlorine substitutions on the biphenyl base.

As non-flammable, heat-resistant oils, PCBs have been used extensively in heat transfer systems and in electrical capacitors/ transformers since the 1930s. Numerous countries manufacture PCBs under various trade names including: Aroclor (United States), Clophen (West Germany), Phenoclor (Italy), Kanechlor (Japan), Pyralene (France), and Sovol (U.S.S.R.), among others (Sawhney, 1986; Cairns et al , 1986).

The first reports of PCBs in wildlife surfaced in 1966 when they were discovered in Swedish fish (Stout, 1986). Yusho Disease in humans, the result of an accident in Japan in which Kanechlor leaked from a heat exchanger into a vat of rice bran oil, became highly publicized shortly after. Regulatory intervention was initiated primarily as a result of the latter incident. Aroclor production consequently fell from 36,287 tonnes in 1970 to 4,535 tonnes in 1973 (Cairns et al., 1986; Smith and Brown, 1987).

Despite the fall in production, the ring structure and chlorinated nature of PCBs which lend them their industrially desirable qualities of stability and lipid

solubility, contributed to the creation of environmentally ubiquitous and persistent compounds. PCBs will consequently remain in the environment, and hence the food chain, until proper disposal techniques are employed world-wide

Oceans are believed to act as a major sink for PCBs It has been estimated that approximately 20% of the PCBs produced to date can be found in the ocean environment. Another 30% is in the open environment while 3 6% has been destroyed. The remainder is still in use or is in landfills (Tanabe and Tatsukawa, 1986). Long-range atmospheric and ocean current transport have been implicated in the presence of PCBs in northern waters (Muir et al , 1990, Stout, 1986)

Recent reports of elevated levels of contaminants in the tissues of polar bear focused attention on the diets of northern Native populations who traditionally rely on wild species for food (Wong, 1985) The concern was enhanced as government recommendations were to increase the consumption of wild foods versus relying on more expensive imported foods (Schaefer and Steckle, 1980)

2.3.5 2 Food Sources

"Bioaccumulation...is used to describe uptake and retention of a chemical by any mechanism or pathway" while bioconcentration is used in a more restricted sense to describe "...the uptake and retention of chemicals from the water mass through such tissues as gills or epithelial tissue" (Shaw and Connell, 1986a 122) In turn, biomagnification describes the process by which " the tissues' concentrations of bioaccumulated tissue residues increase as these materials pass up the food chain through two or more trophic levels" (Shaw and Connell, 1986b. 136).

Mammals and fish undergo "selective" PCB bioaccumulation or

bioconcentration depending on both the type of PCB and the species of organism. The degree of chlorination influences ultimate tissue concentrations of various isomers since the less chlorinated congeners are more readily degraded and excreted by the organism (Shaw and Connell, 1986a). Smaller fish, however, tend to have higher tissue levels of the lower congeners such as tetrachlorobiphenyls, possibly due to their feeding habits (Muir et al., 1988; Tanabe and Tatsukawa, 1986). Feeding habits (trophic level), sex (females excrete PCBs through lactation and placental transfer), longevity (duration of exposure), the size of the adipose compartment, and migratory patterns are also important determinants of the quantity and type of PCB present in an organism (Sawhney, 1986; Stout, 1986). While the levels of various isomers are important for considering toxicological risk, as will be discussed, it is usually the total PCB level which is reported

Through the processes of bioconcentration and biomagnification, the PCB level of the surrounding water becomes an important determinant of PCB levels in fish (Shaw and Connell, 1986a). This becomes evident when comparing PCB levels in fish from the more contaminated Great Lakes with those from the relatively less contaminated Mackenzie River. For example, Lake Michigan whitefish muscle has been recorded as containing between 1 7 and 4.4 ppm PCBs while whitefish muscle from the Mackenzie River near Tuktoyaktuk contains 0 0018 ppm of PCBs (Wong, 1985; Lockhart et al., 1989). Unfortunately, equivalent data are unavailable for the muscle of loche, a predacious bottom-feeding fish living over most of Canada (Muir et al., 1990).

While the PCB levels of the fish tested in the southern waters approach or exceed the Health Protection Branch's maximum residue limit (MRL) of 2 ug/g or 2 ppm wet weight, levels in the more northerly fish are considerably lower than the MRL (Grant, 1983). It is important to note, however, that the MRL for fish is based on an average daily consumption of 20 g/day of fillet tissue. Further, as whole fish contaminant levels are higher than those of the fillets alone, application of this level may be unreasonable for populations consuming a great deal of fish or consuming portions other than the fillets (Wong, 1985).

The same reasoning regarding usual intakes and MRLs applies to animals as well since, as was suggested earlier in the literature review, the average meat intake of the Dene is higher than that of the general Canadian population. Table 2.3 shows the average daily intakes of various food groups in a standard mixed diet together with the derived MRLs such that a PCB intake of <1 ug/kg body wt/day for an average consumer is possible (Grant, 1983)

While PCB concentrations of organisms feeding at the lower trophic levels seem to be controlled by simple bioaccumulation dependent upon the lipid content of the biota and the PCB concentration of the food or water, biomagnification appears to be the major factor contributing to PCB levels in the tissues of organisms at higher trophic levels (Shaw and Connell, 1986b) Thus, top predators may have tissue PCB concentrations 10^7 or 10^8 times the level in the ambient environment (Smith and Brown, 1987) Often, the clearest relationship between PCB concentration and trophic level is evident when wet weight PCB concentration is converted to lipid weight, since PCBs accumulate in lipoid tissue (Shaw and Connell, 1986b). With the exception of fish and eggs, MRLs for other food types are expressed on a lipid weight basis

In a study of PCBs in fatty foods in the Canadian diet, Mes et al (1989) found that PCBs levels in food composites drawn from the Ottawa and Halifax areas were highest in freshwater fish and lowest in skim milk, margarine, and soups. All of the foods tested had PCB levels less than their MRLs Some of the foods which were tested are presented with their respective fat contents, wet weight PCB levels, and lipid weight PCB levels in Table 2 4

In the case of beef flesh, it appears that simple fat content may not predict PCB levels. This may be related to the cuts of meat or grade of animal used for steak versus grinding. In addition to their lipid content, the presence of PCBs in organ meats may reflect their role in detoxification Like other animals and birds, chickens may excrete part of their body burden of PCBs into their young, explaining the presence of PCBs in eggs (Thomann et al., 1987). Similarly, milkfat (e.g. butter) is a route of PCB excretion for females (Thomann et al , 1987).

Table 2.3: Average Daily Intake and Maximum Residue Limits for Various Food Groups with Estimated PCB Intake[a]

Food	ADI[b] (g/person/day)	MRL[c] (ug/g)	PCB Intake (ug/person/day)
Fish	20	2.0[d]	40
Meat (beef)	48	0.2[e]	9.6
Dairy Products[f]	33	0.2[e]	6.6
Eggs	34	0.1[g]	3.4
Poultry	3.6	0.5[e]	1.8

[a] adapted from Grant, 1983
[b] average daily intake
[c] maximum residue limit (ug/g = mg/kg = 1000ng/g = ppm)
[d] wet weight, fillet portion
[e] lipid weight
[f] milk, cheese, butter
[g] whole weight less shell

Unfortunately, a more specific description of "cooking fats" (e.g. lard or vegetable) was not provided in the paper (Mes et al., 1989). Finally, the influence of bioconcentration, and possibly biomagnification depending on the species analyzed, is evident when comparing the PCB levels of freshwater versus marine fish.

On a wet weight basis, Kuhnlein and Kinloch (1988) noted that the PCB content of caribou flesh was 0.009 ug/g while that of its fat was 0.5 ug/g. This is in contrast to narwhal blubber's PCB content of 5.2 ug/g (Muir et al., in press). Narwhal are predacious sea mammals with a higher fat content than caribou which are herbivores and thus lower on the trophic scale. Levels of PCBs in traditional food species consumed by the Dene are presented in Table 2.2.

The influence of food preparation on the PCB content of foods was investigated in a study analyzing levels of PCBs in bluefish fillets both pre- and post-cooking. It was found that levels of PCBs post-cooking (oil and skin were

Table 2.4: PCB Levels of Fatty Canadian Foods (Wet and Lipid Weight Bases)[a]

Food	% Fat	Wet Wt PCBs (ng/g)	Lipid Wt PCBs (ng/g)
Beef steak	10.7	0.5	4.9
Ground beef	23.3	0.6	2.7
Pork, fresh	13.4	0.2	1.8
Pork, cured	22.3	0 4	2.2
Liver/Kidney	8.3	0.6	6 9
Eggs	12.6	0.7	5.2
Marine fish	2.3	3.2	140.3
Freshwater fish	6.0	21.0	349.5
Cold cuts	18.0	0.6	3.1
Cooking fats	100.0	0.2	0.2
Margarine	82.9	0.1	0.1
Butter	89.2	3.4	3.9

[a] adapted from Mes et al. (1989)

discarded) were 27% lower than in the uncooked fish. In the flesh, levels both before and after cooking were virtually identical (2.5 and 2.7 ppm respectively) due to moisture and fat losses during cooking. The authors suggest that some PCBs may also have been vaporized (Trotter et al., 1989). Variations in PCB content due to smoking and drying have not yet been reported.

The presence of PCBs in plants is poorly understood. While it is clear that the lower chlorinated biphenyls predominate, it is unknown whether they are translocated or adsorbed onto the plant surface via vapours or dust (Sawhney, 1986). Mahanty (1986) notes that an environment contaminated with low-levels of PCBs can lead to an alteration in available forms of algae. This may have a long-term effect on the food chain.

2.3.5.3 Metabolism

While the absorption of acute doses of Aroclor 1248 (3g/kg body wt) have

been estimated to be about 90% in male and female Rhesus monkeys, it is unknown how much is absorbed from chronic low-doses (Hamdy and Gooch, 1986). Similarly, whether humans respond in the same manner has not been verified. Dermal and respiratory routes of absorption are also possible (Shaw and Connell, 1986a).

A study with rats, mice, and guinea pigs found that the metabolites resulting from the animals' efforts at detoxifying PCBs are numerous and include mercapto-, methylthio-, methylsulfinyl-, and methylsulfonyl- metabolites. Using labelled methionine, the researchers discovered that the methyl group in these metabolites was derived from methionine (Mio and Sumino, 1985). Liver microsomal enzymes also produce hydroxylated metabolites (Hamdy and Gooch, 1986).

The elimination of PCBs from an organism is believed to follow an exponential curve (Stout, 1986; Hamdy and Gooch, 1986). In humans, the plateau (i.e. maximum tissue concentration) is believed to occur at 67 years (Mes, 1987). Loss of PCBs from the body is primarily through the bile (feces), although women also lose PCBs through lactation and placental transfer (Gamble, 1986; Hamdy and Gooch, 1986; Stout, 1986; Fuller and Hobson, 1986).

2.3.5.4 Dietary and Biochemical Assessment

In the late 1970s a series of publications noted that dietary levels of 100 and 200 ug/kg body wt/day resulted in reproductive dysfunction in the female Rhesus monkey (Allen et al., 1974; Allen, 1975, Barsotti et al., 1976). A 100-fold safety factor applied to the lowest observed adverse effect level (LOAEL) of 100 ug/kg body wt/day was used to derive a tolerable daily intake level (TDI) of 1 ug/kg body wt/day. This level is considered temporary pending more research (Grant, 1983).

The American "Total Diet Study" buys food four times a year at the retail level in Washington, DC and subsequently prepares the food for consumption before analyzing it. Using this market basket approach, the study found that the PCB intake of adult men and women between the years of 1982 and 1984 was

between 0.0004 and 0.0006 ug/kg body weight/day (Gunderson, 1988). Matsumoto et al. (1987) reported that individuals over the age of one year in Osaka, Japan consumed an average of 2000 g of food per day of which 2.4±1.2 ug was composed of PCBs. Similar Canadian dietary data were not available

A comprehensive year-long series of cross-sectional surveys by Kuhnlein (1989b) provides the only report of PCB intake by northern Native Canadians. The study found that Inuit women in Broughton Island aged 20-40 years had a mean daily PCB intake of 25±31 ug PCBs. This mean increased with age such that women over the age of 60 consumed 42±31 ug/day. In contrast, consumption of PCBs by men peaked between the ages of 41 and 60 years at 68±53 ug/day with men over the age of 60 consuming 32±19 ug/day. Seasonal variations in intake of sea mammals led to seasonal changes in mean PCB intake. The highest mean intakes were in September while the lowest were in March (Kuhnlein, in prep.)

Approximately 10% of women and 15% of men consumed over the TDI with the highest consumption being approximately 4 ug/kg body wt/day. While this represented an erosion of the safety factor, it was felt that it did not warrant advice to alter dietary patterns. As the weights used in the derivation of intake per kg body weight were from the Nutrition Canada Eskimo Report versus from Broughton Island itself, it is possible that they may under or overestimate actual intakes per kg body weight (Kuhnlein, 1989b).

The possibility that the intakes over the TDI may not have reflected usual intake may be revealed in the fact that of 207 blood samples taken from individuals living in Broughton Island, NWT in 1985, only 5 individuals required "action" as defined in Table 2.5 due to elevated PCB levels in their blood. Two of these individuals were pregnant women, one was a lactating woman, and two were children. The childrens' levels were both over 20 ppb while PCB levels of the pregnant and lactating women fell between 5 and 19 ppb. Age was positively correlated with PCB levels due to accumulation over the years as well as to greater PCB intake on a daily basis than younger individuals. In general, most of the individuals surveyed had PCB blood levels in the range of 5-19 ppb (Kuhnlein,

Table 2.5: Guidelines for PCBs in Blood[a]

Risk Group	Tolerable[b]	Concern[b]	Action[b]
Children (≤18)	< 5	5-19	> 20
Women (18-44)	< 5	5-99	>100
Preg/Lact Women	< 5	> 5	> 5
Men & Women ≥45	<20	20-19	>100

[a] adapted from Kuhnlein, 1989b

[b] ppb

1989b).

It is important to consider that PCB levels in non-fasted blood samples are 22-29% higher ($p<0.05$) than those of fasted samples due to serum lipid levels. When lipid levels are corrected there is a non-significant difference between the two (Phillips et al., 1989). Consequently, use of fasted or non-fasted blood should be reported as should any correction for blood lipid levels. In addition, Mes et al. (1989) found that there were time-related changes in PCB blood levels of Rhesus monkeys fed various levels of Aroclor 1254 over a period of 37 months. In contrast, adipose levels of PCBs continued to rise throughout the study period.

The presence of PCBs in breast milk will be discussed in the section on "Physiological Significance".

It is unreasonable to extrapolate the findings discussed above to other Native groups due to the high sea mammal (e.g. narwhal and seal) intake of the Inuit which, due to biomagnification, have high PCB levels in their blubber. In contrast, since most traditional Dene food sources are leaner and/or feed at lower

trophic levels, the Dene would be expected to have lower dietary intakes and blood levels of PCBs than the Inuit.

2.3.5.5 Weight Data

As comparison of PCB intake with the TDI requires an estimation of body weight, existing weight data for adult northern Native Indians will be briefly reviewed. It is important to note, however, that weight for age does not provide an estimate of body composition.

In 1958, Mann et al. conducted a health survey of Alaskan Native people (Mann et al., 1962). Although the sample sizes for the Athabaskan Indian adult age groups were small, the data are the earliest found. Women were weighed in indoor clothes while men were clothed only from the waist down. A maximum weight of 160 lbs (72.3 kg) was attained at 45-54 years (n=4) by women while those aged 20-24 (n=3) had a mean weight of 115 lbs (51.9 kg) Women 65 years and over (n=2) had an average weight of 143 lbs (64.6 kg). According to limited data, men reached their maximum weight at age 65+ (n=2) with a weight of 160 lbs (72 3 kg). Like women, men were their lightest at ages 20-24 years when they weighed 130 lbs (58.7 kg) (n=3). Men aged 45-54 weighed an average of 149 lbs (67 3 kg) (n=5) (Mann et al., 1962).

Anthropometric measurements were taken by Szathmary and Holt (1983) in the course of a study of hyperglycemia in the Dogrib people The mean weight ± SD in 59 men over the age of 21 years was found to be 66.6 ± 9 9 kg Women in the same age group (n=97) weighed an average of 58 4 ± 13.0 kg. The mean age for women was 43.5 ± 16.2 years while that for men was 46.7 ± 15.6 years. The weights for men are similar to those found by Mann et al. (1962) for the 45-54 year old age group, although the weights for women are higher in the study by Mann et al. (1962).

Between 1970 and 1972, the Nutrition Canada Survey conducted anthropometric assessments of the Canadian population. The mean weight for all ages of Canadian men was 73.1 kg while that for women was 62.3 kg. Peak

weight for Canadian males was achieved at 40-49 years while it is reached in the age group 50-59 years for Canadian women (HWC, 1980).

The Indian population surveyed consisted of 390 adult men and 559 adult women from across Canada with treaty status. As the response rate was only 30% the sample may be biased (e.g. active individuals out on the land may be missing).

The Indian population was lighter than the Canadian population up to the age of 40-49 years, after which they weighed approximately 6 kg more than the Canadian population. After the age of 70 their weight dropped again. Peak weight (72.3 ± 15.4 kg; n=91) for Indian women was reached in the same age group as that of the Canadian population although Indian men peaked (77.4 ± 13.8 kg) later than the Canadian men at 50-59 years (n=76) versus 40-49 (HWC, 1980). Of adult Indian women, those aged 20-29 years were the lightest with an average weight of 61.5 ± 13.3 kg (n=110). Similarly, Indian men aged 20-29 were the lightest with an average weight of 68.3 ± 12.2 kg (n=69).

Using data from NHANES I (1971-1974) and II (1976-1980), Frisancho (1984) derived percentiles for weight by frame size and height for U.S. adults aged 25-74 years. Males 25-54 years of age with a medium frame and a mean height of 180 cm had a median weight of 81 kg. Women 25-54 years old with a medium frame and a mean height of 165 cm had a median weight of 63 kg. A trend for increased weight with age was evident as men 55-74 years of age with a medium frame size and a mean height of 180 cm had a median weight of 84 kg. Similarly, women 55-74 years of age with a medium frame and a mean height of 165 cm had a median weight of 67 kg (Frisancho, 1984). According to height, the weights for American adults aged 25-54 are approximately equal to those observed for adult (≥19 years) Canadian women (62.7 kg) and men (79.2 kg) by Nutrition Canada (HWC, 1980). As with American women, the weight of Canadian women increased with age such that the median weight of women aged 70+ was 63.8 kg. In contrast to American men, however, the weight of Canadian men decreased with age after the age of 30 such that men aged 70+ years had a median weight of 68.7 kg (HWC, 1980). The latter values do not consider frame size or height.

Peak weights of adult Indian women were the same in the study by Mann et al. (1962) and Nutrition Canada (HWC, 1980), although ages at which weights peaked were higher in the former study (≥65 yrs) than the latter (50-59 yrs). In general, however, weights reported in Nutrition Canada are heavier than those observed by Mann et al. (1962) and Szathmary and Holt (1983) for their samples which consisted exclusively of northern Native Indians. It seems reasonable to speculate that the Hareskin may also be lighter than the Nutrition Canada Indian sample.

2.3.5.6 Physiological Significance

Reviewing data on accidental or occupational exposures is often useful in characterizing a toxicological syndrome in humans. Yusho Disease refers to a 1968 mass "PCB" poisoning in Japan as a result of the consumption of rice bran oil contaminated with Kanechlor (Kashimoto and Miyata, 1987) It was estimated that the PCB intake of each victim was in the range of 0.7 to 1.84 grams (Hsu et al., 1985). Symptoms of the disease included dermal signs (chloracne, edema, keratosis, and hyperpigmentation), ocular signs (swelling of the meibomian glands and hypersecretion of a "cheese-like" discharge from the eyes); respiratory signs (chronic bronchitis with a persistent cough); neurological signs (headache, numbness of the limbs, and diminished vision); and other signs including irregular menstrual cycles, general fatigue, and anorexia (Kashimoto amd Miyata, 1987).

Toxic by-products (polychlorinated dibenzofurans and dioxins) of incomplete thermal degradation of PCBs were later found in the oil (Lauber, 1987; Tiernan, 1985). Suggestions from occupational and animal data concur that Yusho may be symptomatically different from simple PCB poisoning. Polychlorinated dibenzofurans have recently been singled out as potentially causal (Kashimoto and Miyata, 1987).

It has been found in workers occupationally exposed to PCBs that, despite elevated levels of PCBs in the blood (mean of 40 ng/ml in one study with a range up to 920 ng/ml), only a few had mild dermal lesions such as chloracne and

hyperpigmentation (Smith and Brown, 1987). Other studies report hepatomegaly and neuropathy (sexual dysfunction, irritability, low attention span, anorexia, fatigue, lack of coordination, and numbness in the limbs (Singer, 1988; Smith and Brown, 1987).

Discontinuing the handling of contaminated substances results in a rapid disappearance of symptoms (Hara, 1985). As occupational exposure to PCBs is primarily dermal or through inhalation, the usefulness of occupational toxicity data for extrapolation to toxicity resulting from the ingestion of PCBs within a food vehicle may be limited.

Most human exposure to PCBs is more subtle than the widely publicized and complex Yusho incident or occupational exposure (Tiernan, 1985). Exposure to PCBs begins in utero as evidenced by PCB residues in both fetal tissue and amniotic fluid. Subsequent exposure is usually through breast milk, food, water, as well as the general atmosphere (Mes, 1987). Determination of a cause and effect relationship between PCBs and health status is thus even more difficult to establish for the general population.

Numerous target organs and systems have been identified for PCB toxicity including the reproductive system, neurological system, immune system, liver, and the integumentary system.

Animal studies have provided evidence of the fetotoxicity of PCBs. Of 8 rhesus monkeys on a 5.0 ppm Aroclor 1248 diet, only 6 conceived whereas all of those on a 2.5 ppm diet did. However, only 5 of the eight infants born to mothers on the lower dose diet survived although they were smaller than normal. Two of these later died of PCB intoxication. At weaning, the remaining three improved dramatically. Of the 5.0 ppm group, only one of the six who conceived had a live birth (Fuller and Hobson, 1986).

Fein et al. (1984) examined 242 newborn infants whose mothers consumed moderate quantities (6.7±5.8 kg/yr) of Lake Michigan fish and 71 control infants. On average, exposed infants were 190 g lighter than controls with a smaller head circumference in relation to birth weight and gestational age ($p<0.05$). Analysis

showed that these effects were not attributable to 37 potentially confounding variables such as maternal age, smoking, socioeconomic status, or exposure to polybrominated biphenyls (PBBs). Overall fish consumption and cord blood PCBs were correlated with a lower birth weight and a smaller head circumference However, the influence of contaminants other than PCBs (with the exception of PBBs) such as methylmercury, dioxins, and furans, (all known to be present in Great Lakes fish) on the outcome variables was not mentioned

In contrast, Taylor et al. (1984) found that once gestational age was adjusted for, the difference in birthweight between the children of exposed and non-exposed mothers became non-significant As the exposed women worked in capacitor manufacturing plants, it is possible that the discrepancy in results was due to exposure route (dermal versus oral)

Infants of monkeys exposed to 2 5 ppm Aroclor 1248 for an 18 month period ending 12 months prior to pregnancy were demonstrated to have a deficit when tested on a spatial learning and memory task (Levin et al., 1988) The infants had also been breastfed for four months before being tested at four to six years of age. They exhibited difficulties with the shorter delays suggesting an impairment in associational and attentional processes versus memory The authors suggested that innervation to the frontal campus may have been disrupted or that the hippocampus might have lesions although it was not indicated whether this was a prenatal or postnatal occurrence It is also unclear whether the attentional deficits could be attributed to a maternal reaction to the infants due to the mothers' own PCB loads Despite this ambiguity, it is important that a negative functional change was observed which could be attributed to the PCB treatment

Being a lipid-rich food secreted by the mother, breast milk is a vehicle for PCB-excretion. Serum levels in the infant may thus be two to three times that of the mother (Fuller et al., 1986).

Dewailly et al. (1989) found that the mean PCB level in breast milk of Inuit women from the east coast of Hudson Bay to be 111 3 ug/kg with a range of 16 to 514 ug/kg. The average PCB concentration for all of the countries surveyed is

37 ug/kg (Mes, 1987). However, the mean milk fat of the Inuit women was almost five times that of Caucasian women (Dewailly et al., 1989).

Dewailly et al. (1989) note the high infection rates among northern Native children relative to southern children. They postulate that compounds such as PCBs, which are immunosuppressants in animals, may be functioning postnatally to contribute to the high incidence of infection among Inuit children (Peakall, 1986; Franco et al., 1989). Takagi et al. (1989) suggest that PCBs may also act prenatally since the immune system differentiates during fetal development. Alternatively, Trizio et al. (1988) suggest that exposure to low levels of PCBs may have no effect, or may actually enhance mitogen responsiveness.

Recently, an interesting relationship has been demonstrated between PCBs and vitamin A. Bank et al. (1989) found that 1 mg/kg diet of hexachlorobiphenyls led to hepatic depletion and renal accumulation of vitamin A together with a 1.7 fold increase in serum vitamin A levels. Like the hexachlorobiphenyls, tetrachlorobiphenyls were found to cause a depletion of hepatic vitamin A levels. Unlike hexachlorobiphenyls, however, the tetrachlorobiphenyls caused a rapid and pronounced decrease in plasma retinol values within 24 hours of dosing with 1, 5, and 15 mg/kg PCBs. The effect was dose-dependent (Brouwer and van den Berg, 1983; Azais et al., 1987). It has been suggested that the tetrachlorobiphenyl breaks the transthyretin-RBP bond with subsequent filtration and loss of the retinol-RBP complex (Brouwer and van den Berg, 1986).

A study with polybrominated biphenyls yielded the same results (Cullum and Zile, 1985). These authors suggest that the alteration of vitamin A metabolism may lead to an increased vitamin A requirement which poses a health risk for populations with marginal vitamin A status. They go on to postulate that the hepatocarcinomas which may result from PCB toxicity could be the result of localized depletion of vitamin A due to the xenobiotic (Cullum and Zile, 1985; Safe, 1989).

Gamble (1986) proposed that a mechanism for PCB toxicity may be that, like other hydrophobic chemicals, PCBs bind to albumin and low density

lipoproteins for transport through the blood. They then enter the cells on these carriers. Once the host is metabolized, the PCB finds another host such as an enzyme. The binding of the PCB to the enzyme changes its function in a stimulatory or inhibitory manner depending on the conformational change produced. The PCB may also bind to macromolecules in such a way as to immobilize them. The resultant dysfunctions are proposed to explain some of the signs of PCB poisoning such as elevated liver enzymes, depressed immune function, and hepatomegaly.

Another theory is that PCBs are similar enough to steroids to "fool" the receptors to which they bind and thereby mediate their effects, perhaps through the disruption of feedback patterns (Fuller et al , 1986)

It may be argued that while risk due to specific exposure is an interesting academic question, its significance in a dynamic environment typified by the term "chemical soup" is debatable. As noted above, nutrient-contaminant interactions do exist. Wren et al. (1987) found that the kits of mink exposed to dietary methylmercury and PCBs at levels currently found in the environment (1 ppm each) had reduced survival (35.8%) versus controls (72%) If each contaminant was administered alone, there was no difference in survival rates which suggests that there is a synergistic action of methylmercury and PCBs As both of these contaminants are present in fish, it is unknown what influence they might have together on fish or on human health.

2.4 Literature Summary

Prior to contact with White culture, foods consumed by the Hareskin were obtained through active hunting, fishing, and gathering; by sharing; or by trading with other Native groups. Meat and fish consumption was high which led to a diet whose protein, iron, and zinc content was almost certainly substantial. Vitamin, mineral, and trace element intakes were also presumably adequate since, in addition to consuming plant foods, most parts of animals and fish were eaten

Food intake was seasonally determined with fish predominating in the

summer, large game and rabbits in the fall and winter, and beaver and migratory birds in the spring. Preservation of fish and meat through smoking and drying provided not only an important cache of food for times of shortage, but also a source of "out-of-season" foods for dietary diversity. Acute starvation occasionally occurred but chronic malnutrition was not evident.

Thus, under normal conditions, the pre-contact, or traditional, diet and the lifestyle associated with it is believed to have promoted nutritional and physical health. Traditional food use by the Dene also had spiritual and socio-cultural importance.

Numerous factors, based in the history of contact with White culture, have interacted to influence the contemporary Hareskin food system in ways more persuasive than would be evident if choice alone were the only impetus for change.

The diet of Native Canadians post-contact with White culture has incorporated many market foods, the majority of which are high in carbohydrates. At the same time, a decrease in the variety of traditional foods consumed has been observed.

A continuum appears to exist with respect to the relative amounts of traditional and market foods consumed. C der people and those living in more remote communities tend to consume a greater proportion of traditional foods than do young people or individuals living in a more urbanized setting.

In this manner, traditional food use continues to provide nutritional and socio-cultural benefits as well as being economically and ecologically adaptive. However, the combined use of traditional and market foods by northern Native Canadians also has positive attributes. These include food security, practicality, and nutritional diversity. As with any population's diet, however, appropriate choices must be made or sub-optimal nutritional status and, hence, health may result.

Indeed, concomitant to the rapid and dramatic post-contact dietary changes experienced by Native Canadians has been an increase in the incidence of certain

nutrition-related health conditions including obesity, diabetes, gall bladder disease, and dental caries.

The Nutrition Canada Indian Survey was one of the first attempts to establish the contemporary nutrient intake and food use patterns of Native Indians (HWC, 1975). Iron, vitamin A, calcium, and vitamin C were the nutrients found to be at highest risk in the diets of Native Indians, with women almost consistently at greater risk than men. Protein intakes were generally adequate Biochemically, iron and vitamin C levels were indicative of some degree of risk although it is important to remember that serum calcium and vitamin A levels are homeostatically regulated and consequently would not respond as quickly to dietary inadequacies. Zinc was not assessed

As the sampling protocol of the Nutrition Canada Survey was such that only about 5% of the sample came from the Mackenzie Valley Region, generalizations of overall results to Native Indians living in the Mackenzie region are tenuous

Subsequent investigators have described the dietary intakes of particular northern Indian groups. As noted in the Introduction, Appavoo (1990) investigated the diet of the Hareskin; Ritenbaugh et al. (in prep) studied the diet of the Dogrib, Wein (1989) explored the diet of Native Canadians living in northern Alberta, and Sevenhuysen and Bogert-O'Brien investigated the diet of Native women living in northern Manitoba. Hoffer et al. (1981) and Desai and Lee (1974) examined nutrition-related biochemical parameters of Native Indians living in northern Quebec and the Yukon, respectively. As in the Nutrition Canada Indian Survey, vitamins A and C, calcium, and iron were the nutrients most often found at risk in the latter studies. As vitamin A intake has high daily variation due its presence in relatively few foods, there is a tendency to overestimate the prevalence of dietary vitamin A inadequacy.

To date there were no published studies on the PCB intake of Native Indians, although a comprehensive investigation of the nutrients and contaminants (including PCBs) in the food system of the Broughton Island Inuit was conducted by Kuhnlein (1989). As the Inuit eat lipid-rich sea mammals at the top of the food

chain, their PCB intake is probably higher than that of the Dene who consume animals and fish lower both in fat and in position occupied on the trophic scale. It is important to remember that market foods are not immune from the presence of PCBs.

The literature suggests a number of reasons for studying PCBs in a northern food system. First of all, their chlorinated nature and ring structure gives PCBs stability and lipid solubility which contribute to both environmental persistence and biomagnification. Secondly, recent studies report findings of elevated levels of PCBs in loche liver, a traditional food which is much appreciated by the Dene. Finally, the concern surrounding exposure to PCBs and other contaminants has been intensified as a result of government recommendations to increase traditional food use rather than relying on high-cost foods from the south.

Kuhnlein (1989) noted that decisions on food use cannot be made on risk (e g PCB) data in isolation of benefit (e g. nutrients) considerations. For example, since many traditional foods are of animal origin, the protein, iron, and zinc contribution of traditional foods to the total diet should be considered. While protein is generally adequate in the diet of Native Canadians, iron may be at risk. Dietary zinc intake has not been assesssed in northern Native Indians. As noted, vitamin A has been found to be a nutrient at relatively high risk in the diet of many Native Canadians. Liver, a rich traditional food source of vitamin A, has also been found to be relatively high in PCBs.

Interestingly, protein, zinc, and PCBs all interact with vitamin A at the level of the liver. Protein and zinc are required for vitamin A mobilization from the liver while PCBs may increase vitamin A requirements through unclear mechanisms which are proposed to act at the level of the liver. With respect to iron and vitamin A interactions, it has been found that a compromised vitamin A status hinders the resolution of iron-deficiency anemia.

In addition, vitamin A, protein, iron, zinc, and PCBs have all been found to influence immune function. As Native populations have a higher incidence of infections than the general population, it is interesting to speculate that the nutrient

and/or contaminant levels of the diet may be implicated. Thus, the literature suggests that protein, iron, zinc, vitamin A, and PCBs form an appropriate combination for study.

3.0 RESEARCH GOAL.

From an examination of the existing literature, it was apparent that some of the wild foods consumed by the Sahtú (Hareskin) Dene/Metis are contaminated with chemical residues. While Appavoo (1990) has recently explicated the presence of toxaphene in the contemporary food system of the Hareskin, the extent of food species affected by PCBs and the levels of their contamination were unknown. Further, it was unknown whether current use of traditional foods by the Hareskin could lead to levels of PCB consumption capable of resulting in a risk of adverse health outcomes. Some evidence suggests that the FGH Hareskin have already initiated a decrease in fish consumption as a result of concerns regarding the safety of fish caught in Dehcho (Lutra Associates, 1989).

On the other hand, the extent of the nutritional benefits derived from traditional food use by the Hareskin is also unknown, although it is presumed to be significant based on existing literature. Nutritional benefits should be determined concurrent to the determination of contaminant intake as adverse health outcomes could also conceivably result from a *decrease* in traditional food consumption due to a diminishment in the nutritional quality of the diet. Addressing the concerns of the Hareskin regarding the safety of their traditional foods is therefore essential.

The goal of the overall program was to objectively address the latter issues. The ultimate aim was to provide objective data which the Dene (Hareskin) could use in a risk/benefit assessment of their traditional foods. While the multitude of benefits accrued through traditional food use was acknowledged (section 2.2.4), the objectively ascertainable nutritional benefits were the only benefits currently addressed. Through the provision of objective risk/benefit data, it was hoped that the continuation of traditional food use could be promoted to an extent which would involve minimal risk of adverse health effects from the ingestion of contaminants.

Within this mandate, the goal of this thesis was to examine the PCB intake

from traditional foods of the adult Hareskin population in relation to established guidelines. As the established guidelines express PCB intakes per unit body weight, anthropometric measurements were needed. At the same time, it was important to ascertain the contribution of selected nutrients from the same foods to the total dietary intake.

Potential seasonal variations in PCB and nutrient intake resulting from alterations in types and levels of traditional foods used were important to address Similarly, altered PCB and nutrient intake as a result of differences in level of traditional food use was an important issue to investigate. The intention behind the examination of seasonal variation and level of traditional food use was to determine whether there was a specific season or population group which held a greater risk for elevated PCB intake or inadequate nutrient intake.

Through an examination of both benefits (selected nutrients) and risks (PCBs) of traditional food use, with the added dimensions of potential modifications resulting from seasonal variation and/or level of traditional food use, it was expected that the current research would contribute to the larger program goal in three specific ways. First of all, it would provide an idea of the importance of various traditional foods in three separate seasons to the diet of the Hareskin Secondly, it would a perspective of the extent of PCB consumption by the Hareskin through traditional food use. Finally, the research would provide data on the nutrient intake of the Hareskin from both the total diet and from its components (i.e. traditional and market foods).

3.1 Objectives

In order to accomplish the goals of the current research, the following objectives were established:

1. To determine the PCB, retinol, protein, iron, and zinc concentrations (per 100 g fresh weight) in traditional food samples as consumed by the Sahtú (Hareskin) Dene/Metis;

2. To determine seasonal variations in three seasons in levels and species of traditional foods used by the Sahtú (Hareskin) Dene/Metis;

3. To determine seasonal variations in the intake of PCBs, vitamin A, protein, iron, and zinc of adult Sahtú (Hareskin) Dene/Metis living in FGH and CL from the total diet, the market food component, and the traditional food component;

4 To determine variations in the intake of PCBs, vitamin A, protein, iron, and zinc by adult Sahtú (Hareskin) Dene/Metis women living in FGH and CL from the total diet, the market food component, and the traditional food component according to level of traditional food use (i.e. high, medium, and low);

5 To determine the average weights of adult male and female Sahtú (Hareskin) Dene/Metis living in FGH and CL;

6. To determine the intake of PCBs (adult men and women) and of vitamin A, protein, iron, and zinc (adult women only) by the Sahtú (Hareskin) Dene/Metis living in FGH and CL relative to standards established by the Health Protection Branch (for PCBs) and by Health and Welfare Canada (for nutrients).

3.2 Hypotheses

It was expected that the results of the research would indicate:

1. Seasonal differences in types and amounts of traditional foods consumed did exist with the winter being the season of highest traditional food consumption (total grams) and the spring being the season with the highest diversity of traditional foods used;

2. Traditional Hareskin foods contributed a significantly larger proportion of the average Hareskin adult's (19 and over) intake of protein, iron, and zinc than did market foods;

3. There was no significant difference in the contribution to vitamin A intake of adult Hareskin women and men from traditional versus market foods;

4. The average protein, iron, and zinc intake of adult Hareskin women was greater than the RNI while that of vitamin A was less than the RNI;

5. The adult Hareskin intake of PCBs from traditional foods was within the limit proposed as tolerable (< 1 ug/kg body weight/day);

6. Hypotheses 2, 3, and 5 were true for each of the three seasons studied and for each level of traditional food use.

4.0 METHODS

The description of the methods used in this research have been divided into five major sections. The first is a statement of the ethical acceptability of, and community support for, the research. This is followed by a description of the research design. The third major section, "Food Sample Analyses", pertains to the laboratory analyses of the traditional Hareskin Dene/Metis foods and has been subdivided into five areas beginning with a description of the collection and storage of the food samples A discussion of the retinol assay which was conducted will be followed by a description of the proximate analysis, mineral analysis and, finally, the polychlorinated biphenyl analysis. The fourth major section relates to the dietary assessment which was conducted and includes subsections on interviewer training, the interviewing lists which were used, the 24-Hr recall, the traditional FFQ, and the statistical treatment of the dietary data. Finally, the fifth major section provides a discussion of the anthropometric method for weight determination which was utilized.

4.1 Ethics Approval and Community Support

McGill University certified the ethical acceptability of this project. The Government of the Northwest Territories subsequently issued a Scientific Research Licence (Number 8094) for the project.

The Dene Nation was consulted regarding the project's design and plans for implementation. Upon their approval of the project, the same consultation was held with the Band Council in FGH who likewise supported the proposed research. Numerous unsolicited statements of support for the project were voiced by residents of both FGH and CL.

4.2 Research Design

The thesis research consisted of four related components. The first involved

secondary data analysis of a series of cross-sectional dietary surveys conducted in FGH and CL in the summer (July/August) and winter (November/December) seasons of 1988. The content and execution of these surveys is more fully described in sections 4.4.3 and 4.4.4 as well as in Appavoo (1990)

The second component consisted of a further cross-sectional dietary survey of adult women which was conducted in FGH and CL in the spring (May/June) season of 1990. Once again, the details of this survey, including the sampling protocol, are provided in sections 4.4.3 and 4.4.4. Both descriptive and analytical data were required from the series of three dietary surveys

A cross-sectional determination of the weights and heights of all consenting Dene/Metis individuals in FGH and CL was carried out in the spring of 1990 Height data was provided to the Dene Nation and the NWT Department of Health for their information only and will not be discussed further in this thesis Descriptive data for body weight only was required from this third design component and was used for computing PCB intakes per kg body wt.

While the fourth component was a statistical design component and not, by definition, a research design component, it was, nonetheless, an important component of the research. Laboratory analyses of traditional food samples which were collected in each of the three field seasons (i e summer and winter 1988, spring 1990) were conducted in order to make as complete as was feasible the Dene traditional food composition database. Together with data obtained from the dietary surveys, this database was used to determine the nutrient and contaminant intakes on an age/sex group basis of the Native residents of FGH and CL

4.3 **Food Sample Analyses**

4.3.1 Food Sample Collection and Storage

4.3.1.1 Collection and Field Storage

With the assistance of three bilingual (local Slavey dialect and English) Band members experienced in traditional food use in the area, Appavoo (1990) constructed a list of traditional foods used in the communities of FGH and CL

(Table 4.1). The species type, body or plant part, and mode of preparation were noted. This list served as the basis for food sample collection in the summer and winter seasons of 1988. As the methods used to obtain the samples were described in Appavoo (1990), they will only be briefly outlined here Similar food sampling protocol was employed in the second phase of the study (i.e. late spring/early summer 1990). A list of the samples collected in each season appears in Appendix 1.

The objectives of collecting food samples in this phase of the study were first of all to fortify the existing project food composition database by collecting additional specimens of the most widely used traditional foods (caribou, moose, and whitefish); and secondly to augment the project's food composition database with data from food species for which little data exist (dried Canada Goose, raw and smoked black bear, and beaver liver). Relevant food samples were solicited through notices posted in town, messages placed on the local radio, and from specific individuals. Samples suitable for consumption were requested and monetary reimbursements were provided on a per kg basis.

Data regarding the species, weight, age, sex, harvest location and date, and general health/condition of the animal or plant (where appropriate) were collected. Information regarding any sample preparation as well as storage conditions (i.e. if frozen, how long from harvesting to freezing; length of storage; whether the sample had been previously thawed; etc...) was also solicited. When an individual selling a sample was unable to provide the needed data, the individual (if different) who harvested the sample was contacted for the information. If precise data was unknown, best estimates were requested.

Foods commonly consumed cooked were prepared by the researchers in the first phase of the study from the raw form as detailed in Appavoo (1990). The various fish and meats were baked without any additives in individual foil pouches at ca 160°C for ca 30 minutes. The entire pouch contents were then transferred to a whirlpac freezer bag and promptly frozen. In the second phase of the study, no additional preparation was undertaken for the food samples.

Table 4.1[a]: Common and Dene Names, Genus, and Species of Traditional Hareskin Foods Collected and Analyzed for Nutrients and Contaminants

Common Name	Dene Name[b]	Genus	Species
MAMMALS[c]			
Bear	sah	*Ursus*	*americanus*
Beaver	sá	*Castor*	*canadensis*
Caribou[d]	leedee	*Rangifer*	*tarandus*
Moose	líts'é	*Alces*	*alces*
Muskrat	dze	*Ondatra*	*zibethicus*
Rabbit	gah	*Lepus*	*americanus*
BIRDS[e]			
Black scoter	yawile	*Melanitta*	*nigra*
Canada goose	xah	*Branta*	*canadensis*
Ptarmigan	k'áhba	*Lagopus*	*sp.*
FISH[f]			
Cisco	lngeya	*Coregonus*	*autumnalis*
Inconnu	sih	*Stenodus*	*leucichthys*
Loche	nóhfee	*Lota*	*lota*
Pike	lóhda	*Esox*	*lucius*
Trout	bíré	*Salvelinus*	*namaycush*
Whitefish	lngewá	*Coregonus*	*clupeaformis*
WILD PLANTS[g]			
Blackberry	noht'ee	*Empetrum*	*nigrum*
Blueberry, low	jíyéwá	*Vaccinium*	*myrtilloides*
Cloudberry	dahkálé	*Rubus*	*chamaemorus*
Cranberry	lítl'é	*Vaccinium*	*vitis-idaea*
Gooseberry	dahgo	*Ribes*	*oxyancanthoides*
Raspberry	dadedele	*Rubus*	*strigosis*

[a] revised from Appavoo, 1990
[b] As identified by FGH residents fluent in Sahtú N. Slavey. Spellings are approximate.
[c] Wooding, 1982
[d] The Sahtú Dene identify two types of caribou: woodland and barrenland.
[e] Udvardy, 1985
[f] Lutra Associates, 1989
[g] Porsild, 1980

Dried meats, goose, and fish were collected in the form consumed by the household. Various pieces of the dried foods were randomly selected and frozen in whirlpac bags. Berries were collected from a minimum of 10 different plants and promptly frozen.

Once placed in whirlpac freeze' bags, the samples were labelled with the date, species (part) and preparation, the harvest location, and the name of the person packaging the sample. The samples were then placed in a household freezer where they remained until shipping to McGill University in Montreal. Dry ice shipped from Yellowknife to FGH was used to package the samples for transport to Montreal. The samples arrived still frozen on dry ice in Montreal. Wildlife export permit number 37665 was obtained from the Government of the Northwest Territories.

4.3.1.2 Laboratory Storage

Once at McGill, the samples were immediately transferred to a -20°C freezer where they remained for a maximum of 30 days until portioning for subsequent analyses. An attempt was made to make each subsample representative of the larger sample. In Phase II of the study, portioning for the other analyses was undertaken at the same time as the sample required for retinol analysis was taken for immediate digestion. Thus the more unstable retinol was spared the exposure to pro-oxidants which would occur during storage as a subsample.

As will be elaborated upon, subsamples for mineral and toxin analysis were packaged in small whirlpac bags, labelled, packed on dry ice, and sent via a courrier to the appropriate laboratory. Confirmation that they had arrived the same day was made in both cases.

Subsample sufficient for proximate analysis was packed into nalgene tubes and returned to the -20°C freezer. As will be further described, proximate analysis of the samples was completed within 4 months of subsampling. The remainder of the sample was stored under nitrogen in nalgene tubes at -20°C.

4.3.2 Retinol Analysis

Amber glassware and gold lights were used during the assay to minimize exposure of retinol in both samples and standards to visible light. Similarly, nitrogen was used where appropriate to displace oxygen from the area in direct proximity to the retinol. Care was taken to ensure that flow rates and length of nitrogen flushing were standardized in order to minimize variability due to solvent evaporation. Avoidance of other retinol-oxidizing agents (e.g. moisture, metal ions, acids, and excessive heat) was achieved through carefully planned experimental protocol.

The comprehensive and rigorous method of retinol determination described by Thompson and Duval (1989) was utilized with a few minor modifications (Figure 4.1). The changes involved the use of chicken liver homogenate as an additional standard, preparation of the monthly 13-cis retinol standard curve using HPLC-purified 13-cis retinol versus 13-cis retinal, omission of hexadecane from the extraction step upon consultation with J.N. Thompson (HWC, 1990), and omission of the daily 13-cis retinol working standard based on its time costliness versus its value as an additional check-mechanism.

4.3.2.1 Sample Storage

Virtually all of the samples collected in 1988 and analyzed for retinol had been stored under nitrogen at -20°C since the time they were portioned. The literature suggests that retinol is stable in samples stored under these conditions for periods of at least 24 weeks (Parkinson and Gal, 1972). In order to ascertain whether retinol in samples collected in 1988 but analyzed in 1990 had degraded due to prolonged storage, their retinol contents were compared to those of samples both collected and analyzed in the summer of 1990. Where possible, portions from various parts of the sample tissue had been included in the same storage container.

4.3.2.2 Digestion

Working under gold lights, 40 ml ethanolic KOH [10% KOH (BDH:B10210-34) in absolute ethanol] with 40 ml pyrogallol solution [20 g pyrogallol (BDH:B10226-34) in 1 litre absolute ethanol] added as an antioxidant were combined with a weighed portion of the food sample (ca 10 g) containing not more than 5 g of lipid. An attempt was made to include various portions of the stored sample in the weighed sample. The resulting mixture was brought to a gentle boil which was maintained for 30 minutes under water condensers.

Instances of incomplete digestion were noted and the pertinent mixture returned to the heating mantle for an additional ten minutes The latter procedure was necessary for most of the dried food products.

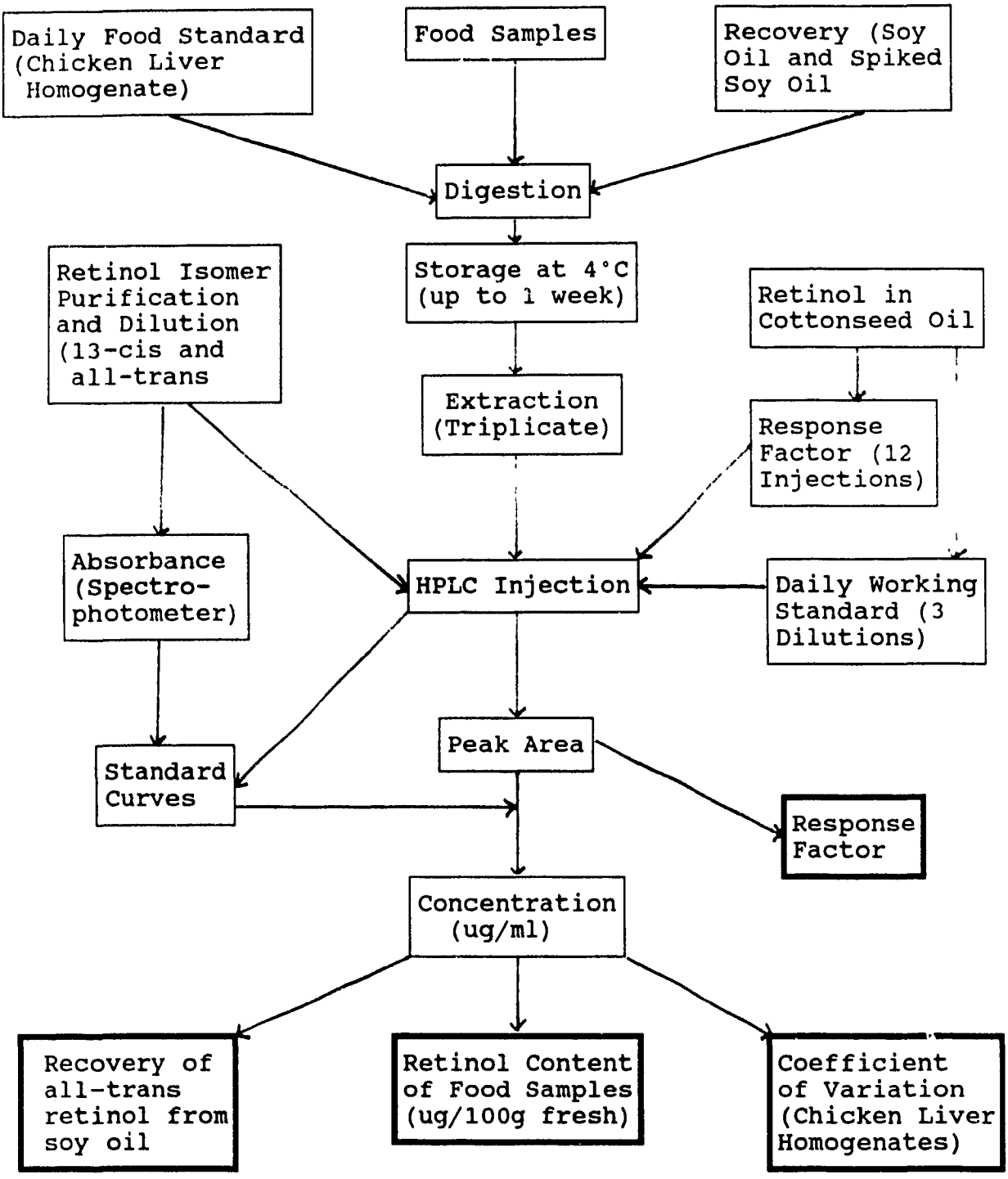
The digest was filtered through glass wool and brought up to volume with absolute ethanol in a 250 ml volumetric flask. Thompson et al. (1989) found that the digests were stable for a period of several days. Immediately prior to extraction, the flasks containing the digests were well mixed.

4.3.2.3 Extraction

Digest extraction was carried out under gold lighting with an 85:15 mixture of HPLC-grade hexane (Omnisolv BDH:B90210-81) and diethyl ether (BDH:B10094) prepared on a daily basis used as the extraction solvent. Peroxide-sensitive strips were used to ensure that the stock diethyl ether was not producing peroxides capable of retinol destruction.

The saponification resulting from alkaline digestion ensured distribution of the vitamin throughout the solution thereby justifying extraction of aliquots (Thompson et al., 1989). In 15 ml centrifuge tubes each triplicate 1.5 ml aliquot of digest, diluted with 2.5 ml of millipore water, had 7 ml of the hexane:diethyl ether mixture added. Before centrifuging, the tubes were vortexed for 30 seconds. After centrifuging at 2000 rpm for 5 minutes, the upper solvent layer was transferred with Pasteur pipets into an amber 25 ml volumetric flask while avoiding contamination by the aqueous layer. While Thompson et al. (1989) found that

Figure 4.1: Summary Schematic of Retinol Determination



maximum amounts of retinol were obtained with two extractions, three extractions were recommended for rigourousness. Thus two more extractions, each with 7 ml of hexane:diethyl ether, were conducted as per the initial extraction.

Any incidence of gelling during vortexing was noted and treated with the addition of three drops of absolute ethanol prior to centrifuging. If gelling occured during centrifugation, ethanol was added and the tube was re-centrifuged Gelling was frequently observed with liver samples.

The pooled extracts were brought up to the 25 ml mark by the addition of HPLC-grade hexane. As retinol destruction was found to occur in the presence of aqueous phase during evaporation, any contaminating aqueous material was allowed time to settle (ca 5 minutes) after inverting the flasks to mix them (Thompson et al., 1989).

Fifteen ml were then transferred from each flask to a corresponding 50 ml centrifuge tube. The tubes were placed in a 60°C water bath with a stream of nitrogen gas flowing into the tubes to promote solvent evaporation Immediately post complete evaporation, the tubes were loosely capped to retain the nitrogen and 0.5 ml of HPLC-grade heptane (Omnisolv BDH:B90189-81) was added to each tube. After heptane addition, the tubes were tightly sealed. Subsequent vortexing ensured that any retinol residue on the sides of the tubes entered the solvent.

An aliquot from each tube was transferred to a 500 ul HPLC autosampler vial using a Pasteur pipet and was immediately flushed with nitrogen and sealed.

4.3.2.4 Retinol Determination by HPLC

A Shimadzu HPLC system consisting of two pumps (LC-6A), an automated injector (SIL-6A), a 15 cm x 4.6 mm 5 micron Supelcosil LC-Si column (Supelco:S-8200, Bellefonte, PA), a variable wavelength UV-Vis absorbance detector (SPD-6AV) set at 325 nm, where absorbance is maximal (Parrish et al , 1985), a Chromatopac integrator (CR4-A), and a system controller (SCL-6A) was used in the assay.

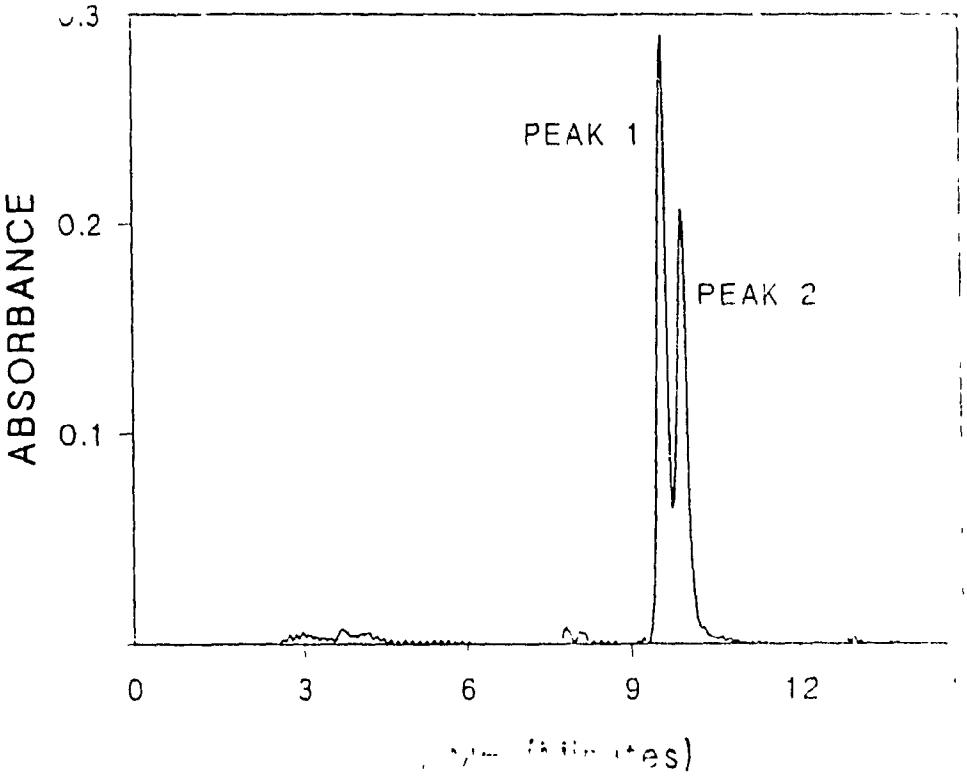
The mobile phase consisted of filtered (0.45 um ultripore nylon filters,

Chromatography Sciences Co.:110-3) and degassed HPLC-grade isopropanol (Omnisolv BDH:B90304-81) in heptane (0.6%). Using a flow rate of 2 ml/minute, 13-cis retinol and all-trans retinol were eluted at approximately 7.8 and 9.1 minutes respectively. Dr. J.N. Thompson (HWC, 1990) confirmed the identities of all-trans retinol and all-trans dehydroretinol by known elution positions and absorbance spectra (325 and 351) using a Waters Photodiode Array Detector (Model 990) (see Figures 4.2 and 4.3) (Parrish et al., 1985). Similarly, the identity of 13-cis retinol was confirmed by known elution position as well as by comparison with purified standards.

The response of the detector as measured by the standard deviation of the surface areas given by the HPLC controller ranged between 2.8% and 4.5% over a period of one month. This was determined by repeating 12 injections of a single standard solution containing roughly 1200 ug/ml of all-trans retinol (Table 4 2). As will be discussed in the next subsection, various dilutions of the standards were injected to confirm the linearity and reproducibility of the response which was measured electronically as the areas under peaks. A daily slope test was conducted to ensure correct interpretation of peak existence. Triplicate determinations of duplicate soy oil digests spiked with stock retinol in cottonseed oil indicated a recovery level of 98% (Table 4.3). This is comparable to recovery levels obtained by other laboratories using HPLC methods (Al-Abdulaly and Simpson, 1989).

Daily isopropanol blanks were injected prior to sample injection in order to ensure that the needle was clear of any residual retinol. Heptane blanks were also injected to verify that the diluting solvent was not contaminated.

For determination of the retinol content of the samples, 32 ul injections were made of the aliquot obtained in the extraction step. As described in subsection 4.3.2.7 entitled "Calculations", each 32 ul injection contained retinol equivalent to [0.0072 x weight (g) of digested sample] per ml of injected solution.



Peak 1 = all-trans retino Peak 2 = all-trans dehydr

Figure 4.3: Absorbance Spectra of Vitamin A Isomers in Loche Liver

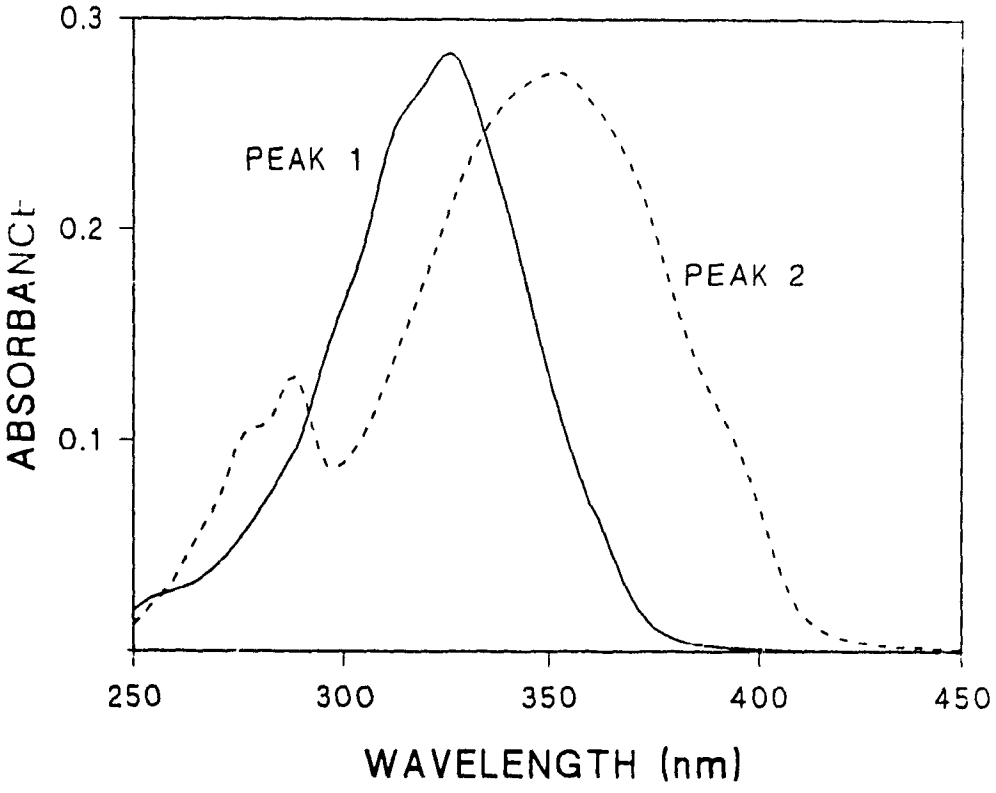


Table 4.2: HPLC Response Factor

Trial	Peak Area (uV) Mean	S.D.	C.V.	# Injec.	Source	Calculated conc.(ug/ml)[a,b]
A	7303738	202486	2.8	12	vial 1	1284
B	6360501	287036	4.5	12	vial 2	1110

[a] using a regression coefficient of 101406

[b] mean of calculated concentrations = 1197, S.D. = 87, and C.V. = 7.3%. Part of the variability is likely attributable to minor differences in retinol concentration between vials 1 and 2 since a third trial with R-CS oil from vial 2 whose aim was to clarify the source of the peak area differences between trials A and B indicated a mean peak area of 6077012 (C.V. between trials B and C = 2.3%)

4.3.2.5 Working Standards

The previously noted instability of free retinol led to the selection of a relatively stable external working standard (retinol in cottonseed oil) together with a food standard (chicken liver homogenate) for daily use.

In order to ensure that the HPLC was functioning consistently, daily injections of a working standard of retinol isomers stabilized in cottonseed oil were made. This working standard consisted of a solution of 50 mg crystalline all-trans retinol (Sigma R-7632) dissolved in 25 g cottonseed oil (Sigma C-7767). Cottonseed oil provided a lipid medium for the retinol in addition to containing gossypol, a naturally-occurring antioxidant (J.N. Thompson, pers. comm., HWC, 1989). In a stoppered 50 ml flask, the mixture was flushed with nitrogen and stirred for 24 hours using a magnetic stirrer. The retinol in cottonseed oil was then stored under nitrogen at 4°C in 5 ml amber vials capped with air tight Teflon-lined screw caps. This stock solution remained stable for about 3 or 4 months.

Daily injections of three dilutions of the working standard were made. The resulting peak areas were converted to retinol concentrations using a standard

curve constructed from purified retinol The daily results were compared in order to verify that substantial variation in HPLC performance had not occured These results were considered in conjunction with those obtained from daily analysis of a chicken liver homogenate.

Table 4.3: Retinol Recovery from Soy Oil

No.	Soy Oil (g)	R-CS Oil added (g)[a]	Mean Peak Area (uV)[b]	Calc. conc. inj. sol'n (ug/ml)[c]	Theor conc. (ug/ml)[d]	Recov. (%)[e]
1	2.07	2.9766	2943963	29.03	29.49	98.4
2	2.11	3.0814	3033011	29 91	30.53	98 0
3	2.03	0	0	0	0	0
4	2.04	0	0	0	0	0

[a] added to soy oil pre-digestion
[b] mean of triplicate aliquots from digest
[c] mean peak area/101406 (regression coefficient)
[d] 1 ml retinol in cottonseed oil = 0.933 g
0.933 g retinol in cottonseed oil was found to contain 1284 ug retinol (repeated injections of a high concentration of retinol in cottonseed oil solution); therefore 2.9766 g contains 4096 ug and 3.0814 g contains 4241 ug. Then, for example,
{[[(4096.4141/250)x1.5]/25]x15}x2 = ug/ml
[e] (calculated concentration/theoretical concentration)x100

Twelve fresh chicken livers were homogenized in a Sears 14-Speed Insta-Blend Blender. The homogenate was portioned into 17x100 mm polypropylene round-bottomed tubes with caps, flushed with nitrogen, sealed, and stored at -20°C for a maximum of 6 months. One homogenate per day was run with the samples to be analyzed. In this way, a check on the entire procedure (digestion, extraction, and HPLC determination) was provided.

4.3.2.6 Standard Curves

Standard curves for all-trans retinol and 13-cis retinol were constructed once a month using purified retinol isomers.

The curve resulting from monthly spectrophotometric (Beckman DU-40 Spectrophotometer) and HPLC readings of the purified all-trans retinol was used to determine both the all-trans retinol and all-trans dehydroretinol contents of the chicken liver homogenate, working standard, and samples Quartz cuvettes were used for spectrophotometric work.

To construct the standard curve, several 60 ul injections of 25 mg of all-trans-retinol (Sigma R-7632) dissolved in 1 ml of 1 5% isopropanol in heptane were made and the retinol peak collected. The time of peak elution was calculated by collecting 30 second fractions bracketing each side of the peak. The fractions were measured spectrophotometrically at 325 nm and the two fractions with the highest absorbance, corresponding to the central portion of the all-trans-retinol peak, were collected. Test injections were made to verify that this fraction consisted of pure all-trans-retinol

After each injection, the collected eluate was pooled into an amber flask and flushed with nitrogen. Between each injection the system was flushed with 10% isopropanol in heptane to ensure that no residual retinol isomers or contaminants remained in the column. A stable baseline at 0.6% isopropanol in heptane was re-established prior to further injections.

Ten dilutions of the pure eluate (i.e. not including the blank) were made such that the maximum expected range of retinol in the foods to be tested was slightly exceeded. The dilutions were read spectrophotometrically (further diluted when necessary for reading) and by the HPLC. Five 32 ul injections of the seven higher concentrations were made with two additional injections for the lower three concentrations - due to higher variability observed with lower concentrations (J.N. Thompson, pers.comm., HWC, 1989). A standard curve was then constructed using Lotus 1-2-3 with a resulting slope of 101406 and an R^2 value of 0.99 (Figure 4.4).

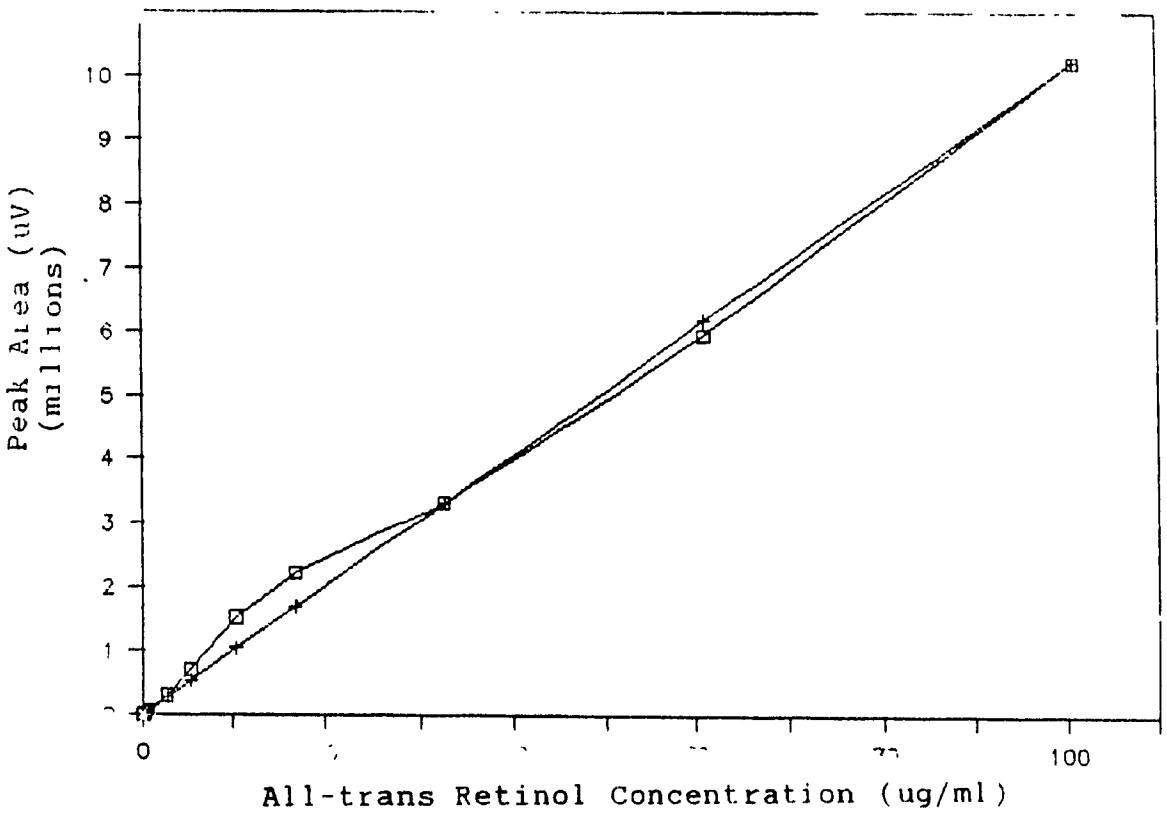
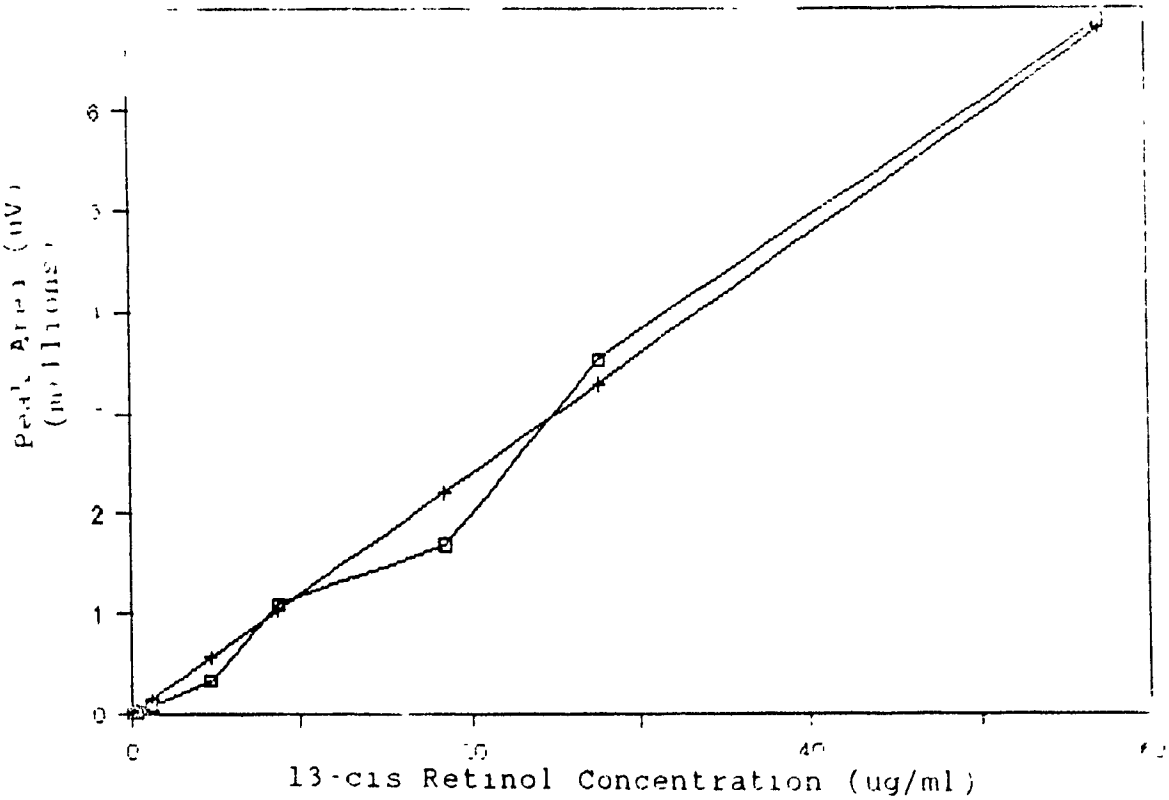


Figure 4 5: 13-cis Standard Curve



A similar protocol was followed to construct the 13-cis retinol (Sigma R-6132) standard curve (Figure 4.5) with the exception that the Beckman spectrophotometer wavelength was set at 328 nm and that five injections were used for all dilutions. The HPLC's UV-Vis absorbance detector wavelength remained at 325 nm. The resulting slope was calculated to be 119060 with an R^2 of 0.99.

4.3.2.7 Calculations

The retinol levels of the daily working standard injections were calculated through comparison of the responses to those of the standard curve as follows:

a) convert grams of retinol in cottonseed oil solution used in the preparation of the daily standard to ml:
[grams R-CS oil x 26.8 ml/25g] = ml R-CS oil solution
b) determine the dilution factor:
[vol.(ml) 0.6% isoprop.in heptane / vol.(ml) R-CS oil] + 1
c) determine the concentration of the injected solution in ug/ml:
[peak area (avg of 12) / regression coeff. from stnd curve]
d) determine the concentration of the original solution of R-CS oil:
[concentration of injected solution x dilution factor]

The calculated values were used to determine the response factor of the HPLC, the recovery level of the procedure, as well as to monitor the HPLC's daily performance.

To calculate the retinol content in 100 g of the relevant food sample, the following schematic diagram and calculations were used:

weight of digested sample (n grams)

↓

in 250 ml (0.004n g/ml)

↓

take 1.5 ml and bring up to 25 ml vol. (0.00024n g/ml)

↓

take 15 of 25 ml, evaporate and add 0.5 ml (0.0072n g/ml)

↓

inject 32 ul in HPLC (0.0072n g/ml)

a) determine retinol conc. of injected solution:
[peak area / regression coefficient] = a ug/ml
b) determine amount of retinol in injected volume:
[(a ug/ml x injected vol.(ul)) / 1000 ul/ml] = b ug
c) determine amount of fresh sample represented by injection volume:
[(injection vol. (ul) x 0.0072n g/ml) / 1000 ul/ml] = c g
d) determine the amount of retinol per 100 g fresh:
[(100ab / c)] = ug retinol per 100 g of sample

4.3.3 Proximate Analysis

Procedures identical to those utilized by Appavoo (1990) for proximate analysis (moisture, ash, protein, fat, carbohydrate, and energy) of food samples collected in the summer and winter of 1988 were used with the food samples collected in the summer of 1990.

A dried and homogenized hamburger food standard, prepared for the analyses of the samples collected in 1988 and stored in the interim in a sealed tube at -20°C, was run with the current samples to ensure comparability of results.

4.3.3.1 Moisture

The moisture content of the food samples was determined according to A.O.A.C. method 24.002 (1984). Quadruplicate portions of weighed sample (ca 10 g each) in foil boats were lyophilized in a Labconco Freeze-Dry-5 freeze drier for

24 hours. The samples were then dried to a constant weight (+/- 0.005 g on an AND analytical balance) in a VWR 1410 Vacuum Oven set at 15 p.s.i. and 60°C (ca 4 hours).

Following moisture determination, the dried sample was homogenized in a Melitta coffee grinder and stored in sealed polypropylene tubes at -20°C.

4.3.3.2 Ash

Ash analysis was conducted as per A.O.A.C. method 24.062 (1984). Previously dried and homogenized sample (ca 1 g) was placed in a dry weighed crucible. Ashing was done at 550°C for 18 hours in a Lindberg 51894 furnace. Once reaching ambient temperature in a dessicator, the ashed sample and crucible were weighed to four decimal places on an AND analytical balance. All transfers were conducted with metal forceps.

4.3.3.3 Crude Fat

Under the direction of Dr. E. Chavez, Department of Animal Science, McGill University, method 24.005 of the A.O.A.C. (1984) was used to determine the crude fat content of the food samples. After ensuring the homogenized and dried sample was at constant weight in a weighed soxhlet thimble, ether was used to extract the lipid for ca 12 hours. The soxhlet thimble and sample were subsequently dried to a constant weight at 100°C. Crude fat was calculated as the dry weight after extraction subtracted from the dry weight before extraction.

4.3.3.4 Crude Protein

A Leco FP-428 Nitrogen Determinator System (601-700-300) located at Macdonald Campus of McGill University was used for determining the crude protein content of the dried and fat-free samples. The precision of the system (coefficient of variation) is 0.5% while its sensitivity is listed as 0.001% (Leco, 1989). Under the direction of Dr. E. Chavez, the analysis was conducted according to the protocol specified by Leco (1989). A furnace temperature of 950°C (for ca

2.5 minutes) was used to release nitrogen gas from a sample weighing ca 150 mg. The nitrogen gas was detected by thermal conductivity. A factor of 6.25 was applied to convert the nitrogen content to crude protein content (Watt and Merrill, 1975).

The standards for calibration purposes were EDTA (9.59% nitrogen, Leco:502-092) for the animal tissue samples and orchard leaves (1.87 +/- 0.04% nitrogen, Leco:502-055) for the plant samples.

4.3.3.5 Carbohydrate and Energy

Formulae were used to calculate both the carbohydrate and energy levels of the samples. The carbohydrate (CHO) content of the plant and liver samples was determined by difference:

%CHO = [100 - (%moisture + %ash + %fat + %protein)]

The carbohydrate content of meat products other than liver was assumed to be zero.

Atwater factors (Watt and Merrill, 1975) were used to calculate the energy content of the food samples:

Kcal = [%pro x 4.27 (meat) or 3.36 (berries)] +
[%fat x 9.02 (meat) or 8.37 (berries)] +
[%CHO x 3.87 (liver) or 4.11 (berries)]

4.3.4 Mineral Analysis

Iron and zinc were analyzed together with other minerals by Environment Canada Laboratories in Vancouver, British Columbia, under the supervision of Dr. P. Kluckner. The portioned samples were received in a frozen state on dry ice.

Mineral analysis was conducted using inductively coupled plasma-atomic emission spectrometry according to the method outlined by McQuaker, Kluckner and Chang (1979) following perchloric acid digestion according to the method of McQuaker, Brown and Kluckner (1979). Tests of analytical precision indicated a coefficient of variation less than 5% and recovery rates of greater than 97%

(McQuaker, Kluckner, and Chang, 1979).

4.3.5 Polychlorinated Biphenyl Analysis

The Department of Fisheries and Oceans (Winnipeg, Manitoba) conducted the PCB analysis under the direction of Dr. D. Muir. The samples were received in a frozen state on dry ice and stored at -40°C until analyzed.

The lipid component of the samples was extracted with hexane. This extract was subsequently cleaned by removing co-extractive lipids on an automated gel permeation chromatograph. A column containing Florisil separated PCBs from most other organochlorine pesticides (Muir et al., 1988).

Analysis of the sample extracts was conducted using a high resolution capillary gas chromatograph with a 60 m x 0.25 mm o.d. fused silica DB-5 column.

Polychlorinated biphenyl isomers obtained from NRC laboratories in Halifax were used as external standards.

4.4 Dietary Assessment

Family traditional food frequency questionnaires and individual 24-Hr recalls were conducted in the communities of FGH and CL. An attempt was made to interview each individual and household in the two communities. The response rates for the July/August and November/December 1988 interviews as well as for the May/June 1990 interviews are indicated in Table 4.4. Reasons for non-response appear in Table 4.5.

The dietary questionnaires, interviewer training protocol, aids for enhancing interviewee recall, and methods for checking, coding, inputting, and analyzing the data used in the 1990 phase of the study were identical to those employed in 1988 as reported in Appavoo (1990). The rationale

Table 4.4 : Response Rates for Dietary Interviews

Interview	July/August 1988		November/December 1988	
	FGH	CL	FGH	Camps[d]
24-Hr[a]	316/518(61%)	46/54(85%)	286/437(65%)	38/54(70%)
FFQ[b]	77/115(67%)	12/12(100%)	70/96 (73%)	11/15(73%)

	May/June 1990	
	FGH	CL
24-Hr[c]	113/127(89%)	14/15(93%)
FFQ[b]	93/106(88%)	10/10(100%)

[a] an attempt was made to interview every individual
[b] an attempt was made to interview each family
[c] an attempt was made to interview each woman aged 19 and over
[d] outpost camps consist of families from both FGH and CL

Table 4.5: Reasons for Non-Response in Dietary Interviews

Season	Interview	Refused FGH	Refused CL[a]	Difficult to Reach FGH	Difficult to Reach CL[a]
Summer'88	24-Hr	12/518(2%)	7/54(13%)	190/518(37%)	1/54(2%)
	FFQ	2/115(2%)	0/12(0%)	36/115(31%)	0/12 (0%)
Winter'88	24-Hr	29/437(7%)	0/54(0%)	122/437(28%)	16/54(30%)
	FFQ	5/96 (5%)	0/15(0%)	21/96 (22%)	4/15(27%)
Spring'90	24-Hr	9/127(7%)	1/15(7%)	5/127(4%)	0/15 (0%)
	FFQ	8/106(7%)	0/10(0%)	5/106(5%)	0/10 (0%)

[a] For winter 1988, CL = outpost camps

behind the choice of dietary tools is described in Appavoo (1990). Essentially, the methods selected involved an acceptable compromise between the ideal and the practical. The samples interviewed in the two phases differed, as will be discussed.

In all cases, an informed consent form was read to each potential interviewee who could then either agree or refuse to participate (see Appavoo, 1990).

4.4.1 Interviewer Training

Interviewers were local Dene or Metis residents who indicated an interest in the employment position. A respected elder woman, bilingual in the local dialect of Slavey and English, was engaged to interview the women aged 50 and over in both FGH and CL.

The prospective interviewer underwent a training regimen in which they were interviewed for both the 24-Hr recall (see Appavoo, 1990) and the food frequency questionnaire (see Appavoo, 1990). The applicant was then briefed on important elements of the mock interview (e.g. encouraging unbiased responses;

providing memory cues such as naming activities or locations in which food may have been consumed; asking such questions as whether lard had been consumed with dried meat or if sugar had been added to rice, when appropriate; and using the portion size measures). The trainee was then requested to interview the trainer; upon completion of this, any comments regarding questionning style or content were made. If the applicant was still interested in the position she was given a kit containing interviewing forms and utensils.

A core of three interviewers, including the elder, conducted the interviews. Three temporary interviewers also assisted.

4.4.2 Interviewing List

In consultation with numerous informed residents and the Band Office, a current listing of each household in FGH together with the name of every woman over the age of nineteen in each household was prepared. A similar household-based list for CL was also developed. These lists served as the basis from which response rates were determined.

Adult women were chosen as the target population in phase II of the research for a number of reasons. The first is that the size of this group is sufficient for meaningful statistical treatment. Adult women are also typically more accessible for interviewing - an important consideration with the relatively short field season. Further, since women are principally responsible for food preparation in the household it was anticipated that they would be most familiar with traditional food use by the household. Further, as the literature indicated that adult women are at higher risk for inadequate nutrient intakes than adult men, the decision was made to interview the largest group at greatest nutritional risk. Households without adult female residents were not interviewed.

4.4.3 Twenty-four Hour Recalls

Individual 24-Hr recalls were conducted in order to obtain information on the nutrient and PCB intakes of various age/sex groups in different seasons. Potential

differences in nutrient and PCB intakes resulting from variations in quantity of traditional food use (high, medium, or low) were also of interest.

In the 1988 phase of the research, an attempt was made to interview all individuals in the two communities. Acknowledging that 100% participation was unlikely, effort was directed towards ensuring adequate representation of the community with respect to level of traditional food use (Appavoo, 1990).

An on-going evaluation of sample representativeness was made during the 1988 interview period using a list drawn up by three local women knowledgeable about traditional food use. These women assigned a rank of high, medium, or low to each family in the community based on their personal knowledge of family practices. High traditional food-using households were those believed to use traditional foods on a daily basis; medium households were those which used traditional foods with moderate frequency (most days); and low traditional food-using households were those perceived as using traditional foods on an infrequent basis (Appavoo, 1990).

The 1988 FGH interview sample attained was considered representative of the community with respect to this criteria since 31% of those interviewed fell into the high category, 51% into the medium, and 18% into the low as compared to the community profile of household traditional food use determined by the Band Members to be 32% high, 52% medium, and 16% low (Appavoo, 1990).

After processing the 1988 dietary data, scores from the food frequency questionnaires were used to rank households as described in the next subsection (4.4.4). Using the non-parametric Kruskal-Wallis test which provides an approximation of the Chi^2 test (SAS, 1989), Appavoo (1990) found that the household ranking determined by the Band members corresponded to that found by ranking the results of the winter food frequency questionnaires. The necessary and reasonable assumption is that individual traditional food use parallels that of the family.

In the 1990 phase of the research, the goal was to interview every adult (aged 19 or over) Dene or Metis woman in FGH and CL. Emphasis was therefore

placed on attaining high levels of community participation and support. To do this, an awareness campaign was conducted to ensure that people knew of our presence, intentions, and the fact that the research was being conducted in response to their request. The local radio station, bulletin boards, as well as word of mouth were used to distribute this message. Weekly reports on our progress were drawn up and read on the local radio in both English and Slavey

Interviewers went door-to-door and obtained consent to conduct the dietary interviews. The 24-Hr recalls requested information on everything consumed (food and drink) in a consecutive 24 hour period beginning at the time of rising on the previous day. Details regarding brand names, whether market foods were prepared according to package directions, how the food was prepared (e.g if fried, what was it fried in - butter, margarine, vegetable oil, lard, etc .), size and width of bannock consumed, any alcohol consumption or vitamin/mineral supplementation, etc. were requested

Best estimations of amounts consumed were made by the interviewee with the assistance of household measures (measuring cups and spoons), locally-purchased tumblers and bowls marked off in 125 ml gradations, and cardboard cutouts of common bannock sizes of a given width.

Upon completion, each form was checked by the author and any requests for clarification were made to the interviewer.

Coding of the market foods on the recalls was carried out according to codes used with the UCB-minilist, a nutrient database from the University of California which has been modified to include Canadian food supplementation data (UCB-Minilist, Dr. S. Murphy, 1989). Polychlorinated biphenyl levels for market foods were not added to the database as few of these foods have published values (PCB levels of selected lipid-rich market foods are reported in Mes, Newsome, and Conacher, 1989). Where codes were unavailable for a given food, the nutrient composition of the food was considered and an acceptable substitute was made from those foods available in the database; alternatively, specific ingredients of a food item were coded where appropriate.

Traditional Hareskin Dene/Metis foods whose nutrient composition had been analyzed for this project were given an original code number and their nutrient composition data were added to the modified UCB-minilist. As with the market foods, substitutions were made for the few traditional foods which were not analyzed but which infrequently appeared on recalls (e.g., pike esophagus was coded as whitefish esophagus).

All units of measurement appearing on the recall forms were converted into grams during coding.

Calculated nutrient intakes were compared against those found in the Canadian Nutrition Recommendations (1990) as well as in relevant literature on the nutrient intakes of Native Canadians. Polychlorinated biphenyl intake was compared against the Tolerable Daily Intake Level of <1 ug/kg body weight/day (Grant, 1983).

4.4.4. Traditional Food Frequency Questionnaire

The family traditional food frequency questionnaire was conducted for two basic purposes. The first was to obtain a basis for ranking families according to their level of traditional food use. Secondly, it provided an indication of the variety and extent of traditional foods being used in a given season.

In each of the three interviewing seasons, an attempt was made to interview every family in both communities. In 1988, the individual in the household who was responsible for food preparation was interviewed. In 1990, the emphasis was placed on interviewing the most elderly woman in the household in an effort to avoid replication of household food frequency questionnaires for families with more than one adult woman resident.

As noted above, the dietary methods used in 1988 and 1990 are virtually identical. Since the 1988 methods are reported in Appavoo (1990), the 1990 interviewing phase alone will be described although, as with the 24-Hr recall data, food frequency data from both phases were analyzed and discussed.

The eldest woman in the household was asked to recall the equency with

which the family had consumed the various traditional foods listed on the food frequency questionnaire (as determined in section 4.3.1.1 and as appears in Appavoo, 1990) in the preceding two month period. Unlike in the 1988 session, individuals were not required to specify family intakes on a weekly basis since some found it easier to relate intakes to other time frames which were noted and converted to intake on a weekly basis when coding. It was judged that this change did not influence the comparability of the interview periods.

Intake information regarding any foods not listed on the form was also requested. Suggestions were made for foods which may have been consumed but where were not listed such as black bear, porcupine, sucker (Catostomus commersoni), or spruce gum. If an individual was unsure of the name of a food species, the 1988 Inuvialuit Harvest Study calendar with pictures of numerous animal and fish species was shown in an attempt at clarification (IRRC, 1988).

Each traditional food species, body part, and relevant preparation technique (e.g., dried, cooked, raw) was given a unique code number. For each family, a value was placed under each food code corresponding to the number of times a family had consumed that food in an average week in the preceding two month period. If the food was not reported to be consumed, a zero was assigned; 0 2 was given for less than once per week; 1.5 corresponded to a consumption frequency of 1-2 times per week; 4 for 3-5 times per week; and 6.5 for 6-7 times per week. The total for a family was derived by adding the score under each code. This total was then used to rank the families according to their relative level of traditional food use.

Families in the top third of the distribution for traditional food frequency scores were classified as high traditional food users while those in the lowest third were classified as low traditional food users. Families falling into the middle third of the distribution were classified as medium traditional food users.

The score for each food type, added over families, was also obtained and used to tank the frequency of use of the various traditional foods. Seasonal patterns of traditional food consumption reflect the variations in food type scores

obtained in July/August and November/December 1988 and May/June 1990.

4.4.5 Statistical Treatment of Dietary Data

Once coded, the 24-Hr recall and food frequency data were entered into a Symphony spreadsheet (Lotus Corp. Release 1.2, 1986). Simultaneous coding and entering of the same interview form data by two individuals provided a means by which to check for any errors. Throughout the thesis, each individual recall was treated as a separate record.

The coded data on the Symphony spreadsheet was translated into Lotus 1-2-3 (Version 2.01) and combined with nutrient composition data from the modified UCB-minilist Version 6.03 of PC-SAS (Statistical Analysis System for Personal Computers) (SAS Institute, 1989) was then employed for the purpose of descriptively analyzing the dietary data.

In addition to generating descriptive statistics, the Statistical Analysis System (SAS Institute, 1989) was also used to conduct t-tests and analysis of variance (ANOVA). T-tests were applied to the data in order to detect any differences in contribution to nutrient intake from market versus traditional foods. Analysis of variance was conducted to assess the magnitude and significance of any association between level of traditional food use or season and the intake of various dietary components (nutrients and PCBs).

4.5 Anthropometric Assessment

An attempt was made to take the weight of each Dene or Metis individual living in FGH and CL as identified by a list drawn using the current Band and Metis Association Lists as well as the input of numerous informed residents. The response rates are shown in Table 4.6. Individuals in FGH or CL who refused measurement or who were either difficult to reach or to obtain measurement from (i.e. in a wheelchair) are noted in Table 4.7.

After obtaining permission, measurement stations were set up in FGH at the school, Elders' Home, Treaty Day ceremonies, Arctic College, the Northern store (the Bay), the Band Office, the Hunter-Trapper Association/Joint Venture Building,

and at Bingo events. Towards the end of the field season, house to house visits were also made to ensure that adequate representation was achieved. In CL, a station was set up at Mr. Bern Will Brown's "Lodge", the steps of the nursing station, and at the Co-op store. House to house visits were the source of most measurements, however.

Weight measurements were frequently converted from metric to imperial values for the respondent's own information, which contributed to some individuals gladly coming forward for measurements.

The standards used for interpretation of the results are the Nutrition Canada Anthropometry Report (1980) as well as the relevant existing literature

4.5.1 Weight

Using a Seca Electronic Balance (Model alpha 770, capacity 200 kg with 0 1 kg divisions), individual weights were taken three times to the first decimal place and averaged. Very occasionally this number was decreased to one or two measurements when time or respondent needs dictated. It is unlikely that this fact led to the formation of unreliable data since repeat measurements were usually identical; the age/sex group mean was the value to be derived and utilized, and finally, the weights were a best estimate since the weight of clothing (trousers, shirt, and undergarments) was not deducted. No shoes, jackets, hats, or extra shirts were worn during weighing.

Table 4.6: Weight Response Rates for FGH and CL

Age (Yrs)	Sex	Fort Good Hope Weight	Colville Lake Weight
<4[a]	M	4/16(25%)	3/3(100%)
<4[a]	F	9/20(45%)	4/4(100%)
4-10[b]	M	32/47(68%)	2/2(100%)
4-10[b]	F	39/46(85%)	5/5(100%)
10-19[c]	M	37/56(66%)	3/3(100%)
10-19[c]	F	40/47(85%)	5/5(100%)
19-35[d]	M	62/71(88%)	6/6(100%)
19-35[d]	F	49/63(78%)	5/5(100%)
35-50[e]	M	27/37(73%)	3/3(100%)
35-50[e]	F	17/30(57%)	3/3(100%)
>50[f]	M	27/42(64%)	9/10(90%)
>50[f]	F	25/44(57%)	6/7 (86%)
TOTAL		368/519(71%)	54/56(96%)

[a] born June 15, 1986 or later
[b] born between and including June 16, 1980 and June 14, 1986
[c] born between and including June 16, 1971 and June 15, 1980
[d] born between and including June 16, 1955 and June 15, 1971
[e] born between and including June 16, 1940 and June 15, 1955
[f] born before and including June 14, 1940

Table 4.7: Weight Non-Response Rates for FGH and CL

Age (Yrs)	Sex	FGH Weight Refused	FGH Weight Missing[a]	CL Weight Refused	CL Weight Missing[a]
<4[b]	M	0/16(0%)	12/16(75%)	0/3(0%)	0/3(0%)
<4[b]	F	0/20(0%)	11/20(55%)	0/4(0%)	0/4(0%)
4-10[c]	M	0/47(0%)	15/47(32%)	0/2(0%)	0/2(0%)
4-10[c]	F	0/46(0%)	7/46(15%)	0/5(0%)	0/5(0%)
10-19[d]	M	2/56(4%)	17/56(30%)	0/3(0%)	0/3(0%)
10-19[d]	F	4/47(9%)	3/47(6%)	0/5(0%)	0/5(0%)
19-35[e]	M	3/71(4%)	6/71(8%)	0/6(0%)	0/6(0%)
19-35[e]	F	5/63(8%)	9/63(14%)	0/5(0%)	0/5(0%)
35-50[f]	M	5/37(14%)	5/37(14%)	0/3(0%)	0/3(0%)
35-50[f]	F	7/30(23%)	6/30(20%)	0/3(0%)	0/3(0%)
>50[g]	M	4/42(10%)	11/42(26%)	0/10(0%)	1/10(10%)
>50[g]	F	8/44(18%)	11/44(25%)	1/7(14%)	0/7(0%)
TOTAL		38/519(7%)	113/519(22%)	1/56(2%)	1/56(2%)

[a] difficult to reach/obtain
[b] born June 15, 1986 or later
[c] born between and including June 16, 1980 and June 14, 1986
[d] born between and including June 16, 1971 and June 15, 1980
[e] born between and including June 16, 1955 and June 15, 1971
[f] born between and including June 16, 1940 and June 15, 1955
[g] born before and including June 14, 1940

5.0 RESULTS AND DISCUSSION

5.1 The Contemporary Diet of the Sahtú (Hareskin) Dene/Metis

5.1.1 Energy Intake

5.1.1.1 Dietary Energy from Protein, Fat, and Carbohydrate

As calculated from 24-Hr recall data using Atwater factors (energy from protein and fat were calculated directly while that from carbohydrate was calculated by difference), the proportion of dietary energy derived from protein, fat, and carbohydrate by adult women living in FGH was consistent over the summer and winter seasons at approximately 35%, 34%, and 30%, respectively. Energy data were not analyzed statistically due to their descriptive role in this thesis. In the spring season, the energy derived by the same women from protein and fat was only 2% lower in each case than that obtained in the other seasons, while that derived from carbohydrate made up the difference by contributing approximately 4% more than in the other seasons to dietary energy intake (see Table 5.1).

TABLE 5.1 : Proportion of Total Dietary Energy from Protein, Fat and Carbohydrate by Season (Adult Women)

	Protein	Fat	Carbohydrate
FGH			
Summer (n=81)	35.6%	34.5%[a]	29.9%
Winter (n=82)	35.5%	34.1%[a]	30.4%
Spring (n=113)	33.0%	32.6%	34.4%
CL			
Summer (n=10)[b]	50.5%	28.7%	20.8%
Winter (n=10)[b]	57.8%	21.2%	21.0%
Spring (n=14)	37.0%	29.0%	34.0%

[a] From Appavoo, 1990
[b] Outpost camps

A different pattern was observed for adult women in CL. Energy intake from protein was highest in the winter at almost 58% of total energy consumed. In the summer, this value decreased somewhat to approximately half of the energy consumed and decreased again in the spring to 37%. Energy contributions from fat were approximately equal in the summer and spring seasons at 29%, while that of the winter was lower at 21%. Carbohydrates contributed 21% of total energy consumed in the summer and winter and 34% in the spring (see Table 5.1).

Adult women's energy contribution from the three macronutrients was most similar for the two communities in the spring season. Lutra Associates (1989) commented on the fact that spring break-up in Colville Lake heralded a decrease in wild food consumption due to difficulties in access as well as safety considerations. Hence, high carbohydrate market foods were consumed since frozen and canned meats were not generally consumed in the village due to the lack of electricity (the Co-op store and some homes had generators) or to concerns regarding the health value of canned food products.

The high energy intake of women from protein in the winter hunting campus can be explained by the fact that much of the food consumed was wild meats and fish. The leanness of wild meats was reflected in the fact that while energy intake from protein was high, that from fat was relatively low. It would be interesting to calculate the energy intake from protein and fat based on food composition data for species caught in the season of study since the values noted above reflect calculations from food composition data which were averaged over the three study seasons. The possibility exists that fat contribution to energy intake may be even lower in the late winter due to fat-depletion of animals and fish (Speth and Spielmann, 1983). It is important to note that some of the women interviewed in the camps were FGH residents.

In general, the proportion of energy from protein, fat, and carbohydrate for adult women in FGH was similar to that found by Ritenbaugh et al. (in preparation) for the Dogrib. However, slightly more energy from protein and fat, and slightly less from carbohydrate was evident for the Hareskin. In contrast, the protein-

derived energy intake of both the general Canadian population and the Native Canadian population studied by Wein et al. (1991) in northern Alberta was 1/3 to 1/2 that of FGH adult women. Further, the general Canadian population consumed slightly more energy from fat and approximately 2/5 more energy from carbohydrate than did adult women from FGH (Sabry, 1988).

TABLE 5.2: Proportion of Energy Intake from Traditional and Market Foods by Season (Adult Women)

	Season		
	Summer	Winter	Spring
FGH	(n=81)	(n=82)	(n=113)
Trad	30%	30%	28%
Mkt	70%	70%	72%
CL	(n=10)	(n=10)[a]	(n=14)
Trad	69%	66%	44%
Mkt	31%	34%	56%

[a] Outpost camps

5.1.1.2 Energy Intake from Traditional and Market Foods

Over the three seasons examined, the proportion of energy derived from market (70%) and traditional (30%) foods remained remarkably consistent for adult women living in FGH (see Table 5.2). In CL, however, seasonal proportions varied with spring having the lowest proportion of energy intake from traditional foods (44%) and summer having the highest (69%). Energy intake from traditional foods in the winter was close behind that of the summer at 66%.

Both FGH and CL women were found to consume a higher proportion of energy from traditional foods than was the Dogrib population studied by

Ritenbaugh et al. (in preparation).

In the summer and winter seasons, the proportion of energy derived from traditional versus market foods was almost reversed for CL and FGH. Colville Lake is more remote than FGH with a consequent decrease in access to diverse market foods. In contrast, the access of CL residents to traditional foods was enhanced Variations in food availability and remote/urban factors have been cited as determinants of traditional food use (Kuhnlein, 1989a; Ritenbaugh et al., in preparation).

The possibility that total amounts of energy consumed may not have changed concomitant to alterations in the proportion of energy derived from traditional versus market foods is refuted by data presented in Table 5.3. While the mean total energy intake of adult women from FGH remained relatively consistent over the seasons at approximately 2000 kcal (4368 kJ), that of women in CL was seen to vary with the season; being lowest in the spring (1560 kcal or 6527 kJ) and highest in the winter hunting camps (3425 kcal or 14330 kj). For both FGH and CL, the mean energy intake from market foods was consistent over the seasons although the contribution to total energy intake was higher in FGH than CL as would be expected from Table 5.2. Thus, variations in energy intake for CL women are primarily attributable to variations in traditional food intake. Wide variations in individual energy intakes existed for each season and community as evident in Table 5.3.

The mean energy intake of adult Native Canadian women (25-49 yrs of age) studied by Wein et al. (1991) was 1654 ± 465 kcal. At 2179 ± 705 kcal, adult Inuit women (20-40 yrs) studied by Kuhnlein (in press) had a higher mean energy intake than the women studied by Wein et al. (1991). The energy intake calculated by Kuhnlein (1989) for the Inuit is closer to the values calculated for the Hareskin than those of Wein et al. (1991). As calculations regarding the proportion of energy intake from traditional foods were not presented in Wein et al. (1991), it is difficult to propose a reason for the discrepancy in energy intakes. However, it is possible that traditional food use is not as high for the group studied by Wein et al. (1991),

TABLE 5.3: Seasonal Differences in Dietary Energy Intake (kcal)[a] from Traditional and Market Foods and Total Diet (Adult Women)

	Mean ± S.D.	Range
FGH		
Summer (n=81)		
Trad	553 ± 592	0 - 2156
Mkt	1318 ± 648	197 - 3389
Total	1871 ± 890	397 - 4983
Winter (n=82)		
Trad	665 ± 840	0 - 4848
Mkt	1549 ± 1029	186 - 5832
Total	2214 ± 1291	186 - 7295
Spring (n=113)		
Trad	583 ± 667	0 - 3030
Mkt	1493 ± 1120	93 - 6527
Total	2076 ± 1167	324 - 7730
CL		
Summer (n=10)		
Trad	2046 ± 1897	0 - 6572
Mkt	931 ± 630	84 - 2187
Total	2977 ± 1637	1017 - 6656
Winter (n=10)[b]		
Trad	2265 ± 1786	322 - 5804
Mkt	1160 ± 847	100 - 3236
Total	3425 ± 1456	1654 - 6092
Spring (n=14)		
Trad	686 ± 357	0 - 1270
Mkt	874 ± 960	40 - 3141
Total	1560 ± 1144	173 - 4135

[a] kj=kcal x 4.184
[b] Outpost camps

thus energy expended on hunting, and hence energy need, would not be as great. This suggestion is supported by the fact that a maximum of 18% of energy for this group is derived from protein. In the current study, calculations for energy intake

were not made on the basis of age as the energy values were intended solely as supplementary data for describing the contemporary Hareskin diet.

5.1.1.3 Contribution of Various Foods to Energy Intake

In each of the three seasons in both communities a traditional food item was the most important contributor to the energy intake of adult women (Tables 5.4 and 5.5). In FGH, moose was the most important contributor to the energy intake of adult women in the summer as determined by percent contribution to total energy intake. Similarly, barrenland caribou was the most important source in the winter. Black scoter assumed this role in the spring. In each season, moose was one of the ten most important contributors to energy intake. With respect to market foods, white sugar was the most important market food source of energy for adult women in FGH in each season studied. Similarly, lard, bannock, hamburger, and white bread appeared in the ten most important contributors for each season in FGH (Table 5.4).

In CL, fish was the most important food source of energy in each season. The importance of fish in the diet of CL residents was noted by Lutra Associates (1989). In summer, smoked/dried whitefish predominated while in the winter and spring, trout was the most important source. The relatively high lipid content of dried fish as compared to baked fish is responsible for the number one ranking of smoked/dried whitefish in the summer. In each season, barrenland caribou appeared in the list of the ten most important foods contributing to the energy intake of CL women. Lard was the most important market food contributor to energy intake in the summer, while bannock predominated in the winter and spring. Other than bannock, no other market food was a consistently important contributor (i.e. in the top ten) to energy intake (Table 5.5).

The predominance of traditional foods and high carbohydrate market foods in the diet of CL women is evident in Table 5.5. There was a substantial difference in the percentage contribution to total intake for the first one or two foods when

Table 5.4: Ten Most Important Food Sources of Energy (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	% Total[a]
4132	Moose, baked	13.7
2230	Sugar, white	8.5
416	Bannock/Biscuits, baked	6.1
1241	Lard	5.8
461	Bread, white	5.3
4110	Inconnu, baked	5.1
370	Beef, hamburger	2.7
974	Eggs, boiled	2.6
1789	Potatoes, fried	2.3
505	Butter	2.2
	Total =	54.3

Fort Good Hope - Winter (n=82)

Food Code	Food	% Total
4150	Caribou (B), baked	13.3
2230	Sugar, white	9.0
1241	Lard	8.3
4132	Moose, baked	6.1
4164	Rabbit, boiled	4.3
461	Bread, white	4.1
416	Bannock/Biscuits, baked	3.8
370	Beef, hamburger	3.1
126	Bacon, fried	2.8
974	Eggs, boiled	2.7
	Total =	57.5

Fort Good Hope - Spring (n=113)

Food Code	Food	% Total
4174	Black scoter/ducks, baked	8.4
4141	Caribou (W), baked	5.3
2230	Sugar, white	4.8
461	Bread, white	4.7
370	Beef, hamburger	4.6
1252	Powdered drinks, prepared	4.2
4132	Moose, baked	4.0
416	Bannock/Biscuits, baked	3.9
1241	Lard	3.6
1683	Pork, lean	3.0
	Total =	46.5

[a] percent contribution from each food to total energy intake

Table 5.5: Ten Most Important Food Sources of Energy (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	% Total[a]
4203	Whitefish (CL), smk/dry	29.6
4202	Whitefish (CL), baked	17.3
4150	Caribou (B), baked	15.8
4174	Black scoter/ducks, baked	5.3
1241	Lard	4.8
1324	Milk, evaporated canned	4.7
2230	Sugar, white	4.1
416	Bannock/Biscuits, baked	3.3
1252	Powdered drinks, prepared	2.0
1788	Potatoes, boiled	1.4
	Total =	88.3

Outpost Camps - Winter (n=10)

Food Code	Food	% Total
4217	Trout, baked	17.9
4150	Caribou (B), baked	10.6
416	Bannock/Biscuits, baked	10.5
4164	Rabbit, boiled	10.5
4141	Caribou (W), baked	9.4
4132	Moose, baked	7.9
1241	Lard	5.7
4202	Whitefish (CL), baked	5.6
4140	Caribou, dried	4.2
1391	Oatmeal, boiled	4.1
	Total =	86.4

Colville Lake - Spring (n=11)

Food Code	Food	% Total
4217	Trout, baked	19.2
416	Bannock/Biscuits, baked	18.6
4202	Whitefish (CL), baked	8.7
4150	Caribou (B), baked	5.5
587	Chocolate	4.5
4174	Black scoter, baked	4.2
1391	Oatmeal, boiled	3.4
2165	Spaghetti, meatballs&tomato sauce	3.4
2230	Sugar, white	3.2
505	Butter	3.1
	Total =	69.6

[a] percent contribution from each food to total energy intake

compared to the rest. In contrast, there was evidence of the use of market meats and eggs, in addition to traditional foods and high carbohydrate market foods, in the diets of FGH women (Table 5.4). Differences in percentage contributions to total energy intake from various food items were not as defined as was seen for CL. Further, the percent of the total energy intake accounted for by the ten foods listed was relatively low in FGH as compared to CL.

For Inuit women aged 20-40, Kuhnlein (1989b) found that bannock was the most important contributor to energy intake with seal, caribou, hamburger, and crackers following in descending order of importance. The high use of lard observed with the Hareskin was not apparent in the Inuit. This may reflect the presence of high lipid traditional foods such as blubber in the diet of the Inuit.

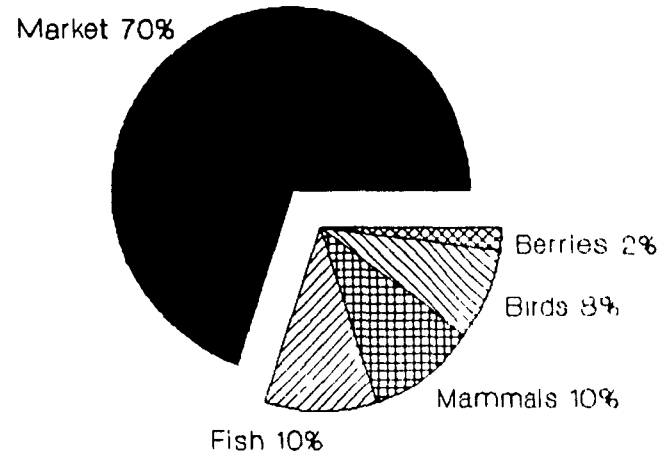
5.1.2 Use of Traditional Food Species

Using family food frequency scores, the proportion of each type of traditional food (i.e. mammal, fish, bird, or berry) used in a given season was calculated. For descriptive purposes, the results were placed in the context of energy contribution from traditional versus market foods as calculated from the 24-hour recalls of individual women. The FFQ data was then translated into fractions of the traditional food energy component (Figures 5.1 to 5.6).

In this manner, it was found that there was an equal use of mammals and fish in the summer in FGH (Figure 5.1). Moose, followed by caribou, rabbit, and beaver were the important mammals consumed. Major fish species utilized included whitefish, cisco, and inconnu as determined by both 24-Hr recall and FFQ responses (Appavoo, 1990) (see Appendix 3).

Mammals were found to comprise the highest percentage of traditional foods consumed in both the winter and the spring seasons in FGH (Figures 5.2 and 5.3). In the winter, caribou, moose, and rabbit were the predominant mammals consumed as determined by both FFQ and 24-Hr recall ranking (Appavoo, 1990) (see Appendix 4). Fish use in the winter in FGH was half that of mammals, with whitefish and loche being the two fish species consumed.

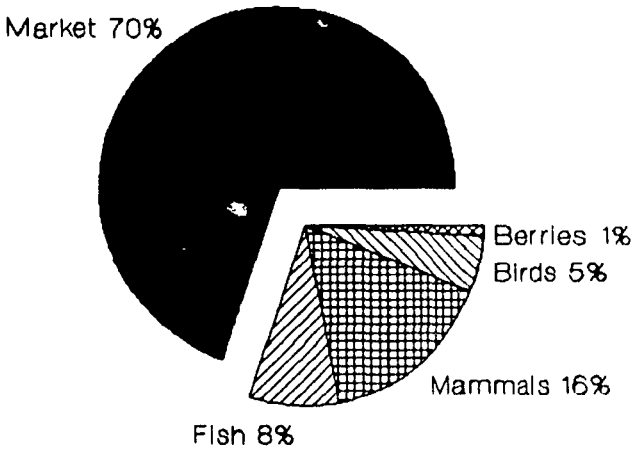
Figure 5.1: Use of Traditional Food Types
(as a % of Total Energy Intake)[1]



FGH - Summer

[1] **Adult Women**

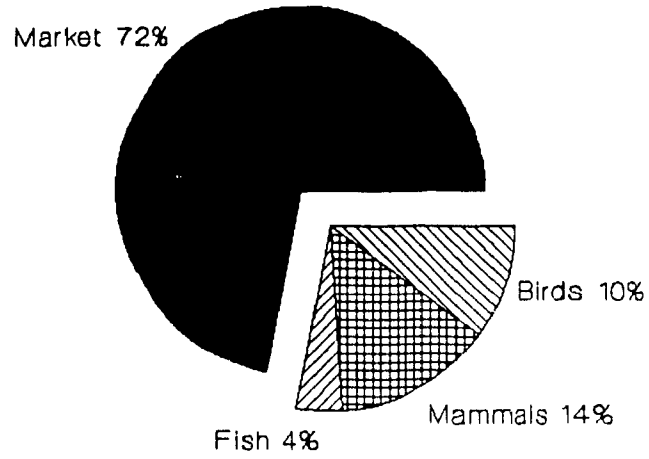
Figure 5.2: Use of Traditional Food Types
(as a % of Total Energy Intake)[1]



FGH - Winter

[1] **Adult Women**

Figure 5.3: Use of Traditional Food Types (as a % of Total Energy Intake)[1]



FGH - Spring

[1] Adult Women

According to both FFQ and 24-Hr recall data, caribou, moose, beaver, and rabbit were the primary mammals consumed in the spring in FGH (see Appendix 5). Spring use of birds was twice that of the winter as determined by FFQ data. Black scoter was the main bird used. Other duck species and Canada goose, including smoked/dried goose, were also consumed.

While the use of berries was reported on FGH or CL FFQ forms in the summer and winter seasons, berry use was not noted on 24-Hr recall forms in the winter. Blueberries and cloudberries were most commonly recorded on both types of forms (Appavoo, 1990). As berries were out of season, the spring FFQ forms did not mention the use of berries.

Although CL women consumed a greater proportion of energy from traditional foods than FGH women, their 24-Hr recalls did not report the same

variety of traditional foods used by FGH women in each season (see Appendices 3 to 8). This may be due to the smaller number of recalls in a shorter space of time obtained for CL residents. Colville Lake residents, however, had a much greater seasonal variation in the proportions of the various categories of traditional food types used (Figures 5.4, 5.5, and 5.6). In the summer, fish were the predominant food type used with whitefish and, to some extent, trout being the fish species consumed (Figure 5.4). Caribou was the only mammal reported to be consumed in CL on the summer 24-Hr recalls although the FFQ suggested a limited use of moose. Black scoter was also consumed in the summer to a certain extent (Appavoo, 1990) (see Appendix 6).

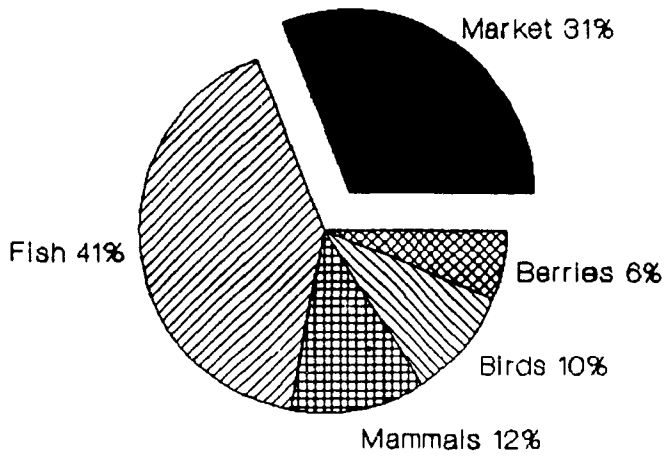
Mammal use in CL was highest in the winter with caribou, moose, and rabbit being the most used species (Figure 5.5). As in FGH, fish use in CL in the winter was approximately half that of mammal use, with trout and whitefish being the two fish species consumed (Appavoo, 1990) (see Appendix 7).

In the spring in CL, mammals are reported to be the most frequently used food type, followed by fish and birds (Figure 5.6). On the 24-Hr recalls, however, fish (trout, whitefish, and loche) use was the most prevalent with caribou being the only mammal, and black scoter the only bird, reported to be consumed (see Appendix 8). This discrepancy may result from the fact that the FFQ reports family food use while the 24-Hr recall records individual data. More importantly, the FFQ records average intakes over the preceding two month period while the 24-Hr recalls for CL were conducted over a consecutive two day period. The latter factor was probably the more important factor due to the lack of ability to obtain an idea of usual group intakes over such a short time frame (Gibson,1987). Table 5.6 provides an indication of the variation in weight (grams) of traditional food consumed per season in each community. Colville Lake had a consistently higher mean traditional food intake on a weight basis, although the ranges of intakes were relatively consistent between communities. Once again, spring was seen to

be the season of lowest traditional food use in CL (491 ± 299 grams). On a weight basis, summer was the season of lowest traditional food consumption in FGH (351 ± 352 grams), although there was only a 10 gram difference between the mean intakes in the summer and spring. Winter in both communities was the season of highest traditional food use both on a weight basis and a participation basis (i.e. % Consuming). In CI, the mean winter traditional food intake was 1647 ± 1386 grams while that of FGH is 474 ± 528 grams.

The mean traditional food weights reported essentially reflected flesh consumption (meat and fish) with the exception of FGH summer in which blueberries and cloudberries contributed 8 grams to the mean traditional

Figure 5.4: Use of Traditional Food Types (as a % of Total Energy Intake)[1]

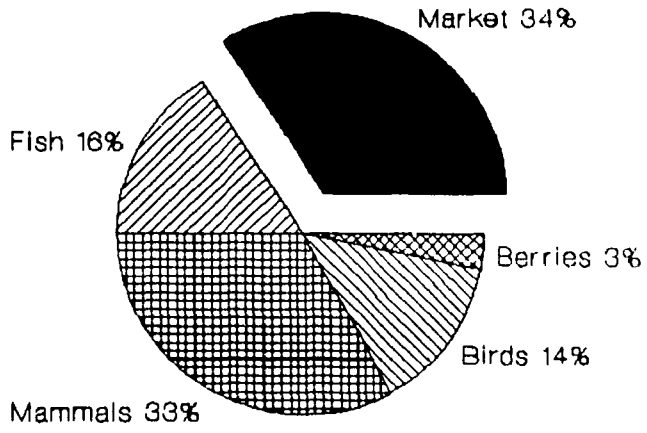


CL - Summer

[1] **Adult Women**

food intake. Thus, the intake of meat and fish by the Hareskin was very high relative to the Canadian and Nutrition Canada averages (Sabry, 1988; HWC, 1977).

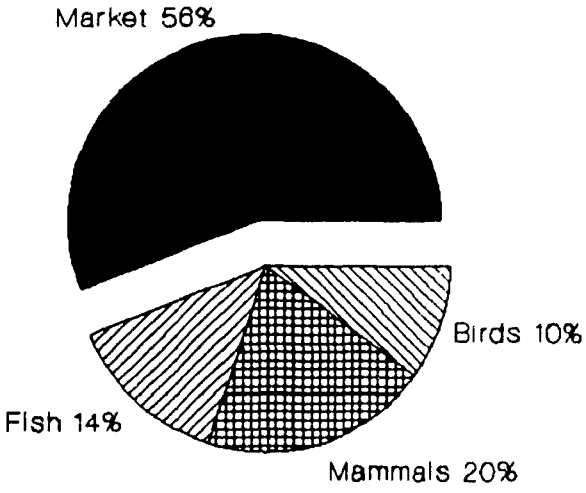
Figure 5.5: Use of Traditional Food Species (as % Traditional Food Energy Intake[1])



CL - Winter

[1] Adult Women

Figure 5.6: Use of Traditional Food Species (as % Traditional Food Energy Intake[1])



CL - Spring

[1] Adult Women

The difference in sample size in the spring season was not expected to be a source of significant seasonal variation since the individuals interviewed had a wide range of ages and consumed variable amounts of traditional foods.

5.1.3 Use of Market Foods

As is apparent from Appendices 3 to 8, tea and coffee were the most widely consumed market items. As they have little energy or nutritional value but a high fresh weight, they were deducted during calculations of market food intake presented (Table 5.6).

All FGH women reported consuming market foods while some CL women did not report consuming any. The higher market food consumption on a weight basis in the spring in FGH versus other seasons is attributable to an elevated intake of sweetened powdered beverages such as Tang. Once these items were eliminated, mean market food intake (grams) equalized among seasons in FGH. It is unclear whether the increased use of powdered beverages reflects a seasonal difference or a secular change. At approximately 650 grams, the mean market food intake in CL was less than that of FGH women and was remarkably consistent between seasons.

As observed by Ritenbaugh et al. (in prep), Kuhnlein (1989b), and Young (1988), white sugar, potatoes, white bread, bannock, eggs, soups, carbonated and powdered beverages, evaporated milk, lard, and oatmeal were important market foods by both weight and number of mentions on 24-Hr recalls (% Consuming).

5.2 Protein, Iron, and Zinc Intake

5.2.1 Protein

5.2.1.1 Protein Intake from Traditional and Market Foods by Season

Using paired difference t-tests between the protein contribution of traditional and market foods to the diets of the same women per season, traditional foods were found to contribute significantly more ($p=0.0001$) to the average daily protein intake of women and men in both FGH and CL than were market foods (Table 5.7).

Table 5.6 : Average Daily Traditional and Market[1] Food Intake (g fresh wt) of Adult Women According to Season

- Fort Good Hope -

	% Consuming	Range[2]	Consumers Mean±SD	Total Mean±SD
Summer (n=81)				
Traditional	70	50- 1375	499± 320	351± 352
Market	100	74- 2438	823± 495	823± 495
Winter (n=82)				
Traditional	76	125- 2750	627± 522	474± 528
Market	100	40- 3355	849± 567	849± 567
Spring (n=113)				
Traditional	71	5- 1850	511± 415	361± 419
Market	100	16-10160	1069±1213	1069±1213

- Colville Lake -

	% Consuming	Range[2]	Consumers Mean±SD	Total Mean±SD
Summer (n=10)				
Traditional	90	120- 2807	1159± 904	1043± 926
Market	90	78- 1763	659± 519	593± 531
Winter (n=10)				
Traditional	100	250- 4500	1647±1386	1647±1386
Market	80	318- 1265	690± 301	552± 385
Spring (n=14)				
Traditional	93	190- 1000	528± 277	491± 299
Market	93	18- 2146	630± 574	585± 576

[1] not including the low-energy, highly consumed beverages tea and coffee but retaining added sugar/milk/coffee mate

[2] including values >0 only

Through the use of Duncan's Multiple Range Test, significant differences (α=0.05) in the seasonal intake of protein from traditional food sources were found for men from FGH and for women from CL (Table 5.7). In each case, winter was the season of highest protein intake while the summer for FGH men, and spring for CL women, were the seasons of lowest protein intake from traditional foods. It is possible that if spring intake of traditional foods had been included for men, protein intakes of CL men would have shown a seasonal difference as well. The absence of spring data for men has likely also led to a calculated average protein intake which is not reflective of actual intake on a yearly basis. Women from CL showed the only statistically significant (α=0.05) seasonal variation in total protein intake, with the spring being the season of lowest protein intake (154 $\pm$ 91 grams), and the winter (considering the intakes of both FGH and CL residents at the outpost hunting camps) being the season of highest protein intake (464 $\pm$ 318 grams).

It is possible that high standard deviations masked seasonal differences for FGH women as a trend towards higher winter intake of protein is evident in Table 5.7. Interestingly, while there was no difference between the intake of protein in the spring and summer for FGH women, CL women consumed significantly less protein in the spring than in the summer. Once again, this was presumed to reflect the diminished use of traditional foods in CL during spring break-up (Lutra Associates, 1989).

No significant seasonal differences in protein intake from market foods were found for either sex in either community. Although not statistically analyzed, there was a trend towards a higher intake of protein from market foods by FGH men and women versus those from CL and a converse trend towards a higher protein intake from traditional foods by CL men and women as compared to those from FGH. Even in the spring, when their protein intake from traditional foods was at its lowest point, CL women consumed more protein from traditional foods than FGH women in either the summer or the spring, and approximately equal protein to that

of FGH women in the winter. This finding reinforced the notion of the higher use of traditional foods in the more remote community of CL relative to FGH.

Although men were seen to consume more total grams of protein than women (Table 5.7), this difference may not be evident if intakes were expressed on either a nutrient density or body size basis (Gibson, 1990; HWC, 1990).

The average protein intakes of men and women from FGH were higher than those reported by Wein et al. (1991) for Native Canadians in northern Alberta and by Sevenhuysen et al. (1987) for Native Canadians in northern Manitoba, and similar to those observed by Kuhnlein (1989) for the Inuit of Broughton Island. The results for CL, however, were substantially higher than those of any known reports for any other Native group in Canada.

5.2.1.2 Seasonal Contribution of Foods to Protein Intake

Total grams of each food reported in all of the 24-Hr recalls of adult women were ranked for purposes of illustrating the relative importance of various food items to protein intake. Moose was found to be the primary source of protein in the summer for adult women in FGH (Table 5.8). Inconnu was the secondary source of dietary protein, contributing approximately one third the protein obtained from moose. Pork chops ranked third.

In the winter, barrenland caribou was the most important source of protein for FGH women, followed by moose and rabbit. Black scoter contributed the most to protein intake in the spring, followed by woodland caribou, moose, and beaver. Eggs, hamburger, and chicken, appearing in the list of the ten most important food sources of protein in each season, were less important sources of protein (Table 5.8).

Fish (whitefish and/or trout), followed by caribou were the primary food sources of protein in each season in CL (Table 5.9). Following fish and caribou, black scoter contributed to the protein intake of adult women in the summer and spring seasons, while rabbit assumed this role in the winter. Each traditional food item consumed by adult women in CL in the summer is present in the list of the

TABLE 5.7: Differences in Mean Daily Protein Intake (g) from Traditional and Market Foods with a Simultaneous Comparison of Mean Adult Intakes Across Seasons

- Fort Good Hope -

Women	Summer (n=81)	Winter (n=82)	Spring (n=113)	Avg (n=276)
Trad	***106±114[a]	***136±166[a]	***106±123[a]	***115±135
Mkt	51± 36[a]	48± 45[a]	54± 57[a]	51± 48
Total	156±110[a]	184±177[a]	160±118[a]	166±136

Men	Summer (n=74)	Winter (n=68)	Avg (n=142)
Trad	**124±126[b]	***188±193[a]	***155±164
Mkt	70± 81[a]	61± 71[a]	66± 76
Total	195±125[a]	249±208[a]	221±172

- Colville Lake -

Women	Summer (n=10)	Winter+ (n=10)	Spring (n=14)	Avg (n=34)
Trad	*332±308[ab]	***442±331[a]	***135± 76[b]	***275±279
Mkt	20± 20[a]	22± 16[a]	19± 22[a]	20± 20
Total	352±294[ab]	464±318[a]	154± 91[b]	296±272

Men	Summer (n=17)	Winter+ (n=15)	Avg (n=32)
Trad	***326±237[a]	***710±736[a]	***506±558
Mkt	40± 37[a]	34± 23[a]	37± 31
Total	366±221[a]	743±737[a]	543±554

* = a significant difference (paired difference t-test) between mean protein intake from traditional and market foods for each season and gender ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
NS = a non-significant difference (paired difference t-test) between mean traditional and market protein intakes
a,b = different letter superscripts across rows indicate significant seasonal variation in mean protein intake (average values not included) ($\alpha=0.05$)
\+ = outpost camps

ten most important contributors to protein intake.

Due to the low consumption of market sources of animal protein and the fact that less than ten varieties of traditional foods were reported to be consumed, the high carbohydrate foods oatmeal, biscuits, and spaghetti appear in the list of the ten most important contributors to protein intake in the winter and spring seasons in CL (Table 5.9). Although their levels of consumption are low, evaporated milk appears on the list of the ten most important contributors to protein intake in the summer and spring, while chicken, beef, and luncheon meats appeared on the summer list only. As seen in Appendix 7, bacon was reported to be consumed by one woman in the winter. It is unclear whether the lack of market meat consumption by CL women in the spring was a seasonal difference, perhaps due to difficulties in importing foods, or whether it represented a secular change (i.e. a change in overall consumption patterns which occurred between 1988 and 1990). Unlike FGH, the ten foods listed for their contribution to the protein intake of adult women in CL accounted for virtually all of the protein consumed (Tables 5.8 and 5.9).

5.2.2 Iron

5.2.2.1 Iron Intake from Traditional and Market Foods by Season

As with protein, traditional foods contributed significantly more ($p \leq 0.005$) to the average iron intake of men and women in FGH and CL than did market foods Intake from supplements was not considered (Table 5.10). However, unlike protein, traditional foods were not found to contribute significantly greater amounts of iron in every case. There was no difference in iron intake between traditional and market foods in the summer for FGH men and the spring for CL women In the case of the men from FGH, this may be attributable to the high standard deviation calculated for the mean intake. For women from CL, the diminished use of traditional foods in general, and of animal flesh in particular, likely contributed to the lower iron intake observed in the spring season. As fish flesh had a lower level of iron than animal flesh, as is clear from Appendix 2, the

Table 5.8: Ten Most Important Food Sources of Protein (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	Total g *
4132	Moose, baked	4514
4110	Inconnu, baked	1391
1683	Pork, chops	643
4254	Moose, dried/smoked	618
4117	Cisco, baked	468
747	Chicken, baked	421
4102	Whitefish (FGH), baked	390
370	Beef, hamburger	344
974	Eggs, boiled	305
353	Beef, round	296
	% Total:	74.2

Fort Good Hope - Winter (n=82)

Food Code	Food	Total g
4150	Caribou (B), baked	4872
4132	Moose, baked	2389
4164	Rabbit, boiled	1648
4102	Whitefish (FGH), baked	851
4103	Whitefish (FGH), smoked/dried	542
370	Beef, hamburger	475
4127	Loche, baked	434
974	Eggs, boiled	368
747	Chicken, baked	338
126	Bacon, fried	269
	% Total:	80.8

Fort Good Hope - Spring (n=113)

Food Code	Food	Total g
4174	Black scoter/ducks, baked	3283
4141	Caribou (W), baked	2591
4132	Moose, baked	2027
4159	Beaver, baked	1234
4164	Rabbit, boiled	925
370	Beef, hamburger	912
1683	Pork, chops	806
689	Chicken, fried	703
4150	Caribou (B), baked	554
974	Eggs, boiled	513
	% Total:	74.8

* = total g reported on all 24-Hr recalls/season

Table 5.9: Ten Most Important Food Sources of Protein (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	Total g *
4203	Whitefish (CL), smk/dry	1251
4150	Caribou (B), baked	953
4202	Whitefish (CL), baked	812
4174	Black scoter/ducks, baked	264
1324	Milk, evaporated canned	70
4140	Caribou, dried	44
689	Chicken, fried	32
353	Beef, round	24
416	Bannock/Biscuits, baked	21
1999	Luncheon meats	10
	% Total:	98.9

Outpost Camps - Winter (n=10)

Food Code	Food	Total g
4217	Trout, baked	1011
4164	Rabbit, boiled	766
4150	Caribou (B), baked	735
4141	Caribou (W), baked	669
4132	Moose, baked	587
4140	Caribou, dried	301
4202	Whitefish (CL), baked	301
416	Bannock/Biscuits, baked	79
1391	Oatmeal, boiled	59
4254	Moose, smoked/dried	49
	% Total:	98.2

Colville Lake - Spring (n=14)

Food Code	Food	Total g
4217	Trout, baked	692
4202	Whitefish (CL), baked	301
4150	Caribou (B), baked	242
4174	Black scoter/ducks, baked	152
4203	Whitefish (CL), smoked/dry	118
4211	Loche, baked	106
416	Bannock/Biscuits, baked	89
2165	Spaghetti, meatballs&tomato sauce	41
1391	Oatmeal, boiled	31
1324	Milk, evaporated canned	26
	% Total:	95.0

* = total g reported on all 24-Hr recalls/season

iron intake of CL women was likely lower due to the consumption of a relatively low-energy fish-based diet (see Table 5.3 and Appendix 8).

No differences in iron intake from market foods across the seasons were found to exist for any group (Table 5.10). Further, traditional and total iron intake for FGH men showed no seasonal differences. Once again, this may be attributable to the high standard deviations in intake. With the exception of FGH men, winter was consistently the season of highest total and traditional food-derived iron intake ($\alpha = 0.05$). For FGH women, there was no significant difference between mean total and traditional food-derived iron intakes in the winter and the spring. The latter finding is probably due to the high mammal consumption in the winter and spring relative to the summer in FGH (see section 5.1.2).

The iron intakes of the Inuit studied by Kuhnlein (1989b) were higher than those found in the current study of the Hareskin, with the exception of men and women in the winter hunting camps. The high mammal flesh consumption in conjunction with the relatively high iron content of traditional meats is presumed to be responsible for the latter exception. The relatively high iron content of seal meat is likely partially responsible for the high iron intakes observed by Kuhnlein (1989b). As with protein, the iron intakes for men and women calculated by Wein et al. (1991) and Sevenhuysen and Bogert-O'Brien (1987) were lower than those found in the current study.

5.2.2.2 Seasonal Contribution of Foods to Iron Intake

Consistent with its relatively low iron content (e.g. whitefish has a mean iron content of between 0.34 and 0.63 mg/100g), fish did not appear in the list of ten major foods contributing to the iron intake of adult women in FGH (Table 5.11) (see Appendix 2). Moose contributed the overwhelming proportion of iron consumed in the summer season, while caribou was the primary source in the winter. Black scoter, followed by caribou, moose, and beaver were the primary contributors to iron intake in the spring. Black scoter had a mean iron content of 8.1 mg/100g while that of moose was 5.1 mg/100g (see Appendix 2).

TABLE 5.10: Differences in Mean Daily Iron Intake (mg) from Traditional and Market Foods with a Simultaneous Comparison of Mean Adult Intakes Across Seasons

- Fort Good Hope -

Women	Summer (n=81)	Winter (n=82)	Spring (n=113)	Avg (n=276)
Trad	*12.2±18.1^{b}	***18.8±24.4^{ab}	***20.4±25.8^{a}	***17.5±23.5
Mkt	8.0± 4.9^{a}	8.6± 6.1^{a}	8.6± 7.2^{a}	8.4± 6.3
Total	20.2±18.8^{b}	27.3±25.8^{a}	29.0±24.5^{a}	25.9±23.6

Men	Summer (n=74)	Winter (n=68)	Avg (n=142)
Trad	^{NS}18.7±34.7^{a}	***26.8±35.0^{a}	***22.6±34.9
Mkt	10.9± 8.2^{a}	10.3± 9.1^{a}	10.6± 8.6
Total	29.6±33.3^{a}	37.1±37.6^{a}	33.2±35.5

- Colville Lake -

Women	Summer (n=10)	Winter+ (n=10)	Spring (n=14)	Avg (n=34)
Trad	*28.0±26.8^{b}	**57.8±44.7^{a}	^{NS}8.1±8.0^{b}	***28.6±34.7
Mkt	3.3± 3.2^{a}	6.1± 4.7^{a}	5.1±6.3^{a}	4.9± 5.1
Total	31.3±25.8^{b}	63.8±42.8^{a}	13.2±10.6^{b}	33.4±34.3

Men	Summer (n=17)	Winter+ (n=15)	Avg (n=32)
Trad	*27.4±28.7^{b}	***79.0±65.4^{a}	***51.6±55.1
Mkt	8.7± 7.4^{a}	10.1± 6.9^{a}	9.4± 7.1
Total	36.1±27.1^{b}	89.1±65.7^{a}	61.0±55.2

* = a significant difference (paired difference t-test) between mean iron intake from traditional and market foods for each season and gender ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
^{NS} = a non-significant difference (paired difference t-test) between mean traditional and market iron intakes
^{a,b} = different letter superscripts across rows indicate significant seasonal variation in mean iron intake (average values not included) ($\alpha = 0.05$)
\+ = outpost camps

Bread, bannock, and enriched cereals appeared in the list of the ten most important contributors to iron intake in FGH due to their mandatory enrichment with iron as discussed in section 2.3.2 of the literature review. The high consumption of coffee contributed to its presence as a relatively important contributor to iron intake despite its very low iron content (HWC, 1988a). Market sources of animal protein, such as beef, eggs, and pork also appeared in the list of top ten contributors to iron intake of FGH women.

Table 5.12 reinforces the suggestion of the relatively low contribution of fish to iron intake. Despite the fact that fish forms the majority of traditional food intake by weight in CL, caribou, rabbit and black scoter are the predominant sources of iron in each season (Table 5.12; Appendices 6 to 8). Due to its high level of consumption fish did, however, appear on the list of ten major foods contributing to iron intake for each season, thereby supporting the nutritionally important role fish plays in the diet of CL residents in particular.

As with FGH, enriched market foods contribute to the iron content of the diets of CL women, particularly in the spring season (Table 5.12).

5.2.3 Zinc

5.2.3.1 Zinc Intake from Traditional and Market Foods by Season

In a pattern following that of protein and iron, the average zinc intake from traditional foods was found to be significantly higher ($p \leq 0.005$) in each community and sex group than that from market foods (intake from supplements was not considered) (Table 5.13). The zinc intake of CL women from traditional (6.2 ± 6.7 mg) versus market foods (2.7 ± 3.2 mg) in the spring, however, was relatively low

Table 5.11: Ten Most Important Food Sources of Iron (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	Total mg *
4132	Moose, baked	664.3
4254	Moose, dried/smoked	128.2
461	Bread, white	82.9
416	Bannock/Biscuits, baked	71.3
4174	Black scoter/ducks, baked	60.7
974	Eggs, boiled	52.9
370	Beef, hamburger	45.5
800	Coffee, prepared	38.7
353	Beef, round	36.2
1683	Pork, chops	31.0
	% Total:	74.0

Fort Good Hope - Winter (n=82)

Food Code	Food	Total mg
4150	Caribou (B), baked	678.6
4164	Rabbit, boiled	357.6
4132	Moose, baked	351.6
461	Bread, white	77.7
974	Eggs, boiled	64.0
370	Beef, hamburger	62.8
416	Bannock/Biscuits, baked	52.5
800	Coffee, prepared	48.4
2456	Wheat/oat/rice cereals, enriched	42.3
4170	Ptarmigan, baked	39.5
	% Total:	79.3

Fort Good Hope - Spring (n=113)

Food Code	Food	Total mg
4174	Black scoter/ducks, baked	881.1
4141	Caribou (W), baked	435.8
4132	Moose, baked	298.4
4159	Beaver, baked	220.2
4164	Rabbit, boiled	200.8
370	Beef, hamburger	120.6
461	Bread, white	115.1
4268	Canada Goose, smoked/dried	97.0
974	Eggs, boiled	89.0
4150	Caribou (B), baked	77.2
	% Total:	77.3

* = total mg reported on all 24-Hr recalls/season

Table 5.12: Ten Most Important Food Sources of Iron (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	Total mg *
4150	Caribou (B), baked	132.7
4174	Black scoter/ducks, baked	70.8
4203	Whitefish (CL), smk/dry	53.6
4202	Whitefish (CL), baked	13.8
4140	Caribou, dried	8.8
416	Bannock/Biscuits, baked	7.5
800	Coffee, prepared	3.8
353	Beef, round	3.0
461	Bread, white	2.6
1324	Milk, evaporated canned	2.1
	% Total:	95.4

Outpost Camps - Winter (n=10)

Food Code	Food	Total mg
4164	Rabbit, boiled	166.2
4141	Caribou (W), baked	112.6
4150	Caribou (B), baked	102.4
4132	Moose, baked	86.4
4140	Caribou, dried	60.2
4217	Trout, baked	34.7
416	Bannock/Biscuits, baked	27.8
1391	Oatmeal, boiled	16.0
4254	Moose, smoked/dried	10.1
2159	Spaghetti noodles, boiled	6.1
	% Total:	97.5

Colville Lake - Spring (n=14)

Food Code	Food	Total mg
4174	Black scoter/ducks, baked	40.9
4150	Caribou (B), baked	33.8
416	Bannock/Biscuits, baked	31.3
4217	Trout, baked	23.8
1391	Oatmeal, boiled	8.4
2165	Spaghetti, meatballs&tomato sauce	8.3
4202/4203	Whitefish (CL), baked/smk-dry	5.1
2104	Soup, vegetable and beef	4.6
800	Coffee, prepared	2.8
4211	Loche, baked	2.4
	% Total:	87.1

* = total mg reported on all 24-Hr recalls/season

and not significantly different. As was the case with their iron intakes, the consumption of a fish-based, relatively low-energy diet by CL women in the spring may have contributed to the lack of a significant difference in zinc intake between market and traditional foods.

As with protein and iron, there was no significant seasonal difference in zinc intake from market foods for men and women from both communities. However, a trend towards decreased intake of zinc from market foods was evident in CL adults relative to FGH adults which may reflect the lower intake of market meats by CL adults.

While women from FGH showed no seasonal variations in zinc intake from traditional or total food sources, men from FGH, and men and women from CL did exhibit significant differences ($\alpha = 0.05$). In each of the latter cases, winter was the season of highest zinc intake. While it was non-significant, a trend towards a higher zinc intake in the winter was also evident for women from FGH.

The zinc intake of the Inuit, like that of protein and unlike that of iron, was found to be similar to that observed for FGH men and women in the current study However, as with protein, the zinc intake of CL and FGH residents in the winter outpost hunting camps was substantially higher than the mean zinc intake of the Inuit, reflecting the substantial intake of meat in the hunting camps. In the summer, the zinc intake of CL residents was similar to that of the Inuit, suggesting that food composition was the determining factor as fish, whose peak consumption was in the summer, did not have the same high levels of zinc as mammal flesh whose peak consumption was in the winter (see Appendix 2). Wein et al. (1991) and Sevenhuysen and Bogert-O'Brien (1987) did not report zinc intake.

5.2.3.2 Seasonal Contribution of Foods to Zinc Intake

Moose and/or caribou were the predominant sources of zinc in each season for adult women in FGH (Table 5.14). In each season, pork and beef were less important contributors to zinc intake. Raw whitefish eggs, containing 3.6 mg Zn/100 g, appeared on the list of the ten most important contributors to zinc

TABLE 5.13: Differences in Mean Daily Zinc Intake (mg) from Traditional and Market Foods with a Simultaneous Comparison of Mean Adult Intakes Across Seasons

- Fort Good Hope -

Women	Summer (n=81)	Winter (n=82)	Spring (n=113)	Avg (n=276)
Trad	***14.7±21.0[a]	***18.7±25.7[a]	***15.6±18.9[a]	***16.2±21.7
Mkt	6.5± 5.3[a]	6.4± 6.4[a]	7.4± 8.1[a]	6.8± 6.8
Total	21.2±20.9[a]	25.1±26.7[a]	22.9±19.9[a]	23.1±21.7

Men	Summer (n=74)	Winter (n=68)	Avg (n=142)
Trad	**17.8±23.7[b]	***27.3±32.4[a]	***22.3±28.5
Mkt	9.1±10.8[a]	7.5± 9.3[a]	8.4±10.1
Total	26.9±23.1[a]	34.8±34.3[a]	30.7±29.2

- Colville Lake -

Women	Summer (n=10)	Winter+ (n=10)	Spring (n=14)	Avg (n=34)
Trad	*22.6±18.7[b]	***54.9±13.6[a]	[NS]6.2±6.7[b]	***25.3±32.3
Mkt	2.6± 2.8[a]	2.7± 0.7[a]	2.7±3.2[a]	2.7± 2.7
Total	25.3±16.7[b]	57.6±13.5[a]	8.9±8.2[b]	28.0±31.9

Men	Summer (n=17)	Winter+ (n=15)	Avg (n=32)
Trad	**21.2±18.0[b]	***87.5±17.6[a]	***52.3±58.3
Mkt	5.6± 5.7[a]	3.9± 0.6[a]	4.8± 4.4
Total	26.7±15.4[b]	91.4±17.6[a]	57.0±57.3

* = a significant difference (paired difference t-test) between mean zinc intake from traditional and market foods for each season and gender ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
NS = a non-significant difference (paired difference t-test) between mean traditional and market zinc intakes
a,b = different letter superscripts across rows indicate significant seasonal variation in mean zinc intake (average values not included) ($\alpha=0.05$)
\+ = outpost camps

intake in the summer season.

Interestingly, the list of foods contributing to zinc intake in the spring in FGH contained the highest variety of traditional food sources of zinc (Table 5.14). Black scoter, the primary source of protein and iron in the spring season in FGH, ranked fourth in contribution to zinc intake due to its lower flesh content of zinc (see Appendix 2).

In CL, caribou was the most important food source of zinc in each season (Table 5.15). Traditional foods were found to contribute the vast majority of the zinc in the diets of adult CL women in every season, echoing results from Table 5.13 in which traditional foods contributed significantly more zinc to the diet than did market foods.

Reflecting its relatively low zinc content, fish did not appear in the list of important food sources of zinc as frequently, or in as important a rank, as it did for protein intake (Tables 5.8, 5.9, 5.14, and 5.15). Fish was in greater evidence, however, on the CL seasonal lists of important food sources of zinc than on those of FGH, probably due to its higher level of consumption in CL.

5.3 Vitamin A

5.3.1 Vitamin A Intake from Traditional and Market Foods by Season

In sharp contrast to the higher intake of protein, iron, and zinc from traditional foods, the average intake of vitamin A by FGH women and men was significantly greater from the market food component of the diet ($p \leq 0.005$) (Table 5.16). Indeed, in each season, market foods contributed significantly more vitamin A to the diets of FGH men and women.

For men and women from CL, there was no significant difference in either the average, or the seasonal, intakes of vitamin A from market and traditional foods.

The low intake of vitamin A from traditional foods in FGH may be attributed to the fact that vitamin A was found in high concentration in only a few foods such as liver. As liver would not be expected to be frequently consumed, it was not

Table 5.14: Ten Most Important Food Sources of Zinc (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	Total mg *
4132	Moose, baked	978.4
1683	Pork, chops	83.4
4254	Moose, dried/smoked	79.2
370	Beef, hamburger	61.2
353	Beef, round	61.0
974	Eggs, boiled	35.3
747	Chicken, baked	27.0
4104	Whitefish eggs, raw	24.8
4110	Inconnu, baked	24.6
2104	Soup, vegetable and meat	21.3
	% Total:	81.2

Fort Good Hope - Winter (n=82)

Food Code	Food	Total mg
4150	Caribou (B), baked	734.9
4132	Moose, baked	517.8
4164	Rabbit, boiled	184.6
370	Beef, hamburger	84.3
974	Eggs, boiled	42.6
2165	Spaghetti, meatballs&tomato sauce	33.7
126	Bacon, fried	29.1
371	Meat and vegetable stew	28.2
1391	Oatmeal, cooked	23.5
1683	Pork, chops	22.4
	% Total:	82.7

Fort Good Hope - Spring (n=113)

Food Code	Food	Total mg
4141	Caribou (W), baked	546.0
4132	Moose, baked	439.4
4174	Black scoter/ducks, baked	273.3
4159	Beaver, baked	203.5
370	Beef, hamburger	162.1
1683	Pork, chops	104.5
4164	Rabbit, boiled	103.7
4150	Caribou (B), baked	83.6
353	Beef, round broiled	69.2
974	Eggs, boiled	59.4
	% Total:	79.0

* = total mg reported on all 24-Hr recalls/season

Table 5.15: Ten Most Important Food Sources of Zinc (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	Total mg *
4150	Caribou (B), baked	143.7
4203	Whitefish (CL), smk/dry	35.2
4174	Black scoter/ducks, baked	22.0
4202	Whitefish (CL), baked	19.4
1324	Milk, evaporated canned	8.3
4140	Caribou, dried	6.0
353	Beef, round	5.0
689	Chicken, fried	2.3
416	Bannock/Biscuits, baked	1.8
1999	Luncheon meats	1.7
	% Total:	97.0

Outpost Camps - Winter (n=10)

Food Code	Food	Total mg
4141	Caribou (W), baked	141.0
4132	Moose, baked	127.2
4150	Caribou (B), baked	110.9
4164	Rabbit, boiled	85.8
4140	Caribou, dried	41.3
4217	Trout, baked	29.0
1391	Oatmeal, boiled	11.4
4202	Whitefish (CL), baked	7.2
416	Bannock/Biscuits, baked	6.7
4254	Moose, smoked/dried	6.3
	% Total:	98.4

Colville Lake - Spring (n=14)

Food Code	Food	Total mg
4150	Caribou (B), baked	36.6
4217	Trout, baked	19.9
4174	Black scoter/ducks, baked	12.7
2165	Spaghetti, meatballs&tomato sauce	7.7
416	Bannock/Biscuits, baked	7.5
4202	Whitefish (CL), baked	7.2
1391	Oatmeal, boiled	6.0
2104	Soup, vegetable	5.5
4211	Loche, baked	4.1
4203	Whitefish (CL), smoked/dry	3.3
	% Total:	89.1

*** = total mg reported on all 24-Hr recalls/season**

surprising that vitamin A intake from traditional foods appeared low. Indeed, liver appeared on the recall of only one adult woman and two adult men. These FGH residents consumed 25, 25, and 125 grams of loche liver, respectively, in the winter season. Loche, caribou, and moose livers did, however, appear more frequently on the FFQ forms. Due to the high intra-individual intake of vitamin A, if many more replicates of the 24-Hr recalls were conducted on non-adjacent days, traditional food contribution to vitamin A intake may be found to be more substantial (Gibson, 1987). It is unclear what effect this increase in data might have on relative market food contribution to vitamin A intake.

The high standard deviation in vitamin A intake for FGH men suggests a higher inter-individual variability in vitamin A intake than was observed for FGH women and CL adults.

With the exception of FGH men, the average vitamin A intakes of men and women from FGH and CL were lower than those observed by Kuhnlein (1989b) for the Inuit and by Wein et al. (1991) for Native Canadians in northern Alberta. As noted below, the use of ringed seal liver may have contributed to increased vitamin A intake levels by the Inuit (Kuhnlein, 1989b). The source of vitamin A in the diet of the Native Canadians studied by Wein et al. (1991) is unknown although, as noted earlier, their average intake of traditional foods was apparently lower than that of the Hareskin.

There was no significant difference in seasonal intake of vitamin A from market or traditional foods, or in total vitamin A intake across seasons (Table 5.16).

5.3.2 Seasonal Contribution of Foods to Vitamin A Intake

Carrots, followed by eggs, were the most important contributors to the vitamin A intake of adult women in FGH during the summer and spring seasons (Table 5.17). In the winter, eggs became the most important source, followed by margarine. Margarine was the only important fortified source of vitamin A in the diets of FGH women with the exception of 2% milk which ranked tenth in the

TABLE 5.16: Differences in Mean Daily Vitamin A Intake (RE) from Traditional and Market Foods with a Simultaneous Comparison of Mean Adult Intakes Across Seasons

- Fort Good Hope -

Women	Summer (n=81)	Winter (n=82)	Spring (n=113)	Avg (n=276)
Trad	5± 14[a]	22±103[a]	10± 31[a]	12± 60
Mkt	***413±414[a]	***394±369[a]	***402±509[a]	***403±442
Total	417±412[a]	415±391[a]	412±508[a]	414±447

Men	Summer (n=74)	Winter (n=68)	Avg (n=142)
Trad	5± 15[a]	99± 556[a]	50± 386
Mkt	*840±2975[a]	***542± 803[a]	***697±2216
Total	845±2974[a]	641±1103[a]	747±2273

- Colville Lake -

Women	Summer (n=10)	Winter+ (n=10)	Spring (n=14)	Avg (n=34)
Trad	79± 70[a]	[NS]299±257[a]	151±153[a]	[NS]173±446
Mkt	[NS]88±121[a]	142± 66[a]	[NS]208±317[a]	153±241
Total	166±119[a]	440±247[a]	359±356[a]	326±482

Men	Summer (n=17)	Winter+ (n=15)	Avg (n=32)
Trad	76± 70[a]	105± 56[a]	90±154
Mkt	[NS]187±330[a]	[NS]297±157[a]	[NS]239±475
Total	263±320[a]	402±168[a]	328±500

* = a significant difference (paired difference t-test) between mean vitamin A intake from traditional and market foods for each season and gender ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
[NS] = a non-significant difference (paired difference t-test) between mean traditional and market vitamin A intakes
[a,b] = different letter superscripts across rows indicate significant seasonal variation in mean vitamin A intake (average values not included) ($\alpha=0.05$)
\+ = outpost camps

summer. Macaroni and cheese, butter, and meat and vegetable soups were less important contributors to vitamin A intake in each season. As noted for the Inuit by Verdier et al. (1987b) and Kuhnlein (1989b), milk was not an important source of vitamin A in the diets of FGH residents. In contrast to results obtained by Kuhnlein (1989b) in which raw ringed seal liver was the primary source of vitamin A in the diets of Inuit women aged 20-40, no traditional food appeared on the list of the ten most important food sources of vitamin A for FGH women. Consumed in the spring where it ranked sixteenth (501 RE) in importance with respect to contribution to total vitamin A intake, smoked/dried goose was found to be the most important traditional food source of vitamin A in the diets of adult women from FGH in the three seasons studied.

In CL, trout consumption contributed to the trend towards a higher intake of vitamin A from traditional foods in the winter and spring seasons (Table 5.18). Unlike FGH, fortified milk products were in the list of ten most important contributors to vitamin A intake in each season for CL women while, on the other hand, eggs did not appear. Further, traditional food sources of vitamin A other than trout (e.g rabbit and whitefish) appeared in the lists for CL women in contrast to results for FGH in which no traditional food item was noted. As with protein, iron, and zinc, the ten foods listed for CL women contributed virtually all of the vitamin A in their diets. These data suggest the lower dietary diversity of CL women.

5.4 Nutrient Intakes of Adult Women Relative to Canadian RNIs

5.4.1 Average Nutrient Intakes of Adult Women of Various Ages

Table 5.19 partitions the total average nutrient intakes of all adult women as they appear in Tables 5.7, 5.10, 5.13, and 5.16 into average intakes according to age group (19-49 years and ≥50 years). While not statistically treated due to the data's purpose as a descriptive tool, there is a trend for older women in FGH to consume greater amounts of protein, iron, and zinc in each season, particularly the winter, and less vitamin A than younger women.

Table 5.17: Ten Most Important Food Sources of Vitamin A (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	Total RE *
620	Carrots, boiled	6530
974	Eggs, boiled	3931
505	Butter	3491
1304	Macaroni and cheese	3464
2104	Soup, vegetable and meat	2763
1457	Pancakes	1562
2079	Soup, chicken	1489
371	Meat and vegetable stew	1141
1323	Milk, 2%	881
747	Chicken, baked	656
	% Total:	78.7

Fort Good Hope - Winter (n=82)

Food Code	Food	Total RE
974	Eggs, boiled	4750
1317	Margarine	3376
2165	Spaghetti, meatballs&tomato sauce	2892
2104	Soup, vegetable and meat	2865
371	Meat and vegetable stew	2734
1304	Macaroni and cheese	2542
505	Butter	1802
2404	Vegetables, frozen mixed	1577
1457	Pancakes	1420
1140	Ice cream	1192
	% Total:	73.8

Fort Good Hope - Spring (n=113)

Food Code	Food	Total RE
620	Carrots, boiled	9329
974	Eggs, boiled	6614
505	Butter	4298
1304	Macaroni and cheese	3814
2104	Soup, vegetable and meat	3344
371	Meat and vegetable stew	1962
1633	Pizza with cheese	1546
2404	Vegetables, mixed frozen	910
1317	Margarine	894
1324	Milk, evaporated whole	840
	% Total:	77.6

* = total RE reported on all 24-Hr recalls/season

Table 5.18: Ten Most Important Food Sources of Vitamin A (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	Total RE *
1324	Milk, evaporated canned	559
4202	Whitefish (CL), baked	427
4203	Whitefish (CL), smk/dry	359
505	Butter	189
2075	Soup, creamed	45
689	Chicken, fried	31
2079	Soup, chicken noodle	30
531	Cake, fruit	6
353	Beef, round	6
1616	Pineapples, canned	5
	% Total:	99.3

Outpost Camps - Winter (n=10)

Food Code	Food	Total RE
4217	Trout, baked	2747
1457	Pancakes	426
1328	Milk, powdered	320
4202	Whitefish (CL), baked	158
505	Butter	113
4164	Rabbit, boiled	81
1391	Oatmeal, boiled	46
1317	Margarine	25
1793	Potatoes, mashed	21
156	Beans and pork in tomato sauce	15
	% Total:	99.7

Colville Lake - Spring (n=14)

Food Code	Food	Total RE
4217	Trout, baked	1880
2104	Soup, vegetable and meat	718
505	Butter	716
2165	Spaghetti, meatballs&tomato sauce	660
1324	Milk, evaporated whole	203
4202	Whitefish (CL), baked	158
587	Chocolate	150
2075	Soup, creamed	141
1793	Potatoes, mashed	120
850	Corn, sweet, canned	41
	% Total:	97.1

* = total RE reported on all 24-Hr recalls/season

Table 5.19: Average Daily Nutrient Intake[1] of Adult Women (Mean ± Standard Deviation)

	Pro (g)	Fe (mg)	Zn (mg)	Vit A (RE)
- Fort Good Hope -				
Summer				
19-49 (n=64)	153±112	20.3±20.1	20.9±21.4	450±391
50+ (n=17)	170±103	19.9±13.5	22.3±19.3	295±478
Winter				
19-49 (n=58)	153±109	23.0±16.6	21.3±19.8	472±394
50+ (n=24)	259±242	37.8±37.1	34.3±35.6	279±317
Spring				
19-49 (n=71)	138± 96	22.8±15.5	20.7±16.1	518±538
50+ (n=42)	198±140	39.5±32.5	26.7±20.3	232±397
Seasonal Avg				
19-49 (n=193)	147±105	22.0±17.4	20.9±19.0	482±450
50+ (n= 83)	210±171	35.0±31.8	28.0±25.6	258±390
- Colville Lake -				
Summer				
19-49 (n=7)	344±308	27.3±16.1	24.5±16.0	177±143
50+ (n=3)	370±324	40.6±44.9	27.1±22.2	143± 24
Winter				
19-49 (n=7)	374±324	58.1±49.3	55.5±49.6	251± 204
50+ (n=3)	675±245	77.2±38.6	62.6±31.2	882±1490
Spring				
19-49 (n=6)	167± 77	19.0±10.5	11.4± 9.4	570±464
50+ (n=8)	112± 70	8.9± 8.9	7.0± 7.2	201±122
Seasonal Avg				
19-49 (n=20)	301±270	35.6±34.3	31.4±35.2	321±325
50+ (n=14)	288±289	30.3±37.4	23.2±27.9	334±662

[1] not including vitamin/mineral supplementation

Older women in CL had the same pattern of nutrient consumption as those in FGH with the exceptions of vitamin A intake in the winter which was higher than that of the younger women, and of protein, iron, and zinc intakes in the spring which were lower than those of the younger women. Variation due to the small sample size of the CL population may have contributed to the latter reversals. For example, one older CL woman reported consuming 4.5 kg of trout in the winter season thereby elevating the mean vitamin A intake of older women. Similarly, on top of the overall decrease in food intake in CL in the spring, an elderly woman caring for her ill husband reported consuming only tea and bannock. This undoubtedly contributed to the decreased protein, iron, and zinc intakes of older women in the spring season.

It is important to note that these data, as with all those presented previously, do not include intakes resulting from vitamin/mineral supplementation.

5.4.2 Average Proportion of the RNI Obtained by Adult Women from Traditional/Market Components and Total Diet

Using recall data averaged over the three study seasons, it is clear that the average woman from both CL and FGH obtained more than her RNI for protein, iron, and zinc (Table 5.20). As would be expected from previously presented data, the overwhelming majority of the RNI for these nutrients was obtained from traditional foods. This was true in every case except for that of younger women (19-49 yrs) from FGH. While the same trend for increased contribution to the RNI from traditional foods existed in their case, there was a smaller margin of difference between traditional and market contributions to RNI.

The large standard deviations suggest that some women may obtain less than the RNI and that some may obtain an even higher percentage of the RNI. This will be discussed further in the next section.

Due to dietary and biological variability (i.e. differences in the absorption of, and requirement for, iron) it is unknown at what proportion of the RNI some risk of iron toxicity may develop. Thus, the physiological implications, if any, of

Table 5.20: Proportion of RNI Met by Mean Daily Intake of Adult Women from Traditional/Market Components and Total Diet (Seasonal Average[1] ± S.D.)

- Fort Good Hope -

19-49 yrs (n=193 recalls)	Pro (% RNI)	Fe (% RNI)	Zn (% RNI)	Vit A (% RNI)
Trad	197±241	95±132	141±211	2± 9
Mkt	141±112	75± 49	92± 78	59±56
Total	339±242	169±134	233±211	60±56
50+ yrs (n=83 recalls)				
Trad	387±360	369±386	272±280	2± 4
Mkt	59± 75	68± 61	39± 56	31±49
Total	446±365	437±397	311±284	32±49

- Colville Lake -

19-49 yrs (n=20 recalls)	Pro (% RNI)	Fe (% RNI)	Zn (% RNI)	Vit A (% RNI)
Trad	631±637	222±267	308±395	14±18
Mkt	62± 48	52± 43	41± 33	26±36
Total	693±621	274±264	349±391	40±41
50+ yrs (n=14 recalls)				
Trad	589±620	351±448	244±310	33±85
Mkt	23± 28	28± 34	14± 14	9±15
Total	612±614	379±467	258±310	42±83

[1] average of summer and winter, 1988 and spring, 1990

consuming, for example, four times the RNI for iron is unknown. As noted earlier, zinc has not been reported to possess toxic potential with the exception of a depression in immune function and a potential for compromised copper status. Likewise, moderately high protein intakes in healthy individuals consuming sufficient quantities of water and energy are also not expected to be problematic (HWC, 1990).

With the exception of 19-49 year old women in FGH, the average proportion of the RNI for vitamin A obtained by adult women is less than 50%. It appears that both older and younger women in FGH obtained more of their RNI for vitamin A from market foods while in CL, younger women obtained more of their vitamin A from market foods and older women obtain a higher proportion from traditional foods. The idea that younger people and those from less remote areas obtain more of their food from market sources appears to be borne out by these results. Once again, however, inter-individual variation in intakes may play an important role due to the small sample size.

5.4.3 Proportion of the RNI Obtained by Adult Women

As expected from the large standard deviations noted in Table 5.20, some women were found to consume less than their RNI for the various nutrients examined (Table 5.21).

Using seasonal averages, the majority of women interviewed in FGH and CL were found to consume less than half the RNI for vitamin A (Table 5.21). This finding is comparable to those obtained in studies of other northern Native populations (Kuhnlein, 1989b; Sevenhuysen and Bogert-O'Brien, 1987). Interestingly, while Native women in northern Manitoba had a mean vitamin A intake (968 RE) higher than that seen with the Hareskin, the proportion of the sample with intakes less than 50% of the RNI was similar (Sevenhuysen and Bogert-O'Brien, 1987). It is possible that the intakes of a few individuals skewed the mean intake upwards.

Direct comparison of intakes with various proportions of the RNI does not

Table 5.21: Count and Percentage of Adult Women Consuming Selected Proportions of the RNI for Iron, Zinc, Protein, and Vitamin A (Seasonal Average)

	FGH: 19-49 yrs (n=193 recalls)			
	<½ RNI	≥½ & <⅔ RNI	≥⅔ & <RNI	≥RNI
Protein	4 (2%)	3 (1%)	13 (7%)	173 (90%)
Iron	16 (8%)	20 (10%)	38 (20%)	119 (62%)
Zinc	19 (10%)	9 (5%)	30 (15%)	135 (70%)
Vit A	101 (52%)	29 (15%)	36 (19%)	27 (14%)

	FGH: 50+ yrs (n=8[illegible] recalls)			
	<½ RNI	≥½ & <⅔ RNI	≥⅔ & <RNI	≥RNI
Protein	2 (2%)	1 (1%)	2 (2%)	78 (95%)
Iron	2 (2%)	1 (1%)	5 (6%)	75 (91%)
Zinc	8 (10%)	4 (5%)	2 (2%)	69 (83%)
Vit A	68 (82%)	6 (7%)	4 (5%)	5 (6%)

	CL: 19-49 yrs (n=20 recalls)			
	<½ RNI	≥½ & <⅔ RNI	≥⅔ & <RNI	≥RNI
Protein	0 (0%)	0 (0%)	1 (5%)	19 (95%)
Iron	1 (5%)	1 (5%)	2 (10%)	16 (80%)
Zinc	2 (10%)	1 (5%)	2 (10%)	15 (75%)
Vit A	13 (65%)	5 (25%)	0 (0%)	2 (10%)

	CL: 50+ yrs (n=14 recalls)			
	<½ RNI	≥½ & <⅔ RNI	≥⅔ & <RNI	≥RNI
Protein	1 (7%)	0 (0%)	0 (0%)	13 (93%)
Iron	3 (22%)	2 (14%)	1 (7%)	8 (57%)
Zinc	3 (22%)	3 (22%)	2 (14%)	6 (42%)
Vit A	12 (86%)	1 (7%)	0 (0%)	1 (7%)

adequately account for the fact that the RNIs exceed the requirements of almost everyone since they represent levels at which requirements for continued health will be met by almost all healthy individuals. Failure to meet the RNI therefore does not imply that an individual's intake is inadequate to meet his or her own needs. Thus, this form of comparison may overestimate the actual incidence of inadequate intakes. However, the farther below the RNI one's intake falls, the higher the risk of not meeting one's own requirements (HWC, 1990; Anderson et al., 1982).

As noted by Anderson et al. (1982), intakes at 54% of the RNI have a probability of inadequacy of 0.975. However, it is important to consider that an idea of usual intake is required for application of probabilities to intake data, and many more than the three days of interviews obtained would be required for a reasonable idea of the usual vitamin A intake (Gibson, 1987; Anderson et al., 1982). Therefore, since vitamin A is stored in the body and since it exhibits such large daily variations in intake, it is difficult to make any conclusions regarding risk of inadequacy based on limited intake data.

The lack of ability to make solid conclusions regarding risk of inadequacy does not render the data meaningless. Based on data presented in Table 5.21, it would seem reasonable to suggest that older women were at higher risk of inadequate intakes than younger women, assuming their patterns of consumption of vitamin A rich foods were similar. This assumption may not be valid considering the fact that organ meat consumption was reported to be diminished in the younger generation (Schaefer and Steckle, 1980). Further, it is reasonable to suggest that the wide variation in vitamin A intake apparent in Table 5.21 may be indicative of a trend towards a higher long-term average (i.e. usual) vitamin A intake than is evident in the figures.

A sensitive and specific clinical, biochemical, and/or functional test for vitamin A status would be required to determine if vitamin A was actually deficient.

As with the general Canadian population, the intake of protein by Hareskin women was generally greater than the RNI (Table 5.21). Young women from CL

had the lowest risk of inadequate protein intake. A small percentage of Hareskin women did, however, show an intake which was less than half of the RNI. It is possible that these individuals were ill, for example, on the day before the recall was conducted such that the reported intake was not usual. Once again, intakes below the RNI do not imply inadequate intakes.

Kuhnlein (1989b) reported similar findings for protein while Sevenhuysen and Bogert-O'Brien (1987) reported slightly lower proportions of individuals consuming levels of protein greater than the RNI. As the protein consumed by the Hareskin was a high quality protein it would be readily digestible and utilizable.

The majority of women consumed greater than 100% of their RNI for iron, although a small percentage consumed less than half of the RNI (Table 5 21) In FGH, younger adult women were at slightly greater risk of inadequacy than older women. The magnitude of the actual difference in risk is unknown since the distribution of iron requirement is skewed in menstruating women (Anderson et al , 1982).

While the proportion of women consuming less than half of the RNI for iron was similar to that observed by Kuhnlein (1989b), it was far less than that calculated by Sevenhuysen and Bogert-O'Brien (1987). The difference may be attributable to the variation in the iron densities of the diets. It is important to note that much of the iron consumed by the Hareskin was in the form of readily available heme iron whose absorption is not greatly influenced by iron status or by the presence of such dietary components as tannins in tea (Sabry, 1988). Therefore, despite the high intake of tea, iron bioavailability probably remained high. No reports on possible genetic variation in the iron (or other nutrient) requirement of Native Canadians is available.

With the exception of CL women $\geq$50 years of age, the majority of women consumed greater than the RNI for zinc. In general terms, more women were at risk of inadequate zinc intake than were at risk of inadequate iron intakes. The reason for this is unclear although it is presumed to reflect the high intake of iron-fortified products such as bread and bannock. In contrast to this finding, more

Inuit women aged 20-40 were found to consume greater than the RNI for zinc (94%) in comparison to iron (91%) (Kuhnlein, 1988b). The reason for the discrepant findings may lie in food composition differences, although the fact that the RNI for zinc was recently elevated may also be implicated (HWC, 1983; HWC, 1990). The current research utilized the higher RNI (9 mg) while Kuhnlein (1989b) employed the earlier RNI (8 mg).

The results noted above should be interpreted with an acknowledgement of the limitations of the RNIs. First of all, as noted earlier, they represent levels adequate to maintain health in nearly all healthy individuals; thus, for any one individual failure to meet the RNI does not imply dietary inadequacy. Further, they assume a normal distribution of requirements which is an assumption requiring further research. It is also important to keep in mind that the RNIs are only the best estimates of competent individuals working with available data (Beaton, 1985; HWC, 1990).

The individual rankings are presented for illustrative purposes only since usual intakes of the individuals were not determined. The dietary data presented in this section are not intended to indicate biological adequacy or inadequacy; additional biochemical, clinical, and/or functional research would be required to make that type of conclusion.

5.5 **Polychlorinated Biphenyl Intake**

5.5.1 Seasonal Intake of Polychlorinated Biphenyls by Men and Women

Polychlorinated biphenyl intake was calculated exclusively from traditional foods although it is recognized that market foods also contain PCBs (Mes et al., 1989). The raticnale for this decision appeared in section 4.4.

The seasonal average daily PCB intake of adult women $\geq$50 years of age from FGH (4.60 $\pm$ 6.79 ug) was significantly greater ($p \leq 0.005$) than that of women between the ages of 19 and 49 (2.16 $\pm$ 3.33 ug) (Table 5.22). This different was presumably due to the higher traditional food intake of older women. Indeed, in each season except summer, older women consumed significantly more PCBs

than younger women. In the summer, the same trend existed although it was non-significant.

There was no difference in the PCB intake of older versus younger women from CL. Trends towards a difference appeared but high standard deviations and a low sample size probably precluded statistical significance (Table 5.22)

No seasonal differences in PCB intake of any age group of women in either community were evident with the exception of younger women in FGH. In the latter case, summer was the season of highest PCB intake despite the fact that winter was the season with the highest average traditional food use High fish consumption was responsible for the significantly higher PCB intake of younger adult women in the summer. In the summer, inconnu (2 24 ug PCBs/100g) contributed half of the PCBs consumed by adult women in FGH (Table 5 23 and Appendix 2). Elevated caribou use led to its appearance as the top contributor to PCB intake in the winter (0.52 ug/100g). The relatively low fish use of the spring led to beaver (1.7 ug/100g), followed by black scoter (0.32 ug/100g), being the most important sources of PCBs in the diets of FGH women in the spring (Table 5.23 and Appendix 2).

The 4.5 kg intake of trout by one older woman in CL was responsible for the elevated mean and high standard deviation of PCB intake in the winter (Table 5.22). In CL, trout was the foremost contributor to PCB intake in the winter and spring seasons (Table 5.24). Smoked/dried whitefish was the main contributor to the PCB intake of adult women from CL in the summer.

Only in the winter season was there a significant difference ($p \leq 0.05$) in the mean PCB intake of younger and older adult men from FGH (Table 5.25). Similarly, no significant differences in seasonal intake of PCBs was evident for either age group in either community. Despite the fact that men were found to weigh and eat more than women, the PCB intake of men was not consistently higher than that of women as might be expected. Food choices (e.g. mammal versus fish) may be implicated.

Table 5.22: Seasonal Daily Intake of Polychorinated Biphenyls (ug) by Adult Women from Traditional Foods (Mean ± SD)

- Fort Good Hope -

Age (yrs)	Summer	Winter	Spring	Average
19-49	(n=64) 3.26±4.79[a]	(n=58) 1.91± 2.01[b]	(n=71) 1.37±2.16[b]	(n=193) 2.16±3.33
50+	(n=17) [NS]4.72±4.84[a]	(n=24) *6.54±10.90[a]	(n=42) ***3.45±3.59[a]	(n=83) ***4.60±6.79
Avg (≥19)	(n=81) 3.56±4.81[a]	(n=82) 3.26± 6.41[a]	(n=113) 2.15±2.94[a]	(n=276) 2.89±4.77

- Colville Lake -

Age (yrs)	Summer	Winter+	Spring	Average
19-49	(n=7) [NS]10.62±12.59[a]	(n=7) 5.19± 4.08[a]	(n=6) [NS]9.38±7.04[a]	(n=20) 8.34± 8.62
50+	(n=3) 8.02± 6.51[a]	(n=3) [NS]38.36±54.09[a]	(n=8) 4.97±3.50[a]	(n=14) [NS]12.78±25.63
Avg (≥19)	(n=10) 9.84±10.80[a]	(n=10) 15.14±30.30[a]	(n=14) 6.86±5.55[a]	(n=34) 10.17±17.51

* = a significant difference (t-test) between mean PCB intake of 19-49 vs 50+ yr old women ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
NS = a non-significant difference (t-test) between mean PCB intakes of 19-49 vs 50+ yr old women
a,b = different letter superscripts across rows indicate significant seasonal variation in mean PCB intake ($\alpha=0.05$)
\+ = outpost camps

Table 5.23: Top Ten Traditional Food Sources of PCBs (FGH Adult Women)

Fort Good Hope - Summer (n=81)

Food Code	Food	Total ug *
4110	Inconnu, baked	140.83
4132	Moose, baked	37.63
4104	Whitefish eggs, raw	26.52
4102	Whitefish (FGH), baked	19.86
4117	Cisco, baked	18.81
4112	Inconnu, smoked/dried	15.83
4103	Whitefish (FGH), smoked/dried	5.82
4105	Whitefish eggs, baked	5.49
4220	Cloudberry, raw	5.49
4254	Moose, smoked/dried	2.77
	% Total:	96.7

Fort Good Hope - Winter (n=82)

Food Code	Food	Total ug
4150	Caribou (B), baked	90.54
4103	Whitefish (FGH), smoked/dried	47.04
4102	Whitefish (FGH), baked	43.33
4127	Loche, baked	31.27
4164	Rabbit, boiled	22.59
4132	Moose, baked	19.91
4159	Beaver, baked	8.50
4170	Ptarmigan, baked	1.42
4105	Whitefish eggs, baked	1.25
4141	Caribou (W), baked	0.81
	% Total:	99.6

Fort Good Hope - Spring (n=113)

Food Code	Food	Total ug
4159	Beaver, baked	78.63
4174	Black scoter/ducks, baked	34.31
4141	Caribou (W), baked	28.44
4110	Inconnu, baked	19.60
4132	Moose, baked	16.90
4217	Trout, baked	16.80
4164	Rabbit, boiled	12.69
4150	Caribou (B), baked	10.30
4102	Whitefish (FGH), baked	9.93
4268	Canada Goose, smoked/dried	4.52
	% Total:	95.8

* = total ug reported on all 24-Hr recalls/season

Table 5.24: Top Traditional Food Sources of PCBs (CL Adult Women)

Colville Lake - Summer (n=10)

Food Code	Food	Total ug *
4203	Whitefish (CL), smk/dry	62.16
4150	Caribou (B), baked	17.71
4202	Whitefish (CL), baked	15.39
4174	Black scoter/ducks, baked	2.76
4140	Caribou, dried	0.39
	% Total:	100

Outpost Camps - Winter (n=10)

Food Code	Food	Total ug
4217	Trout, baked	106.40
4150	Caribou (B), baked	13.66
4164	Rabbit, boiled	10.50
4141	Caribou (W), baked	7.35
4202	Whitefish (CL), baked	5.70
4132	Moose, baked	4.89
4140	Caribou, dried	2.67
4254	Moose, smoked/dried	0.22
	% Total:	100

Colville Lake - Spring (n=14)

Food Code	Food	Total ug
4217	Trout, baked	72.80
4203	Whitefish (CL), smk/dry	5.85
4202	Whitefish (CL), baked	5.70
4211	Loche, baked	4.67
4150	Caribou (B), baked	4.51
4174	Black scoter/ducks, baked	1.59
4107	Whitefish head, baked	0.88
	% Total:	100

* = total ug reported on all 24-Hr recalls/season

Table 5.25: Seasonal Daily Intake of Polychorinated Biphenyls (ug) by Adult Men from Traditional Foods (Mean ± SD)

- Fort Good Hope -

Age (yrs)	Summer	Winter	Average
19-49	(n=58) 3.93±4.51[a]	(n=49) 3.60±4.46[a]	(n=107) 3.78±4.47
50+	(n=16) [NS]6.09±7.01[a]	(n=19) *6.25±4.99[a]	(n=35) *6.17±5.90
Avg (≥19)	(n=74) 4.40±5.18[a]	(n=68) 4.34±4.73[a]	(n=142) 4.37±4.95

- Colville Lake -

Age (yrs)	Summer	Winter+	Average
19-49	(n=10) 9.04±8.13[a]	(n=9) 7.46± 4.75[a]	(n=19) 8.29± 6.62
50+	(n=7) [NS]10.23±9.53[a]	(n=6) [NS]27.91±45.90[a]	(n=13) [NS]18.39±31.74
Avg (≥19)	(n=17) 9.53±8.46[a]	(n=15) 15.64±29.54[a]	(n=32) 12.39±20.99

* = a significant difference (t-test) between mean PCB intakes of 19-49 vs 50+ yr old men ($p \leq 0.05$)
** = a significant difference at $p \leq 0.01$
*** = a significant difference at $p \leq 0.005$
[NS] = a non-significant difference (t-test) between mean PCB intakes of 19-49 vs 50+ yr old men
[a,b] = different letter superscripts across rows indicate significant seasonal variation in mean PCB intake ($\alpha=0.05$)
\+ = outpost camps

As in the current research, Kuhnlein (1989b) found an increased PCB intake with age in women. However, the magnitude of the intakes was much higher in the Inuit studied by Kuhnlein (1989b). While Inuit women 20-40 years of age consumed an average of 25 ± 31 ug PCBs per day, women ≥60 were found to consume 42 ± 31 ug daily. Similarly, PCB intake in men increased up to the age of 60 although after this age it fell to less than half the mean intake of men aged 41-60. Thus, men 20-40 years of age consumed 43 ± 40 ug PCBs/day while men aged 41-60 consumed 68 ± 53 ug of PCBs daily. These relatively high PCB intakes result from the consumption of sea mammal fat. The PCB intakes of the Hareskin are comparatively lower.

Kuhnlein (1989b) found September to be the month with the highest PCB intake (the population average was 18 ug PCBs/day) while March had the lowest PCB consumption (7 ug/day). These findings were similar in timing to the results seen for younger FGH women for whom the summer (July/August) was the season of highest PCB intake (Table 5.22). Similarly, winter and spring had lower PCB intakes for Hareskin women. The higher consumption of caribou, with a concomitant decrease in sea mammal (for the Inuit) and fish (for the Hareskin) intake in the winter, may be implicated.

5.5.2 Intake of PCBs Relative to the Tolerable Daily Intake Level

5.5.2.1 Weight Data

Since a comparison of PCB intakes with the tolerable daily intake level requires a value for body weight, body weights of the Hareskin were measured. Data presented in the literature review suggest that the weights obtained in the Nutrition Canada Indian Survey were probably higher than those of the Dene (HWC, 1980; Mann et al., 1962; Szathmary and Holt, 1983).

Table 5.26 presents the combined average weights (indoor clothes, no shoes) of adults from FGH and CL. A wide range of weights is clear for each age and sex group with mean weights remaining relatively consistent with age. Median weights more closely paralleled mean weights in men than women. Raw weight

data for FGH and CL adults appear in Appendices 9 and 10.

Comparison of weight data with that obtained by Mann et al. (1962) from Athabaskan Indians in Alaska and by the Nutrition Canada Indian Survey (HWC, 1980) is difficult due to variations in age-grouping. However, Hareskin women were found to be lighter at 50+ years (59.1 ± 12.9 kg) than those aged 65 and older studied by Mann et al. (1962) who had an average weight of 64 6 kg Similarly, Native Indian women (50-59 years) participating in the Nutrition Canada Survey had an average weight 13 kg higher than that of Hareskin women aged 50 and over.

Table 5.26: Adult[1] Weights[2] (kg)

- Female -

Age	n	Mean ± SD	Range	Median
19-49	74	60.2 ± 9.6	44.0 - 86.6	57.7
50+	31	59.1 ± 12.9	38.6 - 98.9	55.6
Total (19+)	105	59.9 ± 10.7	38.6 - 98.9	56.9

- Male -

Age	n	Mean ± SD	Range	Median
19-49	98	71.6 ± 10.4	52.1 - 104.7	70.2
50+	36	72.0 ± 13.7	47.5 - 98.9	71.0
Total (19+)	134	71.7 ± 11.4	47.5 - 104.7	70.4

[1] from Fort Good Hope and Colville Lake
[2] indoor clothes, no shoes

Alaskan Athabaskan women 45-54 years of age had an average weight of 72.3 kg which is substantially higher than the 60.2 ± 9.6 kg found in this study for women 19-49 years of age. Nutrition Canada found the lightest mean weight of adult Indian women to be 61.5 ± 13.3 kg which is somewhat heavier than the lightest weight found for Hareskin women (60.2 ± 9.6 kg). In contrast, the average weight of Dogrib women aged 21 and over (58.4 kg) determined by Szathmary and Holt (1983) was very similar to that found for Hareskin women aged ≥ 19 years (59.9 ± 10.7 kg).

Weights for men obtained in the current study are close to those found for men by Mann et al. (1962). For example, men over the age of 50 years were found to have an average weight of 72.0 ± 13.7 kg while Mann et al. (1962) found the average weight of men ≥65 years to be 72.3 kg. Unlike women who weighed less than those studied by Mann et al. (1962), men 19-49 years of age were found to have an average weight of 71.6 ± 10.4 kg which was higher than that found by Mann et al. (1962) for those aged 45-54 (67.3 kg). Similarly, the mean weight of Dogrib men aged ≥21 years (66.6 ± 9.9 kg) was lower than that of Hareskin men aged 19 and over (71.7 ± 11.4 kg) (Szathmary and Holt, 1983). As with women, Nutrition Canada weights for Native Indian men (50-59 years) were substantially higher (77.4 ± 13.8 kg) than those found for Hareskin men over the age of 50 (72.0 ± 13.7 kg).

Thus, the weights obtained for the Hareskin were reasonable within the context of existing literature on the weights of northern Native Indians and are a more reasonable choice to use in PCB intake calculations for the Hareskin than are the Nutrition Canada data.

5.5.2.2 Comparison of PCB Intakes with Tolerable Daily Intake Level

As noted in the literature review, the TDI for PCBs is ≤1 ug/kg body weight/day (Grant, 1983). Figures 5.7 and 5.8 illustrate the mean intake of PCBs on a kg body weight basis by adult women and men from FGH and CL averaged over three and two seasons, respectively. It is clear that the vast majority of

individuals consume less than 25% of the TDI. Only one woman and one man consumed greater than the TDI. The woman was an older woman from CL who reported consuming 4.5 kg of trout on a single 24-Hr recall taken in the winter. Her PCB intake was 1.7 times the TDI (Table 5.27). In the spring and summer seasons her PCB intake was below the TDI. The man was also an older man from CL whose single winter 24-Hr recall reported the consumption of 3.5 kg of dry whitefish. His PCB intake was also 1.7 times the TDI (Table 5.28).

In contrast to these findings, the average PCB intake of Inuit adults ≤65 years on a body weight basis was between 50 and 75% of the TDI, with a maximum intake of over 3 ug/kg body wt/day. Older adults tended to consume even higher levels of PCBs (Kuhnlein, 1989b).

Younger individuals and residents of FGH tended to consume lower proportions of the TDI for PCBs than older individuals and residents of CL (Tables 5.27 to 5.30). Once again, this is a reflection of the higher traditional food use of older people in more remote communities. It is also probably influenced by the higher fish consumption in CL.

It is important to note that while a single 24-Hr recall can be a valuable tool for characterizing group means, it is not considered to be representative of an individual's usual intake (Sanjur, 1980). The central limit theorem suggests that while the spread of values on any one day may be very large, a tighter distribution would be found when considering the usual intakes of individuals (i.e. the mean of many non-adjacent days of observation). In this case, if usual PCB intakes were calculated, more individuals would be expected to fall into the category of consuming less than 25% of the TDI. Further, since average weight data was used with the 24-Hr recall data, calculations of an individual's PCB consumption as a percentage of the TDI is not meaningful on its own. It is also noteworthy that the TDI is not an absolute boundary between safety and physiological damage. It was set with a 100-fold safety factor based on results from studies discussed earlier.

Figure 5.7

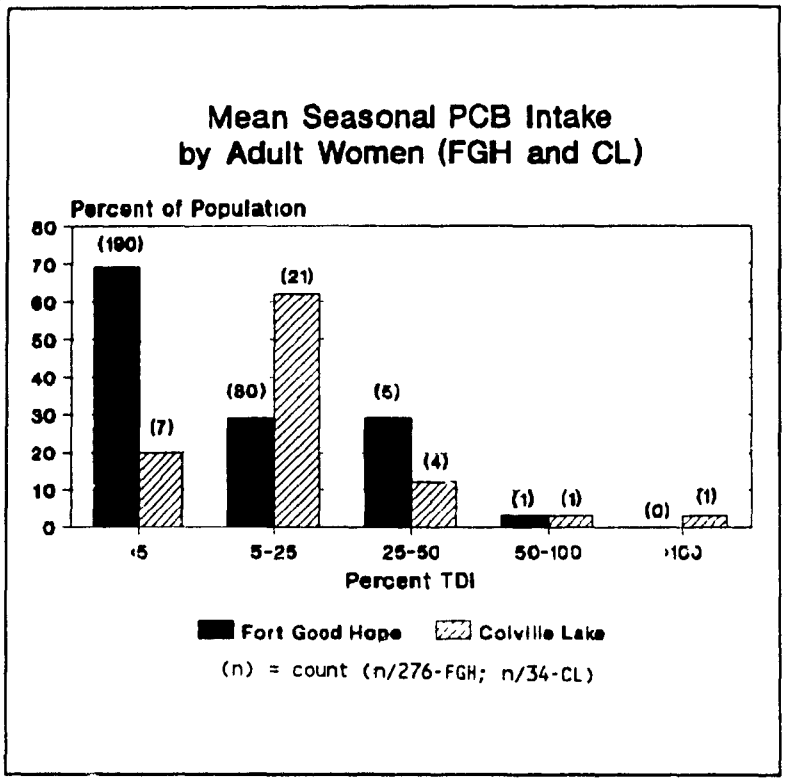


Figure 5.8

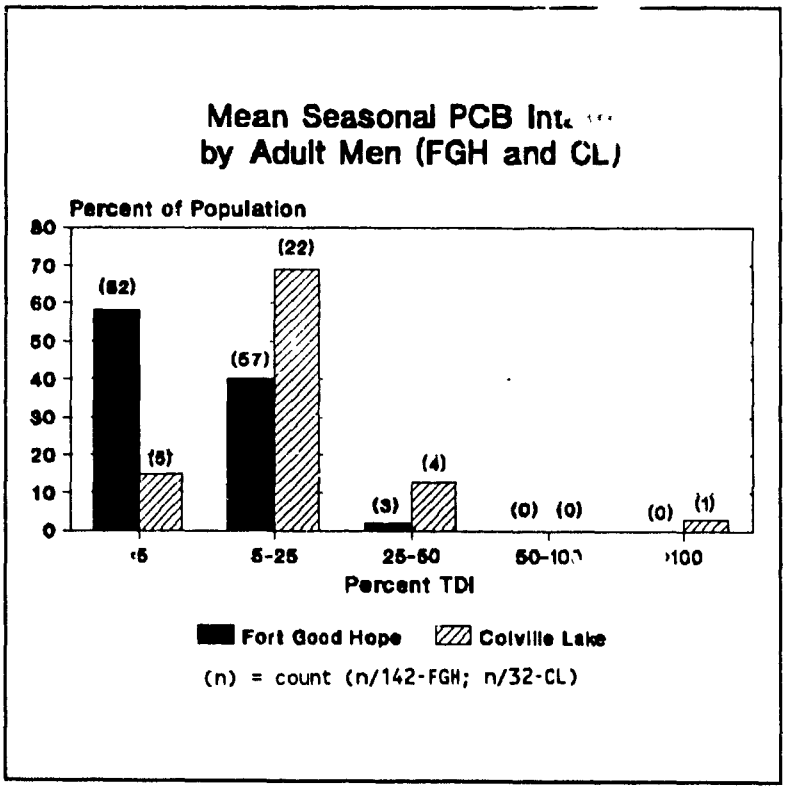


Table 5.27: Count and Percent of Adult Women (50+ yrs) Consuming Selected Proportions of the Tolerable Daily Intake (TDI)[1] for PCBs (by Season)

- Fort Good Hope -

% TDI	Summer (n=17)	Winter (n=24)	Spring (n=42)	Total (n=83)
< 5	10 (59%)	11 (46%)	24 (57%)	45 (54%)
5- 25	6 (35%)	11 (46%)	18 (43%)	35 (42%)
25- 50	1 (6%)	1 (4%)	0 (0%)	2 (2%)
50-100	0 (0%)	1 (4%)	0 (0%)	1 (1%)
>100	0 (0%)	0 (0%)	0 (0%)	0 (0%)
RANGE	0-27.4%	0-91.6%	0-23.8%	0-91.6%

- Colville Lake -

% TDI	Summer (n=3)	Winter[2] (n=3)	Spring (n=8)	Total (n=14)
< 5	0 (0%)	0 (0%)	2 (25%)	2 (14%)
5- 25	2 (67%)	2 (67%)	6 (75%)	10 (72%)
25- 50	1 (33%)	0 (0%)	0 (0%)	1 (7%)
50-100	0 (0%)	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	1 (33%)	0 (0%)	1 (7%)
RANGE	6.4-26.2%	10.0-170.6%	0-18.6%	0-170.6%

[1] TDI = ≤1 ug/kg body wt/day
[2] Outpost camps

Table 5.28: Count and Percent of Adult Men (50+ yrs) Consuming Selected Proportions of the Tolerable Daily Intake (TDI)[1] for PCBs (by Season)

- Fort Good Hope -

% TDI	Summer (n=16)	Winter (n=19)	Total (n=35)
< 5	7 (44%)	9 (47%)	16 (46%)
5- 25	8 (50%)	9 (47%)	17 (49%)
25- 50	1 (6%)	1 (6%)	2 (5%)
50-100	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	0 (0%)	0 (0%)
RANGE	0-31.4%	1.9-26.9%	0-31.4%

- Colville Lake -

% TDI	Summer (n=7)	Winter[2] (n=6)	Total (n=13)
< 5	2 (29%)	1 (17%)	3 (23%)
5- 25	3 (42%)	3 (49%)	6 (46%)
25- 50	2 (29%)	1 (17%)	3 (23%)
50-100	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	1 (17%)	1 (8%)
RANGE	0-33.9%	2.7-166.1%	0-166.1%

[1] TDI = ≤1 ug/kg body wt/day
[2] Outpost camps

Table 5.29: Count and Percent of Adult Women (19-49 yrs) Consuming Selected Proportions of the Tolerable Daily Intake (TDI)[1] for PCBs (by Season)

- Fort Good Hope -

% TDI	Summer (n=64)	Winter (n=58)	Spring (n=71)	Total (n=193)
< 5	42 (65%)	43 (74%)	60 (85%)	145 (75%)
5- 25	19 (30%)	15 (26%)	11 (15%)	45 (23%)
25- 50	3 (5%)	0 (0%)	0 (0%)	3 (2%)
50-100	0 (0%)	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	0 (0%)	0 (0%)	0 (0%)
RANGE	0-41.2%	0-13.7%	0-15.0%	0-41.2%

- Colville Lake -

% TDI	Summer (n=7)	Winter[2] (n=7)	Spring (n=6)	Total (n=20)
< 5	1 (14%)	3 (43%)	1 (17%)	5 (25%)
5- 25	4 (58%)	4 (57%)	3 (50%)	11 (55%)
25- 50	1 (14%)	0 (0%)	2 (33%)	3 (15%)
50-100	1 (14%)	0 (0%)	0 (0%)	1 (5%)
>100	0 (0%)	0 (0%)	0 (0%)	0 (0%)
RANGE	0-61.4%	2.3-19.8%	4.0-32.6%	0-61.4%

[1] TDI = ≤1 ug/kg body wt/day
[2] Outpost camps

Table 5.30: Count and Percent of Adult Men (19-49 yrs) Consuming Selected Proportions of the Tolerable Daily Intake (TDI)[1] for PCBs (by Season)

- Fort Good Hope -

% TDI	Summer (n=58)	Winter (n=49)	Total (n=107)
< 5	35 (60%)	31 (63%)	66 (62%)
5- 25	23 (40%)	17 (35%)	40 (37%)
25- 50	0 (0%)	1 (2%)	1 (1%)
50-100	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	0 (0%)	0 (0%)
RANGE	0-22.8%	0-36.0%	0-36.0%

- Colville Lake -

% TDI	Summer (n=10)	Winter[2] (n=9)	Total (n=19)
< 5	1 (10%)	1 (11%)	2 (11%)
5- 25	8 (80%)	8 (89%)	16 (84%)
25- 50	1 (10%)	0 (0%)	1 (5%)
50-100	0 (0%)	0 (0%)	0 (0%)
>100	0 (0%)	0 (0%)	0 (0%)
RANGE	2.0-38.7%	1.8-24.8%	1.8-38.7%

[1] TDI = ≤1 ug/kg body wt/day
[2] Outpost camps

5.6 Variations in Nutrient and PCB Intake According to Frequency of Traditional Food Use

In each study season, FGH households were ranked according to their traditional food use scores (FFQ) as described in section 4.4. The resulting distributions were divided into thirds. Households falling into the lower third of the distribution for a given season were defined as having a "low" level of traditional food use while those in the top third were deemed to have a "high" level of traditional food use. Households in the middle third of the distribution were said to have a "medium" level of traditional food use.

Descriptive data was calculated for households in each traditional food use (i.e. level) category for each survey season. These data included sample size, mean score, range, and median (Table 5.31). While a clear trend was observed towards increased scores with higher levels of traditional food use in each season, the range boundaries were very close thereby leading to high standard deviations for the mean scores.

Using individual intake data for the oldest woman per household, paired t-tests between market and traditional food contribution to nutrient intake were conducted for each food use level in each season. Analyses of variance for both nutrients and PCBs were conducted both across seasons per food use level as well as across food use levels per season.

Unlike Wein (1989) who, using essentially the same method, determined that frequent (i.e. high) users of traditional foods consumed greater levels of protein and iron per 1000 kcal than infrequent (i.e. low) users, results obtained in the current study are not reported due to their inconclusiveness. It is possible that the larger sample size per food use category of Wein (1989) contributed to the evidence of differences through a minimization of sample variability. Another potential contributing factor may be the use of the FFQ to assign food use levels since it requests average family traditional food use data versus individual data. This may be important since a given individual, in this case the oldest woman in

the household, may not follow the household's consumption pattern. Further, as the FFQ obtains data for the preceding two months while the 24-Hr recall obtains data for the preceding day, the passage of time may have contributed to altered dietary intakes In addition, the FFQ does not obtain quantitative information about intake. Therefore, while a household's score may be low because the members do not consume a large variety of foods, the same individuals may consume large quantities of these foods.

Non-quantitative food frequency data is most useful for defining commonly used foods on a household basis and for helping to ensure that non-response bias due to non-representative interviewing of high, medium, and low traditional food-using households does not occur.

5 7 **Traditional Food Composition**

Much of the preceding nutrient and PCB intake data can be understood within the context of information on the composition of traditional foods.

5.7.1 Retinol Content

As noted in section 2.3.4 very few rich sources of vitamin A exist in the general food system. Likewise, the traditional food system of the Hareskin has a limited supply of vitamin A-rich foods as seen from Table 5.32. Traditional food sources of provitamin A carotenoids were not considered.

At 32,400 RE/100g, baked caribou liver is seen to be a richer source of vitamin A than other livers including moose, loche, and beaver (Table 5.32). The relatively high standard deviations seen are not unusual in trace work (Thompson and Duval, 1989). While the vitamin A content of caribou liver (32,400 RE/100g) was found to be almost three times that of beef liver (10,700 RE/100g), moose liver values (10,300 RE/100g) were virtually identical to those of the beef liver (HWC, 1988a). Smoked/dried inconnu, smoked/dried goose, trout, and rabbit contain lesser amounts of vitamin A. The smoked/dried goose was prepared by hanging the boned, plucked, and gutted carcass of a Canada goose on a rack

Table 5.31: Level of Traditional Food Use Scores (Total Summed FFQ Mentions) for Fort Good Hope Households (by Season)

- Summer 1988 -

Level	n	Mean ± SD	Range	Median
High	21	160.7± 37.3	120.2-271.0	154.5
Medium	21	89.3± 17.1	65.0-118.5	87.3
Low	21	25.9± 20.1	0.2- 58.5	18.0

- Winter 1988 -

Level	n	Mean ± SD	Range	Median
High	18	47.8± 23.3	27.1-118.9	42.1
Medium	20	17.9± 3.3	13.0- 26.7	17.4
Low	20	8.0± 3.6	0.4- 12.7	7.9

- Spring 1990 -

Level	n	Mean ± SD	Range	Median
High	31	64.8± 20.6	43.0-139.0	61.0
Medium	31	25.7± 7.7	16.5- 41.0	24.5
Low	31	8.8± 4.5	0- 15.5	9.2

over a smoking fire, prepared from dry or driftwood, for a period of approximately one month. Smoked and raw bear also contained measurable levels of vitamin A. The smoked bear, containing 12.2 RE/100g, was prepared by smoking it for two days over a rotten wood fire after which it was frozen.

In general, animal muscle flesh was found to be a poor source of retinol. In contrast with HWC reports (1985, 1988a) which note a vitamin A content in cooked moose flesh of 52-58 RE/100g, this research found no vitamin A activity in cooked moose flesh although raw moose flesh was found to contain 1.2 RE/ 100g. Similarly, reports of 847 RE/100g in raw muskrat were not supported by this research which found only trace amounts of vitamin A activity in raw muskrat flesh (Mann et al., 1962) While the method used to analyze vitamin A was not noted in the latter reports, it is possible that the method(s) used was not highly specific It is also possible that the part of the animals sampled, or indeed the individual animals themselves, contained higher levels of vitamin A than the samples analyzed in this research.

Only fish flesh was found to contain all-trans dehydroretinol as expected from the literature (Table 5.32). Due to the fact that HPLC readings were taken at 325 nm (the maximum absorbance for all-trans retinol) versus 351 nm (the maximum absorbance for all-trans dehydroretinol), actual levels of all-trans dehydroretinol, and hence overall vitamin A activity, were underestimated (Parrish et al., 1985)

Thus, despite the presence of rich sources of vitamin A in the traditional Hareskin food system, such as the favoured loche liver with 2900 RE of vitamin A activity per 100 grams of cooked liver, the availability of a wider variety of market foods with provitamin A carotenoids, or which have been fortified with vitamin A, likely contributed to the higher vitamin A intake from market foods reported in section 5.3, particularly in FGH.

The use of the quality control procedures outlined in section 4.3.2 have all contributed to a high level of confidence in the results which were obtained. Vitamin A deterioration resulting from storage periods of up to two years for

Table 5.32 RETINOL CONTENT OF TRADITIONAL DENE FOODS (µg/100g

SPECIES	PART	PREPARATION	FOOD CODE	n	All-trans MEAN	All-trans ± SE	13-cis MEAN	13-cis BIOAC	13-cis ± SE	[illegible] MEAN	[illegible] BIOAC	[illegible] ± SE	[illegible]
Caribou-B	liver	baked	4153	2	30700	7270	2230	1670	52.3	[illegible]	[illegible]	[illegible]	[illegible]
Caribou-B	liver	raw	4152	2	29600	10000	1620	1220	207	[illegible]	[illegible]	[illegible]	[illegible]
Moose	liver	raw	4134	5b	15400	6970	2140	1610	311	[illegible]	[illegible]	[illegible]	[illegible]
Moose	liver	baked	4135	3a	9150	3400	1500	1120	524	[illegible]	[illegible]	[illegible]	[illegible]
Loche	liver	raw	4212	6	2780	2000	143	108	165	[illegible]	[illegible]	[illegible]	[illegible]
Loche	liver	baked	4129	4	2400	3600	110	82.5	132	[illegible]	[illegible]	[illegible]	[illegible]
Beaver	liver	raw	4352	1	547	[illegible]	211	158	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Inconnu	flesh	smoke/dry	4111	1	32.3	[illegible]	4.1	3.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Goose	flesh	dried	4268	2	50.2	3.1	18.8	14.1	2.1	[illegible]	[illegible]	[illegible]	[illegible]
Trout	flesh	baked	4217	4b	49.2	33.3	5.8	4.3	4.3	[illegible]	[illegible]	[illegible]	[illegible]
Rabbit	flesh	raw	4163	1	46.3	[illegible]	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Trout	flesh	raw	4216	1	19.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loche	head	baked	4223	1	18.9	[illegible]	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bear	flesh	raw	4277	1	13.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	flesh	smoke/dry	4103	3*	10.8	3.3	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bear	flesh	smoke	4378	1	12.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loche	skin	baked	4224	1*	10.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	flesh	baked	4102	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	flesh	raw	4101	5	[illegible]	[illegible]	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loche	flesh	baked	4211	2	5.9	5.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Beaver	tail	baked	4161	2a	7.7	7.7	tr	tr	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Inconnu	flesh	smoke/bake	4112	1	tr	0.0	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Caribou-B	flesh	raw	4149	6	3.3	5.2	0.4	0.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loche	flesh	raw	4210	4	2.7	5.5	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rabbit	flesh	boiled	4164	2a	2.7	2.7	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Pike	flesh	bake	4207	2	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moose	flesh	raw	4131	6	1.2	2.8	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loche	skin	raw	4289	1*	tr	0.0	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	eggs	raw	4104	2	tr	0.0	tr	tr	0.0	0.0	[illegible]	[illegible]	[illegible]
Muskrat	flesh	raw	4166	1	tr	[illegible]	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moose	blood	raw	4138	1	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ptarmigan	flesh	baked	4170	1	tr	[illegible]	tr	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Caribou-W	flesh	raw	4278	1	tr	[illegible]	0.0	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Moose	lung	baked	4137	1	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Beaver	flesh	baked	4159	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moose	flesh	smoke/dry	4254	1	tr	[illegible]	[illegible]	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Caribou-B	flesh	baked	4150	2	tr	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pike	flesh	raw	4121	2	tr	[illegible]	tr	tr	[illegible]	tr	tr	[illegible]	[illegible]
Black scoter	flesh	baked	4174	1	0.0	[illegible]	tr	tr	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Beaver	feet	baked	4232	1	tr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moose	lung	raw	4136	1	tr	[illegible]	tr	tr	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	eggs	baked	4105	1	tr	[illegible]	tr	tr	[illegible]	[illegible]	tr	[illegible]	[illegible]
Whitefish-C	flesh	baked	4230	1	tr	0.0	tr	tr	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish-C	flesh	raw	4231	1	tr	0.0	[illegible]	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Caribou-W	flesh	baked	4141	1	0.0	0.0	0.0	0.0	[illegible]	0.0	[illegible]	[illegible]	[illegible]
Cisco	flesh	baked	4117	1	[illegible]	0.0	0.0	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Cisco	flesh	raw	4116	1	0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	[illegible]
Whitefish	flesh	smoke/bake	4108	1	[illegible]	[illegible]	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Beaver	flesh	raw	4158	1	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Inconnu	flesh	baked	4110	1	0.0	[illegible]	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table [illegible] RETINOL CONTENT OF TRADITIONAL DENE FOODS ug/100g

SPECIES	PART	PREPARATION	FOOD CODE	n	All-trans MEAN	All-trans S E	13-cis MEAN	13-cis BIOACT	13-cis S E	D H MEAN	D H BIOACT	D H S E	Total Vit A Activ
Moose	flesh	baked	4132	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whitefish	head	baked	4107	1*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
Caribou-W	flesh	dried	4140	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beaver	flesh	dry	4160	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cisco	flesh	smoke/dry	4118	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inconnu	flesh	raw	4109	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]

KEY

n = number of independent samples analyzed
* = composite sample
a = includes one repeat of one sample
b = includes one repeat of two samples
S E = standard error (standard deviation if one sample analyzed)
D H = dehydroretinol
BIOACT = bioactivity (for 13-cis=13-cis mean x 0.75; for D H =D H mean x 0.40)
tr = trace (peak evident but non-quantifiable)

samples collected in 1988 do not appear to be a concern as values for the same food items obtained in 1990 are similar However, as high vitamin A-containing foods were not sampled in 1990, possible vitamin A deterioration in these tissues cannot be verified.

Biological variability, particularly in wild foods, is important to keep in mind when utilizing nutrient composition values derived from small numbers of samples Since the objective of this research was to obtain an overview of the contemporary diet of the Sahtú (Hareskin) Dene/Metis, it was more important to collect and analyze a wide variety of foods in comparison to obtaining more precise data for a few foods. In addition, as foods do not contain a homogeneous distribution of vitamin A, results expressed "per 100g" are not intended to imply that every 100g portion will contain the stated level of vitamin A (Thompson, 1986)

5.7.2 Protein, Iron and Zinc Content

Due to the predominance of meats in the traditional component of the diet, it is not surprising that traditional foods were found to contribute significantly more protein, iron, and zinc to the diets of the Hareskin than were market foods (see section 5.2). However, when the protein, iron, and zinc composition of wild meats was compared to that of market meats, it was evident that wild meats were denser in these nutrients. Table 5.33 shows the nutrient composition of hamburger and pork chops, the two most widely consumed market meats, in comparison to moose and caribou, the two most widely consumed traditional meats

It was clear that, despite the lower moisture content of the market meats, traditional meats were generally higher in protein, iron, and zinc than market meats. In contrast, although the level is low, pork had more vitamin A than did traditional meats (Table 5.33).

The protein content of caribou (28%) determined in the current research was lower than the value of 38% reported by HWC (1985, 1988a). Unfortunately, no moisture value was reported by HWC (1985, 1988a). It is possible that higher moisture loss could have resulted in the higher protein value reported by HWC

(1985, 1988a) although iron and fat levels are similar. The location from which the muscle was obtained, or the presence of connective tissue, may also conceivably influence moisture and protein concentrations. Interestingly, the moisture, protein, fat, and iron content of raw caribou was within the ranges reported by Mann et al. (1962), Hoppner et al. (1978), and Farmer et al. (1971), suggesting that differences in cooking technique may indeed have influenced the protein contents of the cooked caribou (Appendix 2; HWC, 1985 and 1988a). The zinc content of the caribou was similar to that reported by Hoppner et al. (1978).

Table 5.33: Relative Nutrient Contents of Selected Cooked Market and Traditional Meats (/100g)

Meat Type	Moisture (%)	Protein (g)	Iron (mg)	Zinc (mg)	Vit. A (RE)
Market:[a]					
Hamburger	52	24	2.5	5.4	0
Pork chops	52	28	0.8	1.9	3
Traditional:[b]					
Moose	61	35	5.1	7.5	0
Caribou	68	28	3.9	4.2	tr[c]

[a] from HWC, 1988a, zinc from Sabry, 1988
[b] see Appendix 6 and Table 5.32
[c] trace

The iron content of cooked moose in the current study is higher than that reported by HWC (1985, 1988a). Protein levels, however, are similar. Once again, cooking technique, sampling strategy, or biological variation may be implicated.

Nutrient values for black bear (raw and smoked), beaver tail, feet, liver, and dry meat, black scoter, caribou liver (raw and baked), Canada goose (smoked/dried), cisco (smoked/dried), inconnu (cooked, smoked/dried, smoked/baked), loche flesh, head, liver, and skin (cooked), moose blood, liver, and lung (raw and cooked), and whitefish esophagus (raw), head (cooked), eggs (raw and cooked), and flesh (smoked/baked) have not been previously reported and appear in

Appendix 2. Similarly, incomplete literature exists regarding the proximate composition and iron, zinc, and vitamin A content of beaver (raw and cooked), caribou (cooked), moose (raw and cooked), muskrat (raw), rabbit (raw and cooked), ptarmigan (cooked), cisco (raw and cooked), inconnu (raw), loche flesh and liver (raw), pike (raw and cooked), trout (raw and cooked), and whitefish (raw, cooked, dried). Nutrient data for the preceding foods appear in Appendix 2.

5.7.3 Polychlorinated Biphenyl Content

Toxaphene and PCBs were the two most prominent organochlorine contaminants found in traditional food samples collected in FGH and CL. While toxaphene was present only in fish species and muskrat flesh, PCBs were present in all samples (fish, mammal, bird, berry) analyzed (Muir et al., 1989, Appavoo, 1990).

The PCB content of traditional fish species and parts as consumed were all below the MRL of 2000 ng/g fresh weight (Grant, 1983) (Figures 5.9 to 5.11). However, as noted in section 2.3.5, the MRL may not apply to populations consuming fish at an average level of greater than 20g/day, which was certainly the case for the Hareskin.

Smoked/dried fish flesh tended to have higher PCB levels on a fresh weight basis than did baked flesh. Presumably, this was due to its higher lipid and lower moisture content. However, on a lipid weight basis the reverse was true due to the higher lipid content of smoked/dried fish (Appavoo, 1990). On a fresh weight basis, the fish with the highest PCB level was smoked/dried whitefish obtained in FGH (5.88 ug/100g) (Figure 5.9). At over 15.0 ug/100g (lipid weight), loche flesh, skin, and head collected in FGH were the highest sources of PCBs on a lipid weight basis. Due to its very high lipid content (42.8 grams), loche liver had the lowest level of PCBs on a lipid-weight basis (Figure 5.10 and Appendix 2). Perhaps reflecting their relatively high fat contents, trout and inconnu had the highest PCB levels on a fresh weight basis of the cooked fish fleshes analyzed (Figure 5.11).

Table 5.34 considered the variation in nutrient and PCB composition of

raw flesh and liver from the same loche. While the protein content of the flesh was higher than that of the liver, the liver contained more iron, zinc, vitamin A and PCBs than did the flesh. The role of the liver in vitamin A and iron storage contributed to the relatively high presence of these nutrients in this organ. The high fat content of the liver, together with its role in xenobiotic detoxification, likely promoted the accumulation of PCBs in this organ.

With a concentration of 1.87 ug/100g, inconnu sampled at FGH was found to have a PCB concentration higher than that previously reported (0.35 ug/100g) by Wong (1985) (Appendix 2). Raw loche liver obtained in CL was found to have a mean PCB level higher than the mean range previously reported by Lockhart et al. (1989) and Muir et al. (1990), while raw loche liver from FGH, raw cisco, and raw whitefish were found to have PCB levels similar to those previously reported by Wong (1985), Lockhart et al. (1989), and Muir et al. (1990). It is expected that differences in the age or sex of the 3 CL loche from which liver samples were obtained was responsible for the higher PCB levels found.

The low levels of PCBs in the organ and muscle tissues of animals and birds as consumed on a fresh weight basis are illustrated in Figures 5.12 to 5.14.

Table 5.34: Nutrient and PCB Composition (per 100g) of Raw Loche Flesh and Liver (Same Fish)

Tissue	Moisture (%)	Protein (g)	Fe (mg)	Zn (mg)	Vit A (RE)	PCB (ug)
Flesh	78.3	19.2	0.5	0.7	11.0	0.26
Liver	51.3	7.9	2.0[1]	1.2[1]	8690	3.46

[1] not analyzed (mean of 2 samples of raw loche liver from two different fish)

Figure 5.9

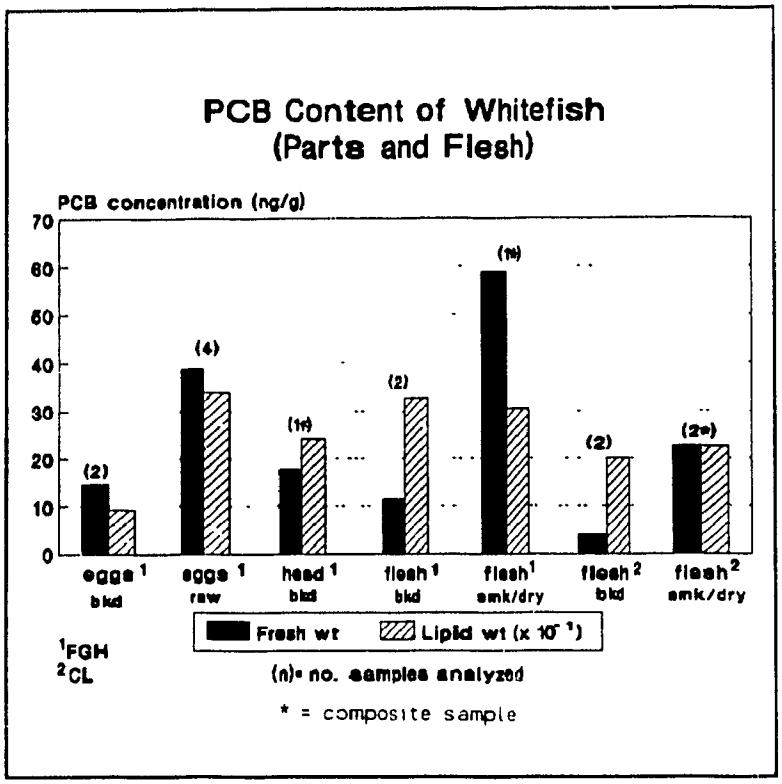


Figure 5.10

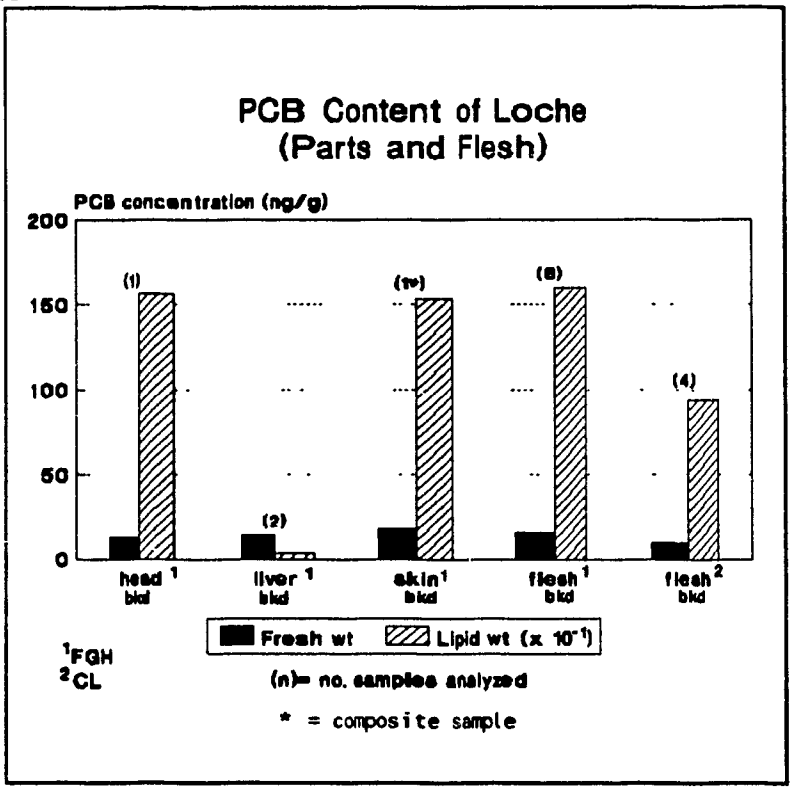


Figure 5.11

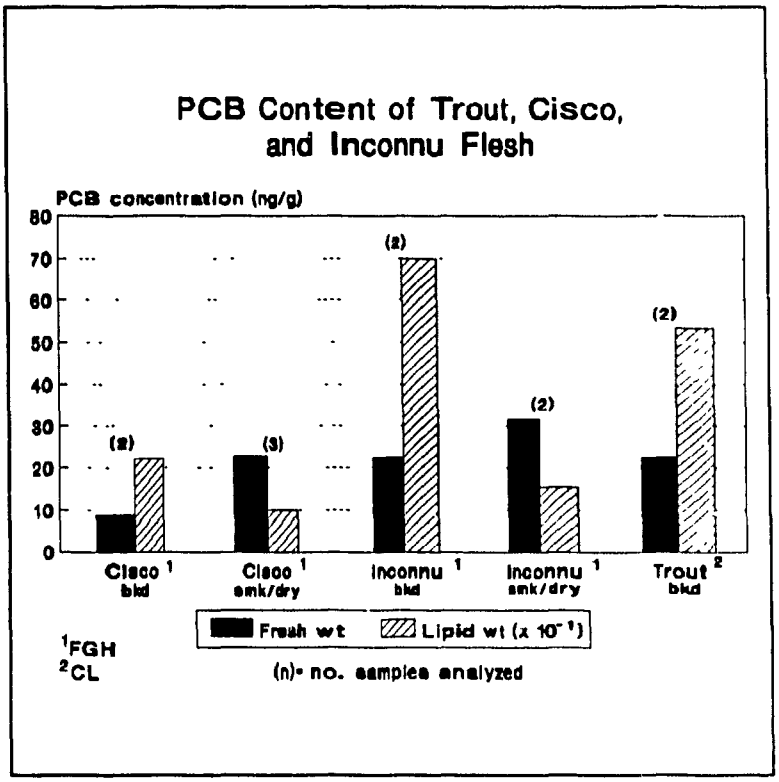


Figure 5.12

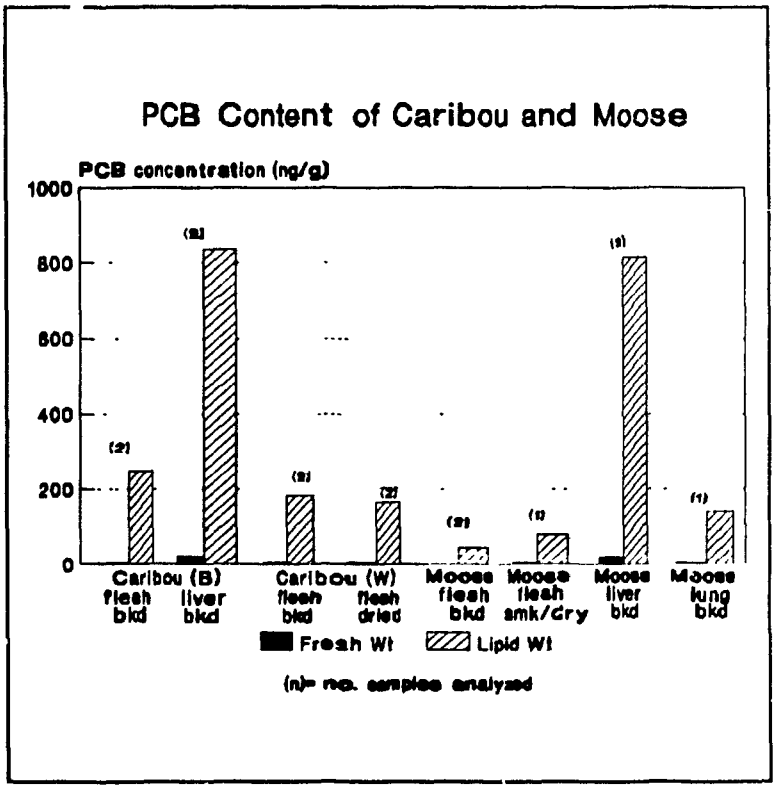


Figure 5.13

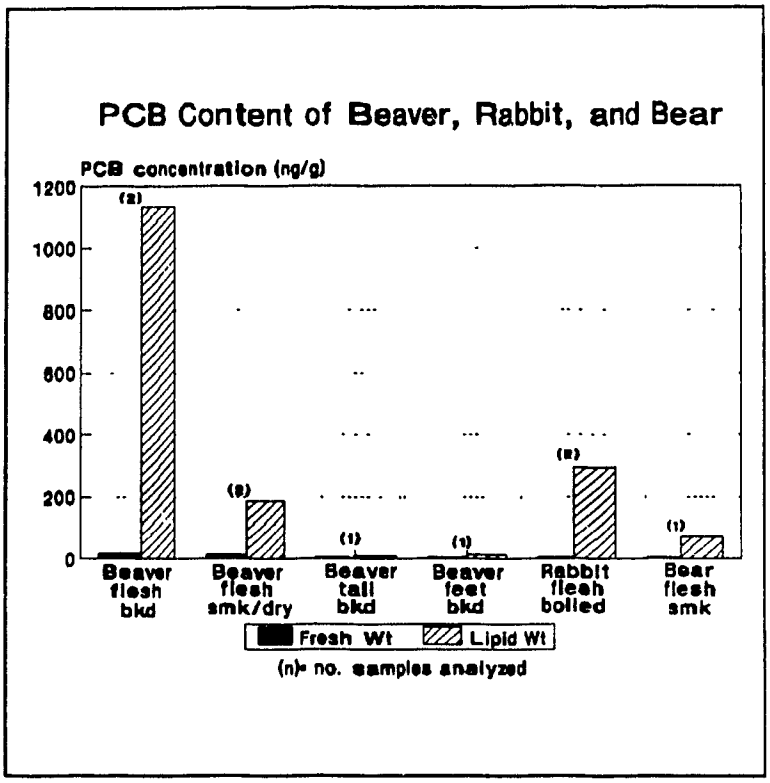
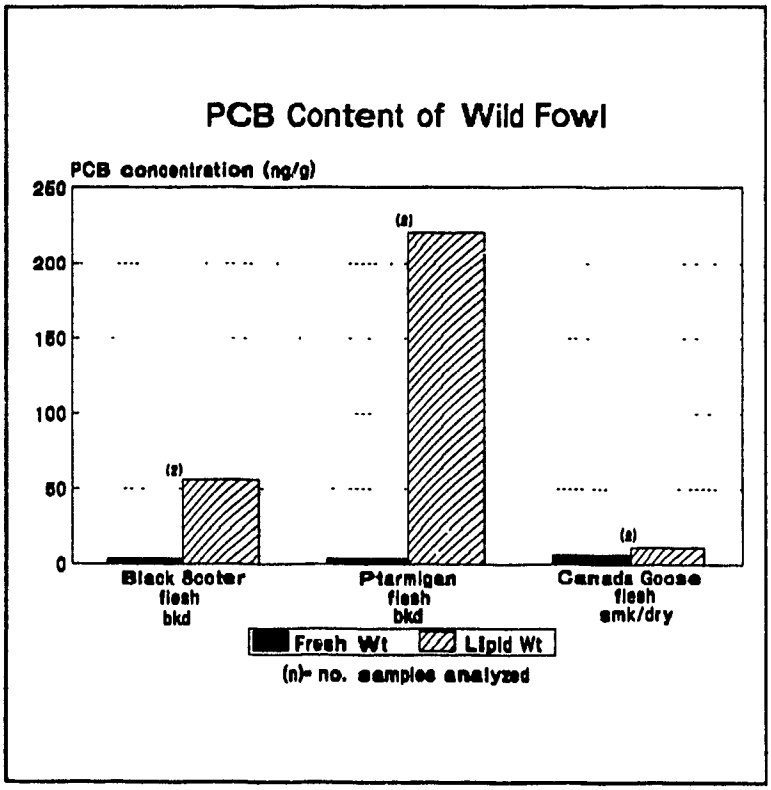


Figure 5.14



However, on a lipid weight basis the relatively high levels of PCBs in the flesh and organ tissue became evident.

The MRL for beef is expressed on a lipid weight basis and is currently set at 200 ng/g (Grant, 1983). If this value, based on an average daily beef consumption of 48 grams, is extended to wild meats and organs, it is clear that cooked beaver flesh had the highest excess (i.e over the 200 ng/g MRL) PCB content followed by cooked caribou and moose livers, cooked moose, and cooked ptarmigan. Other meats and organs (i.e. moose lung) were below the MRL for beef. The high fat content (54%) of smoked/dried Canada goose led to its relatively low PCB content on a lipid weight basis (Figure 5 14) At 0 52 ug/100g, the PCB content of barrenland caribou flesh was approximately half the level (0 9 ug/100g) reported by Kuhnlein and Kinloch (1988).

The reason for the relative accumulation of PCBs in beaver flesh as compared to beaver feet or tail, for example, which have higher fat contents is unknown. Perhaps there are differences in the metabolic potentials of the various tissues. Similarly, the PCB content of caribou and moose livers was excessively high when compared to the PCB level of liver (6.9 ng/g lipid weight) in the Canadian diet as reported by Mes et al. (1989). It is possible that the consumption of vegetation contaminated by PCBs by migrating caribou herds may be a contributing factor.

The nutrient and PCB content of various preparations (raw, baked, dried) of woodland caribou muscle flesh is presented in Table 5.35. As anticipated, the moisture content of the flesh decreased with cooking and again with drying. Concomitant with the moisture loss was an increase in the levels of protein, iron, and zinc. Vitamin A content declined with additional preparation such that cooked and dried caribou contained no vitamin A. The vitamin A value for cooked caribou was imputed from another cooked woodland caribou muscle sample. Non-homogeneous tissue distribution may explain the decrease in vitamin A with additional preparation as might potential oxidation during preparation. As with vitamin A, the PCB content of prepared flesh diminished with additional

preparation. This trend was more evident when calculated on a lipid weight basis (26.6, 12.2, and 7.6 ug/100g respectively for raw, cooked and dried flesh). It is possible that PCB loss through volatilization may have occurred during preparation (Trotter et al., 1989).

All berries analyzed were found to contain low levels of PCBs (see Appendix 2). Cloudberries had the highest concentration of PCBs at 1.22 ug/100g. No previous reports on the PCB levels of wild plant foods were found. Moreover, no data on the PCB content of traditional Hareskin foods other than of selected fish

Table 5.35: Nutrient and PCB Composition (per 100g) of Various Preparations of Woodland Caribou Flesh (Same Animal)

Preparation	Moisture (%)	Protein (g)	Fe (mg)	Zn (mg)	Vit A (RE)	PCB (ug)
Raw	76.7	21.0	4.3	6.7	tr	0.40
Baked	66.7	30.0	4.8	8.9	0[1]	0.22
Dried	14.0	72.4	13.1	11.1	0	0.22

[1] imputed

species and caribou, as noted earlier, have been published.

As noted in the literature review (section 2.3.5), the PCB content of animals, fish, and birds vary with a variety of factors including age, sex, trophic level, fat content, tissue analyzed, and preparation technique. As with the nutrient data, the small number of samples analyzed per food type precluded the ability to obtain a value considered to be representative of all of the latter factors. Therefore, while the values obtained should not be considered representative of the food type as a whole, they did provide a valuable idea of the relative contributions of various traditional food types to PCB intake when combined with intake data.

For example, summer in FGH was the season and location with the lowest

level of traditional food intake on a weight basis but the season of highest PCB intake for FGH women of child-bearing age. The average daily intake of traditional foods by adult women was 351 grams. As noted in Figure 5.1, approximately one third of the traditional food intake was from fish and another third from mammals Birds comprised 27% of the traditional food consumed while berries made up the remaining 6%. Thus, approximately 117 grams each of the 351 grams were derived from fish and mammals. If one considers that inconnu, a widely consumed fish in the summer, had a PCB content of 2.24 ug/100g, the PCB intake from the fish component would be 2.62 ug. Similarly, moose contained 0.29 ug/100g thereby making an average daily PCB contribution of 0.34 ug. Black scoter contained 0.32 ug/100g. If this value is multiplied by an intake of 95 grams, a calculated PCB intake of 0.3 ug would result. Finally, the PCB content of blueberries was 0.29 ug/100g. The contribution to PCB intake from the berry component of the diet therefore worked out to 0 06 ug. Thus, the total average daily PCB intake of an adult FGH woman in the summer would be approximately 3.32 ug or 0.06 ug/kg body weight. As this value was very close to the value of 3.26 ± 4.79 ug PCBs calculated for adult women 19-49 years of age from FGH (n=64) and relatively close to that of older women (n=17) (Table 5 22), confidence in the validity of the FFQ and individual food intake data was enhanced

The same pattern of calculations for the season and location of highest traditional food use (i.e. the winter hunting camps near CL), led to an average daily PCB intake of 10.89 ug or 0.18 ug/kg. This was higher than that calculated for young adult women (n=7), and lower than that calculated for older adult women (n=3) (Table 5.22). The high standard deviation for the PCB intake of older adult women, together with the fact that trout (relatively high in PCBs compared to whitefish) was the only fish accounted for in the calculations may have led to the discrepancy in results.

While the preceding calculations are only estimates, they illustrate the margin of safety which existed with respect to average PCB intake since the calculated intakes are only one sixteenth, and one sixth of the TDI respectively.

6.0 SUMMARY AND CONCLUSIONS

> An overriding consideration is the reality that the whole diet, not individual nutrients, is involved in the diet/health equation (HWC, 1990:11).

As predicted by hypothesis one (Section 3.0), results from the research indicate that seasonal differences in the types and amounts of traditional foods consumed by the Sahtú (Hareskin) Dene/Metis exist. These seasonal changes in traditional food use were found to lead to significant seasonal differences in the nutrient and PCB intake of certain age/sex sub-groups in FGH and/or CL.

Winter was found to be the season of highest traditional food use by adult women both on a total grams consumed basis as well as when considering contributions of the traditional component of the diet to total energy intake. By the same criteria, of the three seasons assessed, spring was found to be the season of lowest traditional food use in CL. This is not necessarily to say that spring would retain this status should an in-depth year-long study be conducted. It was expected that the limited access to aquatic food resources which occurs during spring break-up in CL was responsible for the diminished traditional food consumption in this season. Surprisingly, market food consumption by CL women in the spring was not enhanced to maintain energy intake. It is possible that CL women decreased their energy intake concomitant to a decrease in energy expenditure. Further research would be required to verify or refute this possibility. Despite the depressed traditional food intake of CL women in the spring season, the total grams of traditional foods consumed remained higher than that of FGH women.

In FGH, there was no clear differentiation between summer and spring with respect to grams of traditional food consumed or energy intake from traditional foods. This was despite variations in the types of traditional foods consumed in each season, as described below. Thus, for FGH women, there was no apparent season of "lowest" traditional food use for the three seasons assessed. Market

food consumption on the basis of both total energy consumption as well as on total grams consumed remained virtually constant throughout the study seasons in both communities.

Seasonal variations also existed in the proportions of different traditional food types (i.e. mammal, fish, bird, berry) used as determined by FFQ data, as well as in the use of individual species within these categories (FFQ and 24-Hr recall data).

Despite the fact that traditional food consumption by CL women was consistently found to be higher than that of FGH women, women in FGH reported consuming a larger variety of traditional foods (species and parts), particularly in the summer and spring seasons. The reason for the low variety of parts reported by CL women was unclear and not due to interviewer differences since, within a season, the same interviewers conducted the interviews in the two communities It is possible that the smaller sample size in CL together with the lower number of interview days contributed to this difference.

Fish was found to form a vital part of the diet of CL women In the summer, it constituted 60% of the traditional food consumed as determined by FFQ The proportion of the diet composed of fish products fell to approximately one third in the spring and one quarter in the winter. Nevertheless, fish was the most important food item on a total grams consumed basis in each season Further, fish contributed the largest proportion of the dietary intake of energy, protein, and vitamin A by CL women. Due to its high level of consumption, fish also contributed to the iron and zinc intake of the diets of CL women despite low tissue concentration of these nutritionally important trace elements.

In contrast, while FGH women reported fish consumption in each season, moose, caribou, and black scoter/other ducks appeared as the most important food items on a total grams consumed basis in the summer, winter, and spring respectively. The same foods contributed the majority of the dietary intake of energy, protein, iron, and zinc of FGH women. Rabbit was the most important source of iron in the winter season.

In general terms, the contribution of the traditional component of the diet to the protein, iron, and zinc intake of both men and women was significantly greater than that from the market food component, as predicted in hypothesis two. This was expected due to the meat-based nature of the traditional component of the diet and was true for each season, as anticipated in hypothesis six with the exception of a non-significant difference in iron intake of FGH men in the summer and non-significant differences in the iron and zinc intake of CL women in the spring. It was important to ascertain this, however, for the purpose of scientifically illustrating the extent of the nutritional benefits of traditional food use. Indeed, the protein intakes of CL residents were found to be higher than those reported in the existing literature for any other Native Canadian group.

In contrast, while there was no significant difference in the contribution of traditional and market foods to the vitamin A intake of CL adults in each season as speculated in hypotheses three and six, market foods were found to be significantly more important in each season to the intake of vitamin A by women and men in FGH than were traditional foods. The well-known high intra-individual variation in vitamin A intake may have precluded findings of occasional high intakes of vitamin A from traditional foods such as caribou liver.

On average, Hareskin women from both FGH and CL had intakes in excess of their RNIs for protein, iron, and zinc. This was anticipated in hypothesis four. As the protein is of a high quality, and since the iron and zinc are both relatively bioavailable, absorption and utilization of these nutrients is expected to be optimal.

The calculated intakes of vitamin A, however, were such that less than 50% of the RNI for vitamin A, on average, was attained by older (≥50 years) women from both FGH and CL and younger (19-49 years) women from CL. Once again, this finding was predicted in hypothesis four. Younger women from FGH attained an average of 60 ± 56% of the RNI for vitamin A. It is important to point out that many non-adjacent days of observation are needed in order to obtain a reliable estimate of usual vitamin A intake. Increased sample size is not adequate compensation for a low number of replicates (Gibson, 1990). It must also be

considered that as the RNI is set above the requirement of most individuals, failure to consume the RNI for a given nutrient can only lead to the conclusion that intakes are less than recommended (HWC, 1990).

The concentration of nutrients and PCBs in traditional food species varied with the preparation technique and the type of tissue analyzed The variation was largely attributable to moisture loss and possibly to the oxidation or volatilization of compounds such as vitamin A and PCBs during preparation

Although many gaps in the literature were found to exist regarding the nutrient and PCB content of the traditional foods of the Hareskin, data regarding the protein, iron, zinc, and PCB content of traditional foods were generally found to compare well with existing data. Vitamin A values for muskrat and moose were lower than those found in the literature The reason for the variation is unknown although it may reflect differences in the method of analysis, possible vitamin A deterioration of the samples, or geographical/seasonal differences in the tissues analyzed.

Polychlorinated biphenyls were found to be present in every traditional food analyzed, including berries. The levels in foods as consumed were generally below the relevant MRL except in the cases of beaver flesh, caribou and moose liver, moose flesh and ptarmigan flesh. Despite the high PCB levels of caribou liver on a lipid weight basis, its occasional consumption should not be problematic and would serve as a rich source of vitamin A. Notwithstanding its lipid-soluble nature, it was not possible to predict the presence of PCBs in given tissues based on fat content, particularly in the case of beaver. Reasons for the relatively high PCB levels in these tissues versus domesticated "equivalents" analyzed by Mes et al (1989) are unknown. In general terms, fish was the predominant dietary source of PCBs.

Despite the relatively high average intake of traditional foods by adult men and women in FGH and CL, in the context of the fact that PCBs were one of the two most prominent organochlorine contaminants found in the traditional foods (the other being toxaphene), average PCB intakes were still found to be below the

TDI as predicted by hypothesis five. The two individuals who had PCB intakes greater than the TDI (170% of the TDI) had recalls for other seasons which led to calculated PCB intakes less than the TDI. Thus, the usual PCB intake of these individuals was probably less than the TDI As anticipated in hypothesis six, most of the population was found to consume less than 25% of the TDI in each season studied The summer intake of PCBs by young (19-49 years) adult women was significantly higher than that of the other seasons. This was probably due to an elevated fish consumption during the summer season. At the mean level of consumption, PCB intake during this season was still only 5% of the TDI. Therefore, adults consuming a variety of Dene foods at the average level of consumption are not at risk of exceeding the current TDI for PCBs.

The weights used in the calculations of the proportion of the TDI consumed were obtained from the Hareskin population. These weights were lowere on average than those found for Indian people by Nutrition Canada (HWC, 1980).

Contrary to hypothesis six, level of traditional food use (i.e. high, medium, or low) was not found to predict nutrient or PCB intake. Numerous factors may have influenced this finding including the small sample size of each level of traditional food use group which may have contributed to a high level of variability, and a potential lack of correlation between the family food frequency data and the corresponding single 24-Hr recall data.

All research involving dietary assessment has inherent limitations. First of all, there is no means by which to obtain "usual" intake data (Block, 1982). Comparisons of FFQ and 24-Hr recall data can provide a general idea as to the reasonableness of the data, but a determination of the degree to which the data represents usual intake remains obscure. This is of particular concern for the calculation of vitamin A intake.

Used in conjunction with intake data, food composition data can provide only a rough estimation of the intake of a nutrient or contaminant since preparation techniques, storage conditions, and seasonal and biological variation, for example, can influence the nutrient and contaminant composition of food items.

Finally, comparison of nutrient intake data with standards is fraught with difficulties since nutrient requirements vary among individuals Comparison of PCB intake with the TDI is also tenuous since the TDI is based on limited animal data. Further, it is unknown what influence such factors as nutritional status, physiological status, and the intake of other contaminants may have on the vulnerability of a given individual to physiological disruption through the ingestion of PCBs.

Hence, it must be understood that dietary assessment is not intended to serve as a proxy for complete nutritional or toxicological assessment. The value of dietary assessment in the context of this research lies in its ability to provide general data on exposure to nutrients and/or contaminants which can indicate directions for future effort.

In conclusion, it is inescapable that PCBs were found in the contemporary food system of the Sahtú (Hareskin) Dene/Metis. However, the current levels of PCB intake did not indicate a risk on a population basis when interpreted according to the accepted TDI. Further, the nutritional benefits of traditional food use as assessed in this research were obviously substantial. Thus, a balanced combination of market and traditional foods has the potential to be safe, nutritious, practical, and satisfying.

In consideration of the high average level of meat and fish consumption by northern Native Canadians in comparison to that of the general Canadian population, the development of locally relevant MRLs for PCBs in traditional foods would seem reasonable. A better understanding of the PCB content of market foods consumed in the north would be beneficial. Further, in view of the possibility of inadequate vitamin A intake by adult Hareskin women, PCB intakes should be monitored due to their ability to further compromise vitamin A status as noted in section 2.3.5 of the literature review. A more definitive study on the usual vitamin A intake of the Hareskin People, together with a functional or biochemical test of vitamin A status, should also be considered.

More data are required to improve information gaps on the benefits and

risks of the contemporary Sahtú (Hareskin) Dene/Metis food system. Specifically, more food sampling would be helpful to precisely define age, sex, body part, and preparation technique differences in PCB isomer levels in food species consumed. Data on contaminant/contaminant and contaminant/nutrient interactions are also needed. Long-term, community-specific intake studies would be beneficial in order to better characterize usual PCB and nutrient intakes over extended periods of time and at physiologically susceptible stages. Also, more data regarding the toxicity of various PCB isomers would also be useful.

An assessment of perceived risks would be useful such that any concerns regarding the safety of traditional food use can be dealt with. An acknowledgement of perceived risks is important since they may preclude an acceptance of the most confident assurances of the levels of "real" risk, particularly if there is an unequal distribution of burdens and benefits (Freudenburg, 1988).

However unattainable zero-risk in food is, the fact remains that striving towards it is an important goal socially, physiologically and environmentally.

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Appendix 1

Food Sample Harvest Date and Source[a]

LAB NO[b]	NO	SPECIES	PART	PROCESS	HARVEST DATE
9022F1a1	88	Bear	flesh	raw	13-Jun-90
9022F1a3	89	Bear	flesh	smoked	15 Jun 90
807F1i1	36	Beaver	feet	baked	15 Jun 88
807F1a2	34	Beaver	flesh	baked	15-Jun-88
807F2a2	35	Beaver	flesh	baked	15-Jun-88
807F1a3	37	Beaver	flesh	dry	15-Jun 88
807F2a1	35	Beaver	flesh	raw	15-Jun 88
807F1a1	34	Beaver	flesh	raw	15-Jun [illegible]
807F2a3	56	Beaver	flesh	smk/dry	30 Aug 88
807F1h2	36	Beaver	tail	baked	15-Jun 88
9007F1b1	90	Beaver	liver	raw	13-Jun 90
812F1a2	60	Black Scoter	flesh	baked	15-Nov [illegible]
812F2a2	61	Black Scoter	flesh	baked	30 Sep [illegible]
818F1a1	41	Blackberry	berry	raw	24-Aug [illegible]
9018F1a1	95	Blackberry	berry	raw	[illegible]
815F1a1	38	Blueberry	berry	raw	[illegible]
9023F1a3	92	Canada Goose	flesh	smk/dry	[illegible]
9023F2a2	94	Canada Goose	flesh	smk/dry	[illegible]
809F2a2	48	Caribou-B	flesh	[illegible]	[illegible]
809F1a2	47	Caribou-B	flesh	baked	[illegible]
809F2a1	48	Caribou-B	flesh	raw	25-Oct-[illegible]
809F1a1	**47**	**Caribou-B**	**flesh**	**raw**	**17-Nov-88**
809F1b2	49	Caribou-B	liver	baked	15 Nov [illegible]
809F2b2	50	Caribou-B	liver	baked	15 Nov
809F2b1	**50**	**Caribou-B**	**liver**	**raw**	**15-Nov-88**
809F1b1	49	Caribou-B	liver	raw	15-Nov 88
9009F1a1	85	Caribou-B	flesh	raw	05 Jun [illegible]
9009F2a1	86	Caribou-B	flesh	raw	03 Jun 90
9009F3a1	**87**	**Caribou-B**	**flesh**	**raw**	**02-Aug-90**
9009F3x1	**87**	**Caribou-B**	**flesh**	**raw**	**02-Aug-90**
821F1a2	51	Caribou-W	flesh	baked	17-Nov-88
821F2a2	52	Caribou-W	flesh	baked	26-Nov 88
821F2a3	53	Caribou-W	flesh	dried	15 Nov 88
821F1a3	51	Caribou-W	flesh	dried	17-Nov 88
821F1a1	51	Caribou-W	flesh	raw	17 Nov-88
821F2a1	52	Caribou-W	flesh	raw	26-Nov 88
803F1a2	17	Cisco	flesh	baked	16-Jul-88
803F2a2	18	Cisco	flesh	baked	16-Jul-88
803F2a1	16	Cisco	flesh	raw	16-Jul-88
803F1a1	15	Cisco	flesh	raw	16-Jul-88
803F3a3	68	Cisco	flesh	smk/dry	01-Jul-88
803F2a3	20	Cisco	flesh	smk/dry	12-Aug-88
803F1a3	19	Cisco	flesh	smk/dry	12-Aug-88
820C1a1	43	Cloudberry	berry	raw	24-Jul-88
814F1a1	62	Cranberry	berry	raw	15-Sep-88
9014F1a1	96	Cranberry	berry	raw	15-Aug-90

cont.

Appendix 1 cont.

Food Sample Harvest Date and Source[a]

LAB NO[b]	NO[c]	SPECIES	PART	PROCESS	HARVEST DATE
816F1a1	39	Gooseberry-G	berry	raw	12-Jul-88
9016F1a1	97	Gooseberry-G	berry	raw	20-Jul-90
817F1a1	40	Gooseberry-P	berry	raw	29-Jul-88
9017F1a1	98	Gooseberry-P	berry	raw	14-Aug-90
802F2a2	11	Inconnu	flesh	baked	02-Aug-88
802F1a2	10	Inconnu	flesh	baked	02-Aug-88
802F1a1	9	Inconnu	flesh	raw	02-Aug-88
802F2a1	10	Inconnu	flesh	raw	02-Aug-88
802F1a4	14	Inconnu	flesh	smk/dry	02-Aug-88
802F2a3	13	Inconnu	flesh	smk/dry	02-Aug-88
802F1a3	12	Inconnu	flesh	smk/dry	02-Aug-88
805F6a2	77	Loche	flesh	baked	30-Nov-88
805F7a2	76	Loche	flesh	baked	28-Nov-88
805C1a2	25	Loche	flesh	baked	26-Jul-88
805F5a2	75	Loche	flesh	baked	27-Nov-88
805F2a2	72	Loche	flesh	baked	27-Nov-88
805C3a2	69	Loche	flesh	baked	15-Nov-88
805C2a2	26	Loche	flesh	baked	[illegible]
805F1a2	71	Loche	flesh	baked	[illegible]
805F3a2	73	Loche	flesh	baked	03-Dec-88
805C4a2	70	Loche	flesh	baked	15-Nov-88
805C3a1	**69**	**Loche**	**flesh**	**raw**	**15-Nov-88**
805F6a1	77	Loche	flesh	raw	30-Nov-88
805C4a1	70	Loche	flesh	raw	15-Nov-88
805F3a1	**73**	**Loche**	**flesh**	**raw**	**03-Dec-88**
805C1a1	25	Loche	flesh	raw	26-Jul-88
805F1a1	71	Loche	flesh	raw	27-Nov-88
805F2a1	72	Loche	flesh	raw	27-Nov-88
805F5a1	**75**	**Loche**	**flesh**	**raw**	**27-Nov-88**
805C2a1	26	Loche	flesh	raw	26-Jul-88
9005F1a1	94	Loche	flesh	raw	06-Jul-90
805F1g2	71	Loche	head	baked	27-Nov-88
805F2g2	72	Loche	head	baked	27-Nov-88
805C2g2	70	Loche	head	baked	15-Nov-88
805C1g2	69	Loche	head	baked	27-Nov-88
805F3g2	77	Loche	head	baked	30-Nov-88
805F3b2	77	Loche	liver	baked	30-Nov-88
805F1b2	72	Loche	liver	baked	27-Nov-88
805C1b2	70	Loche	liver	baked	15-Nov-88
805F2b2	73	Loche	liver	baked	03-Dec-88
805F1b1	71	Loche	liver	raw	27-Nov-88
805C2b1	26	Loche	liver	raw	26-Jul-88
805F2b1	73	Loche	liver	raw	03-Dec-88
805C1b1	25	Loche	liver	raw	26-Jul-88
805C3b1	69	Loche	liver	raw	15-Nov-88

cont.

Appendix 1 cont.

Food Sample Harvest Date and Source[a]

LAB NO[b]	NO[c]	SPECIES	PART	PROCESS	HARVEST DATE
9005F1b1	94	Loche	liver	raw	06-Jul-90
805F6y2	75	Loche	skin	baked	27-Nov-88
805C2y2	70	Loche	skin	baked	15-Nov-88
805F3y2	77	Loche	skin	baked	30-Nov-88
805F4y2	73	Loche	skin	baked	03-Dec-88
805F1y2	71	Loche	skin	baked	27-Nov-88
805C1y2	69	Loche	skin	baked	15-Nov-88
805F2y2	72	Loche	skin	baked	27-Nov-88
805F5y2	74	Loche	skin	baked	24-Nov-88
805C1y1	69	Loche	skin	raw	15-Nov-88
805F4y1	73	Loche	skin	raw	03-Dec-88
805F1y1	71	Loche	skin	raw	27-Nov-88
805F5y1	74	Loche	skin	raw	24-Nov-88
805F2y1	72	Loche	skin	raw	27-Nov-88
805C2y1	70	Loche	skin	raw	15-Nov-88
805F3y1	77	Loche	skin	raw	30-Nov-88
805F6y1	75	Loche	skin	raw	27-Nov-88
810F1d1	45	Moose	blood	raw	23-Sep-88
810F2a2	45	Moose	flesh	baked	23-Sep-88
810F1a2	44	Moose	flesh	baked	26-Nov-88
810F1a3	46	Moose	flesh	smk/dry	23-Sep-88
810F1a1	**29**	**Moose**	**flesh**	**raw**	**13-Jul-88**
810F4a1	45	Moose	flesh	raw	26-Nov-88
810F2a1	30	Moose	flesh	raw	17-Jul-88
810F3a1	44	Moose	flesh	raw	26-Nov-88
810F1b2	44	Moose	liver	baked	26-Nov-88
810F2b2	46	Moose	liver	baked	23-Sep-88
810F3b2	46	Moose	liver	raw	23-Sep-88
810F1b1	31	Moose	liver	raw	16-Jul-88
810F2b1	44	Moose	liver	raw	26-Nov-88
810F1c2	44	Moose	lung	baked	26-Nov-88
810F1c1	44	Moose	lung	raw	26-Nov-88
9010F1a1	79	Moose	flesh	raw	08-Jun-90
9010F2a1	80	Moose	flesh	raw	05-Jun-90
9010F3a1	81	Moose	flesh	raw	28-Jun-90
9010F4a1	82	Moose	flesh	raw	13-Jun-90
808F2a1	33	Muskrat	flesh	raw	15-Jun-88
808F1a1	32	Muskrat	flesh	raw	07-Aug-88
804C2a2	24	Pike	flesh	baked	26-Jul-88
804C1a2	23	Pike	flesh	baked	26-Jul-88
804F2a2	22	Pike	flesh	baked	28-Jul-88
804F1a2	21	Pike	flesh	baked	03-Aug-88
804C2a1	24	Pike	flesh	raw	26-Jul-88
804C1a1	23	Pike	flesh	raw	26-Jul-88
804F2a1	22	Pike	flesh	raw	28-Jul-88

cont.

Appendix 1 cont.

Food Sample Harvest Date and Source[a]

LAB NO[b]	NO[c]	SPECIES	PART	PROCESS	HARVEST DATE
804F1a1	21	Pike	flesh	raw	03-Aug-88
813F3a2	59	Ptarmigan	flesh	baked	28-Nov-88
813F1a2	57	Ptarmigan	flesh	baked	27-Nov-88
813F2a2	58	Ptarmigan	flesh	baked	27-Nov-88
811F2a5	55	Rabbit	flesh	boiled	19-Nov-88
811F1a5	54	Rabbit	flesh	boiled	19-Nov-88
811F1a1	54	Rabbit	flesh	raw	19-Nov-88
811F2a1	55	Rabbit	flesh	raw	19-Nov-88
819F1a1	42	Raspberry	berry	raw	30-Jul-88
806C2a2	28	Trout	flesh	baked	26-Jul-88
806C1a2	27	Trout	flesh	baked	26-Jul-88
806C2a1	28	Trout	flesh	raw	26-Jul-88
806C1a1	27	Trout	flesh	raw	26-Jul-88
801F3e1	8	Whitefish	eggs	raw	16-Aug-88
801F2e1	4	Whitefish	eggs	raw	10-Aug-88
801F1f1	5	Whitefish	esophagus	raw	10-Aug-88
801F2a2	5	Whitefish	flesh	baked	10-Aug-88
801F1a2	4	Whitefish	flesh	baked	26-Jul-88
801C1a2	1	Whitefish	flesh	baked	26-Jul-88
801C2a1	2	Whitefish	flesh	baked	26-Jul-88
801C1a1	1	Whitefish	flesh	raw	26-Jul-88
801F2a1	**4**	**Whitefish**	**flesh**	**raw**	**10-Aug-88**
801F1a1	3	Whitefish	flesh	raw	08-Aug-88
801C2a1	2	Whitefish	flesh	raw	26-Jul-88
801F1a4	7	Whitefish	flesh	smk/dry	14-Aug-88
801C1a3	6	Whitefish	flesh	smk/dry	16-Jul-88
801F1g2	5	Whitefish	head	baked	10-Aug-88
801F1e2	64	Whitefish	eggs	baked	01-Sep-88
801F3e2	**66**	**Whitefish**	**eggs**	**baked**	**06-Dec-88**
801F2e2	65	Whitefish	eggs	baked	06-Dec-88
801F4e2	67	Whitefish	eggs	baked	06-Dec-88
801F6e1	65	Whitefish	eggs	raw	06-Dec-88
801F5e1	64	Whitefish	eggs	raw	01-Sep-88
801F7e1	66	Whitefish	eggs	raw	06-Dec-88
801F8e1	67	Whitefish	eggs	raw	06-Dec-88
801F4a3	63	Whitefish	flesh	smk/dry	15-Jul-88
9001C1a1	91	Whitefish	flesh	raw	20-Jun-90
9001C1a3	92	Whitefish	flesh	smk/dry	19-Jun-90
9001F1a1	93	Whitefish	flesh	raw	01-Aug-90
9001F1h1	93	Whitefish	flesh	raw	01-Aug-90
801F1a2	78	Whitefish-C	flesh	baked	26-Nov-88
801F1a1	78	Whitefish-C	flesh	raw	26-Nov-88

[a] Revised from Appavoo (1990) to include foods collected in 1990

[b] A `C' as the fourth digit of LAB NO indicates collection from Colville Lake, an `F' indicates Fort Good Hope

[c] Samples with the same 'NO' are from the same individual

Appendix 2

Summary of Nutrient and PCB Content (per 100g) of Traditional Dene Foods (Mean and Range)

Code	Species	Part	Process	No.	Moisture X(g)	Moisture Range	Pro X(g)	Pro Range	Fat X(g)	Fat Range
4277	Bear	flesh	raw	1	72.8		21 6		4 0	
4378	Bear	flesh	smoked	1	55.2		32 1		10 1	
4232	Beaver	feet	baked	1	51 4		21 0		26 6	
4159	Beaver	flesh	baked	2	69 9	66 3-73.5	26 7	24 2-29 2	1 5	1 4- 1 6
4160	Beaver	flesh	dry	2	35 5	34 1-36 9	52 9	49 4-56 3	6 8	6 1- 7 5
4158	Beaver	flesh	raw	2	74 6	73 1-76 1	18 7	17 2-20 1	4 7	1 5- 8 0
4161	Beaver	tail	baked	1	44 8		11 3		43 1	
4352	Beaver	liver	raw	1	72 2		19 4		2 2	
4174	Black Scoter	flesh	baked	2	63 1	62 7-63.5	30 1	27 3-33 0	5 7	5.5 - 5.
4195	Blackberry	berry	raw	2*	86 6	86.6-86 6	0.5		1 0	
4191	Blueberry	berry	raw	1*	87 6		0 8		0 7	
4268	Canada Goose	flesh	smk/dry	2	4 3	2 0- 6 5	34 2	18 1-50 2	54 1	33 5-74 7
4150	Caribou-B	flesh	baked	2	68 2	67 8-68 6	27 7	27 7-27 8	2 1	1 9- 2 3
4149	Caribou-B	flesh	raw	6	73 1	69 9-76 4	22.7	21 0-24 9	1 9	1.1- 2 7
4153	Caribou-B	liver	baked	2	66 7	66.6-66 8	23 7	21 8-25 7	2 5	2 3- 2 7
4152	Caribou-B	liver	raw	2	71 8	70 5-73 0	20 0	19 3-20 8	2 4	2 2- 2 7
4141	Caribou-W	flesh	baked	2	66 4	66 1-66 7	29 6	29 2-30 0	1 8	0 9- 2 6
4140	Caribou-W	flesh	dried	2	35 3	14 0-56 6	54 1	35 8-72 4	2 9	1 6- 4 2
4278	Caribou-W	flesh	raw	2	74.5	72 3-76 7	22 6	21 0-24 1	1 5	0 7- 2 2
4117	Cisco	flesh	baked	2	72 4	71 8-73 0	22 0	21 5-22 6	4 0	3 7- 4 2
4116	Cisco	flesh	raw	2	76 3	75 6-77 0	18 2	17 8-18 5	3 9	2 8- 4.9
4118	Cisco	flesh	smk/dry	3	13 4	8 9-18 9	58 3	43 4-68 1	22 5	16 9-33 6
4220	Cloudberry	berry	raw	1*	83 9		2 0		1 0	
4192	Cranberry	berry	raw	2*	80 5	79 2-81 8	0.7		0 7	
4193	Gooseberry-G	berry	raw	2*	85 0	83 7-86 3	0 9		1 2	
4194	Gooseberry-P	berry	raw	2*	80 6	79 6-81 5	1.0		0 3	
4110	Inconnu	flesh	baked	2	73 5	72 8-74 3	22 1	20 4-23 8	3 2	2 6- 3 7
4109	Inconnu	flesh	raw	2	72 5	71 9-73 1	19 2	17 5-20 8	6 9	4 8- 9 1
4112	Inconnu	flesh	smk/bake	1	57 3		35 2		5 3	
4111	Inconnu	flesh	smk/dry	2	18 7	14 6-21 8	57 2	51 3-63 1	20 4	18 3-22 5
4211	Loche (CL)	flesh	baked	4	76 6	75 2-77 5	21 3	20 9-21 9	1 0	0 4- 1 6
4127	Loche (FGH)	flesh	baked	6	75 9	7. 7-78 9	22 2	18 3-26 0	1 0	0 6- 1 6
4210	Loche (CL)	flesh	raw	4	81 1	79 7-81 5	17 5	16 2-19 0	0 7	0 6- 0 9
4126	Loche (FGH)	flesh	raw	6	80 6	78 3-82 1	17 8	16 5-19 2	0 4	0 3- 0 7
4223	Loche (FGH)	head	baked	1	74 7		23 5		0 8	
4129	Loche (FGH)	liver	baked	2	37 9	35 6-40 2	12 1	9 0-14 9	42 8	38 0-47 4
4212	Loche (CL)	liver	raw	3	53 5	42 5-62 5	9 1	7 2-[illegible]	29 7	16 5-4[illegible]
4128	Loche (FGH)	liver	raw	2	45 3	41 3-51 3	7 0	6 1- 7 9	4[illegible]	36 4-4[illegible]
4224	Loche (FGH)	skin	baked	1*	64 3		31 8		1 2	
4289	Loche (FGH)	skin	raw	1*	74 8		24 1		1 0	
4138	Moose	blood	raw	1	73 8		20 5		0 5	
4132	Moose	flesh	baked	2	61 4	55 1-64 8	24 8	31 [illegible]	[illegible]	[illegible]
4254	Moose	flesh	smk dry	1	9 0		73 2		4 4	
4131	Moose	flesh	raw	6	73 6	70 4-75 8	22 7	[illegible]	[illegible]	[illegible]
4135	Moose	liver	baked	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4134	Moose	liver	raw	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Moose	lung	baked	[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
[illegible]			[illegible]							

Code	Ash X(g)	Ash Range	CHO X(g)	CHO Range	Energy X(kcal)	Energy Range	Fe X(mg)	Fe Range	Zn X(mg)	Zn Range	PCB X(ug)	PCB Range
4277	1 13		0 0		127 9		1 91		3 05		0 07	
4378	2 04		0.0		228 0		8 38		6 68		0 71	
4232	0 70		0 0		329 3		1.45		0 88		0 41	
4159	1 08	1 00-1 15	0 0		127 4	115 5-139 3	4 76	4 65-4 88	4 40	3 84-4 95	1 70	1 65-1 75
4160	2 31	2 29-2 32	0 0		287 1	265 7-308 4	12 18	12 0-12 36	8 68	8 52-8 83	1 28	0 30-2 25
4158	0 94	0 87-1.00	0 0		122 5	99.7-145 3	3 80	3 58-4 02	3 10	2 96-3 23	1 46	0 86-2 05
4161	0 44		0 0		436 8		0 65		0 27		0 49	
4352	1 33		4.8		121 8		30 02		3 31		n/a	
4174	0 80	0 48-1 11	0 0		180 2	166 1-194 4	8 09	7 61-8 57	2 51	2 19-2 83	0 32	0 24-0 39
4195	0 34	0 23-0 44	11.5	9 9-13 2	46 7	46 0- 47 4	0 29	0 22-0 36	0 11	tr-0 11	0 66	
4191	0 24		9 1		41 4		0 18		0 26		0 29	
4268	2 14	1 22-3 06	0 0		633 8	517 1-750 5	12 44	8 53-16 36	5 03	3 21-6 85	0 58	0 42-0 74
4150	1 32	1.20-1 43	0 0		137 0	135 5-138 5	3 86	2.98-4 73	4 18	2 63-5 72	0 52	0 46-0 57
4149	1.06	0 27-1.31	0 0		113 9	99 1-127 5	3 99	2.83- 5 00	3 60	2 89-4 41	0 38	0 16-0 74
4153	1 42	1 39-1 44	5 7	3 6- 7 8	145 5	143 5-147 5	20 77	12 66-28 88	5 93	3 32-8 55	2 09	2 04-2 14
4152	1 29	1 24-1 33	4 5	2 7- 6 2	124 9	118 7-131 0	18 94	15 39-22 50	5 19	3 01-7 37	1 63	1 22-2 44
4141	1 38	1 34-1 41	0 0		142 4	136 4-148 3	4 98	4 80- 5 16	6 24	3 63-8 86	0 33	0 12-0 53
4140	2 11	0 86-3 36	0 0		257 4	167 7-347 2	10 83	8.59-13 08	7 43	3 76-11 1	0 48	0 22-0 74
4278	1 07	0 99-1 14	0 0		109 5	95 8-123 2	4 17	4 07- 4 26	5 14	3 58-6 71	0 40	0 40 0 40
4117	1 22	1 19-1 24	0 0		129 7	129 6-129 9	0 65	0 47- 0 83	0 45	0 40-0 51	0 89	0 50-1 27
4116	1 04	1 01-1 07	0 0		112 3	104 1-120 5	0 87	0 61- 1 13	0 41	0 37-0 45	0 64	0 57-0 71
4118	3 40	2 38-4 06	0 0		456 3	422 9-488 4	6 31	4 24- 8 86	1 61	1 31-1 65	2 27	1 70-3 50
4220	0 51		9 5		49 6		0 36		0 72		1 22	
4192	0 35	0 24-0 45	17 8	14 9-20 6	68 1	62 1- 74 0	0 25	0 24- 0 25	0 16	0.13-0 18	0 43	
4193	0 60	0 53-0 68	24 8	9 1-15 8	102 0	45 2- 56 8	0 62	0 27- 0 96	0 14	0.10-0 17	0 39	
4194	0 67	0 64-0 69	17 2	14 6-19 8	64 7	58 3- 71 1	0 48	0 38- 0 58	0 09	0 04-0 13	0 38	
4110	1 19	1 12-1 24	0 0		123 1	120 7-125 4	0 40	0 38- 0 41	0 39	0 37-0 41	2 24	0 55-3 93
4109	1 26	1 09-1 42	0 0		144 4	131 9-157 0	0 43	0 43- 0 43	0 33	0 32-0 33	1 87	1 27-2 47
4112	2 06		0 0		198 6		0 82		0 57		1 42	
4111	3 20	2 95-3 40	0 0		428 3	422 1-434 5	3 99	3 86- 4 12	1 02	0 94-1 10	3 17	2 47-3 86
4211	1 08	1 03-1 12	0 0		99 5	94 0-103 7	0 48	0 40- 0 59	0 81	0 74-0 86	0 43	0 71-1 16
4127	1 08	0 91-1 33	0 0		103 3	92 5-117 9	0 43	0 27- 0 75	0 86	0 53-1 22	1 60	0 34-4 97
4210	0 99	0 80-1 00	0 0		81 3	74 0- 88 7	0 36	0 27- 0 45	0 63	0 55-0 74	2 03	0 47-3 38
4126	1 04	0 98-1 27	0 0		80 0	73 3- 85 5	0 35	0 15- 0 54	0 57	0 45-0 78	1 78	0 26-2 76
4223	0 97		0 0		107 0		0 31		1 34		1 22	
4129	1 26	1 06-1 46	6 0	5 3- 6 7	603 2	556 0-650 3	1 45		1 00		1 39	1 38-1 39
4212	0 78	0 64-0 97	6 0	5 0- 7 9	618 6	283 6-566 9	2 14	1 17- 3 26	2 81	1 35-4 10	4 [illegible]	3 00-6 74
4128	[illegible]	[illegible]	3 9	1 8- 6 0	493 9	369 2-618 6	2 02		1 22		2 67	1 88 3 46
4224	1 9[illegible]		0 0		146 2		1 54		1 95		1 64	
4289	1 35		0 0		111 3		0 82		1 64		[illegible]	
4138	0 94		0 0		91 9		61 54		0 15		[illegible]	
4132	[illegible]	[illegible]	0 0		1[illegible] 6	148 9-17[illegible]	5 12	4 30- 5 95	7 54	6 [illegible]	[illegible]	[illegible]
4254	4 [illegible]		0 0		373 8		16 [illegible]		10 [illegible]		[illegible]	
4131	[illegible]	[illegible]	0 0		[illegible]	[illegible]	4 55	3 2[illegible]- 6 41	[illegible]	[illegible]	[illegible]	[illegible]
4135	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible] 7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4134	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Appendix 2 cont.

Summary of Nutrient and PCB Content (per 100g) of Traditional Dene Foods (Mean and Range)

Code	Species	Part	Process	No	Moisture X(g)	Moisture Range	Pro X(g)	Pro Range	Fat X(g)	Fat Range	Ash X(g)	Ash Range	CHO X(g)	CHO Range	Energy X(kcal)	Energy Range	Fe X(mg)	Fe Range	Zn X(mg)	Zn Range	PCB X(ug)	PCB Range
4122	Pike (FGH)	flesh	bake	2	73 5	72.7-74 4	25 3	24.4-26 2	0 4	0.4- 0 4	1 23	1.22-1 23	0 0		111 7	108 1-115 2	0 54	0 33- 0 74	0 64	0 49-0 78	1 02	0 78-1 25
4121	Pike (FGH)	flesh	raw	2	78 3	77 9-78 6	20 0	19 7-20 4	0 7	0 5- 0 9	1 20	1.14-1 25	0 0		91 4	91 0- 91 8	0 34	0 22- 0 46	0 56	0 51-0 60	0 80	0 65-0 93
4206	Pike (CL)	flesh	raw	2	80 4	80 1-80 7	17 6	17 6-17 7	0 8	0 8- 0 9	1 24	1.14-1 31	0 0		82 8	81 8- 83 9	0 48		0 90		0 63	0 44-0 81
4170	Ptarmigan	flesh	baked	2	68 7	68 4-68 9	28 0	27 6-28 3	1 5	1 4- 1 5	0 89	0.41-1 36	0 0		132 5	131 8-133 3	9 01	5 75-12 28	1 12	1 07-1 17	0 33	0 21-0 44
4164	Rabbit	flesh	boiled	2	72 3	72 2-72 4	25 5	25 4-25 7	1 2	1.0- 1 4	1 00	0 90-1 11	0 0		119 7	118 3-121 0	5 54	5 50- 5 57	2 86	2 72-3 00	0 35	0 19-0 52
4163	Rabbit	flesh	raw	2	77 0	76 3-77 7	20 8	20 1-21 5	0 8	0 6- 1 0	0 93	0 79-1 07	0 0		96 0	91 2-100 8	5 77	5 22- 6 33	2 48	2 25-2 70	0 50	0 41-0 58
4196	Raspberry	berry	raw	1s	79 5		1 6		1 1		0 48		14 7		66 9		0 98		0 44		0 17	
4217	Trout	flesh	baked	2	71 7	70 5-72 9	21 3	19 5-23 1	4 2	3 6- 4 8	1 20	1 19-1 20	0 0		129 0	115 7-142 2	0 73	0 48- 0 98	0 61	0 52-0 71	2 24	1 99-2 49
4216	Trout	flesh	raw	2	74 6	74 0-75 2	21 3	20 8-21 7	3 9	3 9- 4 0	1 17	1 14-1 21	0 0		126 3	124 0-128 6	0 53	0 46- 0 59	0 44	0 42-0 46	1 14	0 54-1 73
4105	Whitefish (FGH)	eggs	baked	2	50.6	48.5-52.7	25.6	24.8-26 4	15 7	14 2-17 2	1 69	1.55-1 83	6 4	6 3- 6.6	255 7	259 0-292 6	1 69	1 26- 2 12	3.91	3.81-4 01	1 47	1 00-1 93
4104	Whitefish (FGH)	eggs	raw	4	60.4	58.2-65 9	21 6	19.2-23 3	11 4	9 8-12 5	1 60	1.04-1 95	5 0	4 2- 6 0	214 2	185 9-228 6	2 60	1 13- 5 18	3.60	2 39-4 35	3 86	0 91-11 87
4106	Whitefish (FGH)	esophagus	raw	1	79 6		14 7		4 1		0 77		0 0		99 6		0 00		0.00		n/a	
4102	Whitefish (FGH)	flesh	baked	2	73 1	72 2-73 9	22 3	19 9-24 7	3 5	2 1- 5 0	1 38	1 27-1 49	0 0		127 1	124 1-130 0	0 63	0 48- 0 77	0 40	0 39-0 40	1 14	0 85-1 42
4202	Whitefish (CL)	flesh	baked	2	76 7	74 1-79 4	20 1	18 3-21 9	1 9	1 6- 2 3	1 16	1.14-1 17	0 0		103 1	92 2-113 9	0 34	0 29- 0 39	0 48	0 46-0 50	0 38	0 32-0 44
4201	Whitefish (CL)	flesh	raw	3	75 8	73 1-79.9	18 9	17.8-20 7	3 5	0 7- 5 3	1 30	1 23-1 40	0 0		112 2	82 1-129 0	0 66	0 35- 0 92	0 46	0 43-0 51	1 14	0 19-2 08
4101	Whitefish (FGH)	flesh	raw	4	76 2	75 4-77 7	17 6	16 1-18 8	3 5	1 8- 5 1	1 85	1.28-3 21	0 0		106 6	91 5-121 3	0 40	0 23- 0 62	0 40	0 25-0 66	0 57	0 23-1 02
4203	Whitefish (CL)	flesh	smk/dry	2s	17 2	13 0-21.3	65 9	63 0-68 9	11 2	3 0-19 4	3 90	3 31-4 49	0 0		382 8	321 4-444 2	2 09	1 49- 2 70	1 64	1 52-1.77	2 23	1 33-3 13
4103	Whitefish (FGH)	flesh	smk/dry	1s	13 0		67 7		19 4		3 31		0 0		441 2		3 76		1 25		5 88	
4107	Whitefish (FGH)	head	baked	1s	71 5		18 9		7 4		1 01		0 0		147 1		4 76		5 01		1 76	
4108	Whitefish (FGH)	flesh	smk/bkd	1	48.1		42.3		5 8		2 63		0 0		233 1		1.54		0 74		0 77	
4230	Whitefish-C	flesh	baked	1	73.6		23 6		1 1		1 37		0 0		110 7		0.39		0.83		0.58	
4231	Whitefish-C	flesh	raw	1	80.0		18 2		0 7		1 14		0 0		84 0		0.45		0.75		0 64	

Key
FGH = harvested in Fort Good Hope
CL = harvested in Colville Lake
-G = green
-P = purple
-C = "crooked back"
B = barrenland
W = woodland
n/a = not analyzed
tr = trace
X = mean
s = composite sample
No = number of independent samples analyzed

Total Traditional Food Intake (grams) by Adult Women (n=81)
- FGH Summer 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
4132	Moose, bkd	32	40	63	1225	12975	406	274	160	263
4110	Inconnu, bkd	22	27	50	1000	6287	286	228	78	174
4117	Cisco, bkd	6	7	125	750	2125	354	197	26	107
4102	Whitefish, bkd	7	9	125	500	1750	250	116	22	78
4254	Moose, smk/dry	5	6	18	450	791	158	153	10	54
4174	Black scoter/ducks, bkd	1	1	750	750	750	750	0	9	83
4104	Whitefish eggs, raw	4	5	63	375	688	172	120	9	46
4112	Inconnu, smk/dry	1	1	500	500	500	500	0	6	55
4164	Rabbit, boiled	2	2	100	375	475	238	138	6	43
4220	Cloudberry, raw	1	1	450	450	450	450	0	6	50
4202	Whitefish (CL), bkd	1	1	375	375	375	375	0	5	41
4105	Whitefish eggs, bkd	1	1	375	375	375	375	0	5	41
4106	Whitefish esophagus, raw	2	2	50	200	250	125	75	3	23
4191	Blueberry, raw	3	4	75	75	225	75	0	3	24
4203	Whitefish (CL), smk/dry	1	1	186	186	186	186	0	2	21
4159	Beaver, bkd	1	1	125	125	125	125	0	2	14
4111	Inconnu, smk/bkd	1	1	93	93	93	93	0	1	10
Total		57	70	50	1375	28420	499	320	351	[illegible]

Total Market Food Intake (grams) by Adult Women (n=81)
- FGH Summer 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
2277	Tea	62	77	100	3200	55860	901	650	690	685
800	Coffee	45	56	100	4000	38700	860	813	478	741
1252	Powdered drinks	9	11	226	1400	5468	608	448	68	242
2079	Chicken noodle soup	13	16	125	868	4963	382	178	61	157
2104	Vegetable & meat soup	11	14	45	742	3542	322	170	44	1269
2230	Sugar, white	75	93	3	700	3365	45	81	42	78
461	Bread, enriched white	45	56	23	230	2960	66	38	37	43
416	Bannock, baked	15	19	100	400	2850	190	90	35	83
974	Eggs, boiled	23	28	55	220	2520	110	43	31	55
1683	Pork chops	17	21	58	300	2383	140	63	29	64
404	Cola drink	5	6	339	658	2014	403	128	25	102
1793	Potatoes, mashed	16	20	24	300	1948	122	82	24	61
747	Chicken, boned canned	11	14	46	370	1929	175	87	24	68
1872	Rice, white	9	11	23	750	1823	203	198	23	92
1391	Oatmeal	6	7	240	480	1680	280	89	21	77
1788	Potatoes, boiled	10	12	50	300	1650	165	84	20	62
407	Gingerale	2	2	597	1017	1614	807	210	20	130
1323	Milk, 2%	7	9	10	496	1546	221	154	19	77
1304	Macaroni and cheese	10	12	56	225	1526	153	62	19	55
370	Hamburger	9	11	60	300	1423	158	76	18	56
371	Meat and vegetable stew	5	6	224	238	1176	235	6	15	57
1789	Potatoes, french fried	11	14	50	126	1108	101	29	14	36

Appendix 3 cont.

Total Market Food Intake (grams) by Adult Women (n=81)
- FGH Summer 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
1457	Pancakes	6	7	50	450	1100	183	130	14	60
353	Beef, round broiled	7	9	50	340	1034	148	86	13	49
847	Corn, sweet creamed cnd	5	6	126	252	1008	202	62	12	51
1241	Lard	39	48	1	105	982	25	22	12	20
1324	Milk, evaporated	17	21	4	270	969	57	86	12	46
689	Chicken, fried	7	9	85	296	891	127	75	11	42
1999	Luncheon meats	11	14	45	180	844	77	39	10	30
1432	Orange juice, canned	3	4	240	270	750	250	14	9	47
929	Coffee whitener	29	36	3	180	738	25	37	9	25
394	Beer	1	1	720	720	720	720	0	9	80
379	Corned beef hash	2	2	238	448	686	343	105	9	56
2075	Cream of chicken soup	3	4	50	248	546	182	93	7	39
2292	Tomato, ripe raw	3	4	37	346	531	177	128	7	42
27	Applejuice, canned	2	2	240	240	480	240	0	6	37
505	Butter	37	46	3	60	463	13	12	6	10
2165	Spag.w/meatballs&tom.sce	3	4	9	220	449	150	100	6	34
1355	Mushrooms	5	6	25	200	423	85	63	5	26
1566	Pie, apple	3	4	100	150	400	133	24	5	26
2159	Spaghetti noodles	3	4	75	150	375	125	35	5	25
2099	Tomato soup	2	2	125	248	373	187	62	5	31
1140	Ice cream	2	2	90	270	360	180	90	4	31
1633	Pizza with cheese	2	2	150	150	300	150	0	4	23
850	Corn, sweet cnd	6	7	24	85	295	49	19	4	14
620	Carrots, boiled	4	5	38	76	266	67	17	3	15
2286	Tomato, ketchup	8	10	15	60	245	31	18	3	11
229	Beef, chuck	2	2	74	148	222	111	37	3	18
2600	Gravy, meat brown	2	2	75	144	219	110	35	3	18
1413	Onion, white	5	6	15	90	202	40	27	2	12
1149	Jelly	8	10	7	60	191	24	16	2	9
812	Cookies, assorted	2	2	40	150	190	95	55	2	17
1783	Pork, ham	2	2	28	150	178	89	61	2	17
13	Apple, raw	1	1	160	160	160	160	0	2	18
1343	Muffin	1	1	150	150	150	150	0	2	17
1638	Frozen dinner	1	1	150	150	150	150	0	2	17
554	Cake, coffee	1	1	150	150	150	150	0	2	17
587	Chocolate	2	2	56	84	140	70	14	2	11
977	Eggs, scrambled	1	1	140	140	140	140	0	2	16
1616	Cnd fruit (heavy syrup)	1	1	139	139	139	139	0	2	15
126	Bacon, cured	8	10	8	24	130	16	4	2	5
1826	Pudding	1	1	130	130	130	130	0	2	14
1322	Milk, skim	1	1	125	125	125	125	0	2	14
1258	Lettuce	3	4	25	74	124	41	23	2	9
866	Corn flakes	3	4	28	56	112	37	13	1	8
1786	Potatoes, baked	1	1	100	100	100	100	0	1	11
2014	Pork, sausage	3	4	20	40	100	33	9	1	7
1809	Potato chips	3	4	10	50	90	30	16	1	7
916	Crackers	3	4	24	32	86	29	3	1	6
1938	Mayonnaise	5	6	7	30	81	16	8	1	4
2404	Vegetables, mixed frozen	1	1	70	70	70	70	0	1	8

Appendix 3 cont.

Total Mean Intake in Grams by Adult Women (n=81)
FGH Summer 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
186	Beans, snap green cnd	1	1	65	65	65	65	0	1	7
2439	Wheat flour	2	2	7	50	57	29	22	1	6
547	Cake, devil's food	1	1	55	55	55	55	0	1	6
943	Cucumbers	1	1	50	50	50	50	0	1	6
1949	Salmon, canned	2	2	22	28	50	25	3	1	4
1518	Peas, green immature cnd	1	1	43	43	43	43	0	1	5
1134	Honey	2	2	7	35	42	21	14	1	4
653	Cheese, processed	2	2	21	21	42	21	0	1	3
1317	Margarine	6	7	3	10	41	7	3	1	2
2701	Oil, corn	2	2	10	30	40	20	10	1	4
1546	Oysters, cnd	1	1	31	31	31	31	0	0	3
780	Cocoa mix	2	2	7	7	14	7	0	0	1
2049	Syrup, maple	1	1	10	10	10	10	0	0	1
1561	Pickles, sweet	1	1	10	10	10	10	0	0	1
2051	Syrup, corn	1	1	5	5	5	5	0	0	1
2156	Soy sauce	1	1	5	5	5	5	0	0	1
1373	Mustard, prepared	1	1	3	3	3	3		0	
Total		81	100	74	5423	161216	1990	44.	1990	44.

Appendix 4

Total Traditional Food Intake (grams) by Adult Women (n=82)
- FGH Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
4150	Caribou (B), bkd	35	43	30	2750	17581	502	481	214	401
4132	Moose, bkd	14	17	100	1750	6867	491	514	84	281
4164	Rabbit, boiled	12	15	125	2000	6455	538	497	79	269
4102	Whitefish, bkd	13	16	125	500	3818	294	124	47	118
4127	Loche, bkd	7	9	208	500	1958	280	91	24	83
4103	Whitefish, smk/dry	1	1	800	800	800	800	0	10	88
4159	Beaver, bkd	1	1	500	500	500	500	0	6	55
4170	Ptarmigan, bkd	2	2	125	313	438	219	94	5	37
4141	Caribou (W), bkd	1	1	250	250	250	250	0	3	27
4105	Whitefish eggs, baked	2	2	25	60	85	43	18	1	7
4154	Moose, smk/dry	1	1	63	63	63	63	0	1	7
4123	Loche head, bkd	2	2	14	25	39	20	6	1	3
4129	Loche liver, bkd	1	1	25	25	25	25	0	0	3
Total		62	76	125	2750	38879	627	522	474	528

Total Market Food Intake (grams) by Adult Women (n=82)
- FGH Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
2277	Tea	61	74	83	9600	82683	1356	1442	1008	1377
800	Coffee	42	51	200	3200	48400	1152	879	590	853
1391	Oatmeal	12	15	25	1800	4705	392	448	57	220
2230	Sugar, white	74	90	3	1200	4264	58	139	52	133
1252	Powdered drinks	11	13	226	565	4068	370	119	50	133
2104	Soup, vegetable and meat	11	13	20	609	3673	334	191	45	134
404	Cola drink	11	13	211	1014	3460	315	222	42	135
974	Eggs, boiled	24	29	55	500	3045	127	84	37	74
371	Meat and vegetable stew	5	6	118	952	2819	564	305	34	155
461	Bread, enriched white	44	54	23	207	2774	63	41	34	44
2165	Spag.w/meatballs&tom.sce	6	7	220	550	2410	402	105	29	108
1793	Potatoes, mashed	12	15	25	400	2325	194	116	28	82
416	Bannock, baked	14	17	50	200	2100	150	63	26	62
370	Hamburger	8	10	25	714	1961	245	191	24	94
407	Gingerale	4	5	253	759	1773	443	192	22	105
2159	Spaghetti noodles	9	11	75	300	1725	192	101	21	69
1241	Lard	42	51	3	265	1671	40	54	20	43
1789	Potatoes, boiled	11	13	25	320	1595	145	93	20	60
747	Chicken, boned canned	10	12	56	300	1549	155	91	19	60
1324	Milk, evaporated	33	40	5	140	1501	46	35	18	31
1872	Rice, white	11	13	38	300	1400	127	79	17	52
2079	Soup, noodle	4	5	148	792	1388	347	264	17	95
1140	Ice cream	6	7	22	360	1192	199	126	15	62

Appendix 4 cont.

Total Market Food Intake (grams) by Adult Women (n=82)
- FGH Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
1304	Macaroni and cheese	5	6	112	336	1120	224	71	14	56
1789	Potatoes, french fried	7	9	60	250	1060	151	66	13	47
1457	Pancakes	5	6	150	300	1000	200	55	12	50
1999	Luncheon meats	10	12	45	184	913	92	43	11	34
1420	Orange, raw	3	4	50	800	900	300	354	11	88
126	Bacon, cured	13	16	16	375	881	68	96	11	46
1783	Pork, ham	5	6	46	500	858	172	171	11	59
929	Coffee whitener	21	26	5	113	646	31	29	8	20
1683	Pork chops	4	5	85	232	641	160	53	8	36
1032	Gelatin dessert, plain	4	5	160	160	640	160	0	8	35
689	Chicken, fried	4	5	74	296	640	160	86	8	34
2099	Soup, tomato	1	1	495	495	495	495	0	6	54
1432	Orange juice, canned	2	2	240	240	480	240	0	6	37
13	Apple, raw	2	2	150	300	450	225	75	6	37
379	Corned beef hash, canned	1	1	448	448	448	448	0	5	49
1355	Mushrooms	7	9	22	157	415	59	47	5	23
1786	Potatoes, baked	1	1	400	400	400	400	0	5	44
1323	Milk, 2%	3	4	90	185	398	133	9	5	7
2404	Vegetables, mixed frozen	5	6	28	170	369	74	52	5	22
1320	Milk, whole	2	2	100	244	344	172	72	4	29
1317	Margarine	17	21	3	68	340	20	20	4	12
29	Applesauce	2	2	65	260	325	163	98	4	29
471	Bread, wholewheat	6	7	23	115	322	54	29	4	16
1809	Potato chips	8	10	30	64	292	37	11	4	11
2456	Wheat flakes	7	9	28	56	266	38	12	3	11
2097	Soup, split pea	1	1	250	250	250	250	0	3	27
505	Butter	21	26	2	30	239	11	10	3	7
2049	Syrup, maple	3	4	30	160	220	73	61	3	18
653	Cheese, processed	5	6	21	56	203	41	11	2	10
2164	Spaghetti w/tomato sauce	1	1	200	200	200	200	0	2	22
812	Cookies, assorted	3	4	40	80	160	53	19	2	11
1633	Pizza with cheese	1	1	150	150	150	150	0	2	17
513	Cabbage, boiled	4	5	16	62	150	37	22	2	9
1413	Onion, white	3	4	23	67	135	45	18	2	9
396	Spirits, 86 proof	1	1	129	129	129	129	0	2	14
850	Corn, sweet cnd	2	2	43	85	128	64	21	2	10
229	Beef, chuck or rib	1	1	125	125	125	125	0	2	14
916	Crackers	3	4	18	75	114	38	26	1	9
1846	Raisins	3	4	28	56	112	37	13	1	7
1566	Pie, apple	1	1	100	100	100	100	0	1	11
569	Cake, yellow	1	1	100	100	100	100	0	1	11
2600	Gravy, meat brown	2	2	18	72	90	45	27	1	8
1493	Peanuts	1	1	90	90	90	90	0	1	10
1938	Mayonnaise	4	5	3	60	83	21	23	1	7
1611	Pineapple, raw or juice-	1	1	80	80	80	80	0	1	9
649	Cheese, cream	2	2	21	56	77	39	18	1	7
2282	Tomato, ripe raw	2	2	37	37	74	37	0	1	6
1149	Jelly	2	2	20	53	73	37	17	1	6
1483	Peaches, canned heavy sy	1	1	56	56	56	56	0	1	6

Appendix 4 cont.

[illegible] grams) by Adult Women (n=82)
FGH Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
957	Doughnut, cake-type	1	1	50	50	50	50	0	1	6
587	Chocolate	1	1	45	45	45	45	0	1	5
512	Cabbage, raw	1	1	43	43	43	43	0	1	5
1258	Lettuce	3	4	5	25	43	14	8	1	3
1546	Peppers, sweet cooked	1	1	31	31	31	31	0	0	3
928	Cream, half and half	1	1	30	30	30	30	0	0	3
646	Cheese, cheddar	1	1	28	28	28	28	0	0	3
2701	Oil, corn	2	2	10	15	25	13	3	0	2
620	Carrots, boiled	1	1	19	19	19	19	0	0	2
2286	Tomato, ketchup	2	2	6	11	1	9	3	0	1
3030	Cream, whipping	1	1	16	16	16	16	0	0	2
780	Cocoa mix	1	1	14	14	14	14	0	0	2
847	Corn, sweet creamed cnd	1	1	14	14	14	14	0	0	2
1134	Honey	1	1	7	7	7	7	0	0	1
1328	Milk, powdered skim	1	1	6	6	6	6	0	0	1
2439	Wheat flour	1	1	2	2	2	2	0	0	0
Total		82	100	659	9939	200668	2447	1424	2447	1424

Appendix 5

Total Traditional Food Intake (grams) by Adult Women (n=113)
- FGH Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
4174	Black scoter/ducks, bkd	26	23	5	1440	10891	419	364	96	248
4141	Caribou (W), bkd	24	21	125	1000	8750	365	234	77	184
4132	Moose, bkd	18	16	5	750	5828	324	208	52	145
4159	Beaver, bkd	13	12	125	750	4625	356	162	41	120
4164	Rabbit, boiled	7	6	125	1625	3625	518	497	32	176
4150	Caribou (B), bkd	2	2	250	1750	2000	1000	750	18	165
4110	Inconnu, bkd	3	3	125	500	875	292	156	8	53
4102	Whitefish, bkd	4	4	125	250	875	219	54	8	42
4268	Canada Goose, smk/dry	6	5	50	240	780	130	54	7	37
4217	Trout, bkd	3	3	250	250	750	250	0	7	40
4122	Pike, bkd	2	2	250	250	500	250	0	4	29
4106	Whitefish esophagus, raw	1	1	375	375	375	375	0	3	25
4140	Caribou (W), dry	5	4	15	125	364	91	49	3	17
4160	Beaver, dry	1	1	250	250	250	250	0	2	19
4161	Beaver tail, bkd	1	1	125	125	125	125	0	1	9
4232	Beaver feet, bkd	1	1	125	125	125	125	0	1	12
4107	Whitefish head, bkd	1	1	50	50	50	50	0	0	5
4105	Whitefish eggs, bkd	1	1	45	45	45	45	0	0	4
Total		80	71	5	1850	40837	511	415	361	419

Total Market Food Intake (grams) by Adult Women (n=113)
- FGH Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
800	Coffee	69	61	200	4600	71300	1033	960	631	903
2277	Tea	75	66	200	4000	56300	751	577	498	589
1252	Powdered drinks	30	27	113	7938	22515	751	1368	199	779
394	Beer	4	4	336	4320	8016	2004	1532	71	469
404	Cola drink	13	12	339	1130	7458	574	256	66	203
1788	Potatoes, boiled	25	22	50	800	5490	220	151	49	116
1391	Oatmeal	17	15	30	480	4860	286	153	43	118
2104	Vegetable & meat soup	10	9	16	1116	4287	429	313	38	153
974	Eggs, boiled	34	30	55	330	4240	125	44	38	62
461	Bread, enriched white	55	49	23	238	4112	75	50	36	51
370	Hamburger	15	13	22	750	3769	251	207	33	114
407	Gingerale	10	9	30	753	3439	344	209	30	116
1683	Pork chops	9	8	90	686	2986	332	229	26	111
2230	Sugar, white	92	81	3	173	2943	32	32	26	31
416	Bannock, baked	20	18	50	450	2850	143	97	25	68
689	Chicken, fried	10	9	111	444	2456	246	102	22	76
2079	Chicken noodle soup	7	6	186	496	2244	321	105	20	82
371	Meat and vegetable stew	5	4	119	714	2023	405	193	18	93

Appendix 5 cont.

Total Mean Intake (grams) by Adult Women (n=113)
- FGH Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
2165	Spag.w/meatballs&tom.sce	4	4	330	660	1870	468	126	17	90
929	Coffee whitener	41	36	3	732	1853	49	118	16	74
1304	Macaroni and cheese	6	5	112	448	1680	280	107	15	67
27	Applejuice, canned	2	2	240	1440	1680	840	600	15	137
396	Spirits	4	4	29	688	1663	416	257	15	91
2159	Spaghetti noodles	9	8	75	300	1575	175	79	14	52
1324	Milk, evaporated	46	41	5	170	1555	34	35	14	28
1872	Rice, white	10	9	38	338	1464	146	100	13	51
1789	Potatoes, french fried	9	8	63	131	1451	161	73	13	48
1793	Potatoes, mashed	8	7	67	400	1367	171	101	12	51
353	Beef, round broiled	3	3	298	500	1173	391	83	10	64
1323	Milk, 2%	5	4	15	492	1122	224	159	10	57
2075	Cream of chicken soup	2	2	372	744	1116	558	186	10	73
1633	Pizza with cheese	7	6	75	200	1004	143	54	9	37
1241	Lard	41	36	2	90	941	23	22	8	17
1320	Milk, whole	2	2	244	488	732	366	122	6	51
1786	Potatoes, baked	4	4	100	200	700	175	43	6	22
1999	Luncheon meats	6	5	45	184	613	102	54	5	26
505	Butter	43	38	1	50	570	13	11	5	9
747	Chicken, boned canned	2	2	148	360	508	254	106	5	36
1783	Pork, ham	3	3	46	340	478	159	129	4	33
141	Banana, raw	3	3	150	150	450	150	0	4	24
471	Bread, wholewheat	5	4	23	276	437	87	95	4	27
2051	Syrup, corn	4	4	20	320	420	105	124	4	30
1809	Potato chips	10	9	16	119	418	42	29	4	15
156	Beans, w/pork & tom.sce	3	3	40	250	415	138	86	4	26
1457	Pancakes	4	4	90	135	405	101	19	4	19
2284	Tomato, cnd solid&liquid	1	1	400	400	400	400	0	4	37
587	Chocolate	8	7	28	103	399	50	22	4	14
620	Carrots, boiled	6	5	38	114	380	63	28	3	16
126	Bacon, cured	15	13	16	56	376	25	10	3	9
2328	Turkey, cooked	1	1	375	375	375	375	0	3	35
1140	Ice cream	4	4	23	180	343	86	60	3	19
547	Cake, devil's food	3	3	110	110	330	110	0	3	18
1258	Lettuce	4	4	16	148	312	78	54	3	18
1636	Frzn din-chick&pot&vegs	1	1	312	312	312	312	0	3	29
569	Cake, yellow	2	2	150	150	300	150	0	3	20
13	Apple, raw	2	2	150	150	300	150	0	3	20
1413	Onion, white	6	5	5	225	299	50	80	3	21
977	Eggs, scrambled	2	2	140	140	280	140	0	2	18
1420	Orange, raw	3	3	75	100	275	92	12	2	15
847	Corn, sweet creamed cnd	1	1	252	252	252	252	0	2	24
1432	Orange juice, canned	1	1	240	240	240	240	0	2	22
812	Cookies, assorted	2	2	80	140	220	110	30	2	15
1654	Popcorn, popped	6	5	21	56	217	36	12	2	9
2404	Vegetables, mixed frozen	3	3	43	85	213	71	20	2	12
1479	Peach, raw	1	1	200	200	200	200	0	2	19
916	Crackers	5	4	12	90	195	39	28	2	10
1938	Mayonnaise	5	4	3	60	190	38	27	2	10

Appendix 5 cont.

Total Market Food Intake (grams) by Adult Women (n 113)
- FGH Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S D (g)	Total Mean (g)	Total S D (g)
1149	Jelly	5	4	7	80	181	36	36	2	11
2600	Gravy, meat brown	2	2	36	144	180	90	54	2	14
857	Corn, sweet frzn boiled	3	3	30	85	172	57	22	2	10
2164	Spaghetti w/tomato sauce	1	1	167	167	167	167	0	1	16
1017	Fish sticks, frzn cooked	2	2	50	100	150	75	25	1	11
1870	Rice, brown	1	1	150	150	150	150	0	1	14
1355	Mushrooms	2	2	50	100	150	75	25	1	10
2282	Tomato, ripe raw	1	1	148	148	148	148	0	1	14
866	Corn flakes	4	4	28	42	140	35	7	1	7
1616	Cnd fruit (heavy syrup)	1	1	139	139	139	139	0	1	13
1826	Pudding	1	1	130	130	130	130	0	1	12
850	Corn, sweet cnd	2	2	43	85	128	64	21	1	4
653	Cheese, processed	4	4	14	47	124	31	14	1	6
1425	Orange juice, fresh	1	1	100	100	100	100	0	1	9
1566	Pie, apple	1	1	95	95	95	95	0	1	9
1317	Margarine	9	8	3	20	90	10	5	1	3
646	Cheese, cheddar	2	2	28	56	84	42	14	1	4
1032	Gelatin dessert, plain	1	1	80	80	80	80	0	1	7
2286	Tomato, ketchup	4	4	5	34	79	20	14	1	3
2014	Pork, sausage	2	2	20	40	60	30	10	1	4
2324	Tuna, canned	1	1	60	60	60	60	0	1	6
1134	Honey	1	1	56	56	56	56	0	1	5
943	Cucumbers	1	1	55	55	55	55	0	0	5
958	Doughnuts, cake	1	1	50	50	50	50	0	0	5
452	Bread, raisin	1	1	46	46	46	46	0	0	4
2701	Oil, corn	4	4	3	20	32	8	7	0	2
1545	Peppers, sweet green	1	1	25	25	25	25	0	0	2
2439	Wheat flour	1	1	21	21	21	21	0	0	2
2456	Wheat flakes	2	2	4	14	18	9	5	0	1
928	Cream, half and half	1	1	15	15	15	15	0	0	1
1561	Pickles, sweet	1	1	15	15	15	15	0	0	1
2229	Sugar, brown	1	1	10	10	10	10	0	0	1
649	Cheese, cream	2	2	5	5	10	5	0	0	1
2156	Soy sauce	2	2	3	3	5	3	0	0	0
1497	Peanut butter	1	1	5	5	5	5	0	0	0
1373	Mustard, prepared	1	1	5	5	5	5	0	0	0
		113	100	100	11560	248431	2199	1598	2199	1598

Appendix 6

Total Traditional Food Intake (grams) by Adult Women (n=10)
- CL Summer 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
4202	Whitefish (CL), bkd	5	50	250	1375	4050	810	434	405	508
4150	Caribou (B), bkd	6	60	250	875	3438	573	199	344	320
4203	Whitefish (CL), smk/dry	6	60	120	932	1986	331	294	199	280
4174	Black scoter/ducks, bkd	2	20	125	750	875	438	313	88	224
4140	Caribou (W), dry	1	10	81	81	81	81	0	8	24
Total		9	90	120	2807	10430	1159	904	1043	926

Total Market Food Intake (grams) by Adult Women (n=10)
Ranked in Descending Order According to Total (Sum) Consumed
- CL Summer 1988 -

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
2277	Tea	9	90	1000	4200	20000	2222	877	2000	1066
800	Coffee	2	20	400	3400	3800	1900	1500	380	1014
1252	Powdered drinks	2	20	226	1130	1356	678	452	136	338
1324	Milk, evaporated	3	30	60	720	1035	345	277	104	219
1788	Potatoes, boiled	3	30	100	200	500	167	47	50	81
1616	Cnd fruit (heavy syrup)	1	10	487	487	487	487	0	49	146
404	Cola drink	1	10	339	339	339	339	0	34	102
2230	Sugar, white	6	60	20	120	315	53	32	32	36
416	Bannock, baked	1	10	300	300	300	300	0	30	90
1391	Oatmeal	1	10	240	240	240	240	0	24	72
1872	Rice, white	1	10	225	225	225	225	0	23	68
2159	Spaghetti noodles	2	20	38	150	188	94	56	19	45
1241	Lard	4	40	23	60	158	39	14	16	21
2075	Cream of chicken soup	1	10	118	118	118	118	0	12	35
689	Chicken, fried	1	10	113	113	113	113	0	12	34
2079	Chicken noodle soup	1	10	99	99	99	99	0	10	30
461	Bread, enriched white	2	20	46	46	92	46	0	9	18
1999	Luncheon meats	1	10	92	92	92	92	0	9	28
353	Beef, round broiled	1	10	85	85	85	85	0	9	26
531	Cake, fruit	1	10	50	50	50	50	0	5	15
1413	Onion, white	1	10	45	45	45	45	0	5	14
1134	Honey	1	10	35	35	35	35	0	4	11
505	Butter	3	30	5	10	25	8	2	3	4
1149	Jelly	1	10	13	13	13	13	0	1	4
1258	Lettuce	1	10	13	13	13	13	0	1	4
929	Coffee whitener	1	10	10	10	10	10	0	1	3
Total		10	100	1276	5849	29732	2973	1303	2973	1303

Appendix 7

Total Traditional Food Intake (grams) by Adult Women (n=10)
- CL Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D (g)	Total Mean (g)	Total S.D. (g)
4217	Trout, bkd	2	20	250	4500	4750	2375	2125	475	1344
4164	Rabbit, boiled	3	30	750	1500	3000	1000	354	300	498
4150	Caribou (B), bkd	5	50	125	1000	2653	531	316	265	347
4141	Caribou (W), bkd	2	20	1010	1250	2260	1130	120	226	455
4132	Moose, bkd	2	20	438	1250	1688	844	406	169	383
4202	Whitefish (CL), bkd	1	10	1500	1500	1500	1500	0	150	450
4140	Caribou (W), dry	5	50	31	150	556	111	41	56	63
4254	Moose, smk/drv	1	10	63	63	63	63	0	6	19
Total		10	100	250	4500	16469	1647	1386	1647	1386

Total Market Food Intake (grams) by Adult Women (n=10)
- CL Winter 1988 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D (g)	Total Mean (g)	Total S.D (g)
2277	Tea	8	80	800	14400	31000	3875	4192	3100	4057
800	Coffee	3	30	600	1400	3200	1067	340	320	523
1391	Oatmeal	6	60	120	480	2280	380	146	228	218
416	Bannock, baked	4	40	165	440	1110	278	114	111	154
2159	Spaghetti noodles	4	40	150	225	675	169	33	68	85
2230	Sugar, white	8	80	15	103	342	43	26	34	29
1457	Pancakes	1	10	300	300	300	300	0	30	90
929	Coffee whitener	3	30	5	225	248	83	101	25	67
1241	Lard	6	60	5	125	215	36	41	22	36
156	Beans w/pork & tom.sauce	1	10	125	125	125	125	0	13	38
1793	Potatoes, mashed	1	10	100	100	100	100	0	10	30
1328	Milk, dry	1	10	45	45	45	45	0	5	14
2049	Maple Syrup	1	10	20	20	20	20	0	2	6
126	Bacon, cured	1	10	20	20	20	20	0	2	6
1149	Jelly	1	10	20	20	20	20	0	2	6
505	Butter	1	10	15	15	15	15	0	2	5
1317	Margarine	1	10	3	3	3	3	0	0	1
1324	Milk, evaporated	1	10	3	3	3	3	0	0	1
Total		10	100	885	14400	39719	3972	3762	3972	3762

Appendix 8

Total Traditional Food Intake (grams) by Adult Women (n=14)
- CL Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D. (g)	Total Mean (g)	Total S.D. (g)
4217	Trout, bkd	8	57	250	875	3250	406	240	232	271
4202	Whitefish (CL), bkd	3	21	250	1000	1500	500	354	107	262
4150	Caribou (B), bkd	2	14	375	500	875	438	63	63	155
4174	Black scoter/ducks, bkd	4	29	5	245	505	126	116	36	84
4211	Loche, bkd	2	14	125	375	500	250	125	36	99
4203	Whitefish (CL), smk/dry	2	14	47	140	187	94	47	13	37
4218	Whitefish (CL) head, bkd	1	7	50	50	50	50	0	4	13
Total		13	93	190	1000	6867	528	277	491	299

Total Market Food Intake (grams) by Adult Women (n=14)
- CL Spring 1990 -
Ranked in Descending Order According to Total (Sum) Consumed

Food Code	Food Description	Number Consuming	Percent Consuming	Minimum (g)	Maximum (g)	Sum (g)	Consumers Mean (g)	Consumers S.D (g)	Total Mean (g)	Total S D (g)
2277	Tea	12	86	200	2000	10200	850	595	729	626
800	Coffee	3	21	200	2200	2800	933	899	200	566
416	Bannock, baked	7	50	25	300	1250	179	121	89	124
1391	Oatmeal	4	29	240	360	1200	300	60	86	139
1252	Powdered drinks	3	21	226	678	1130	377	213	81	183
2104	Vegetable & Meat Soup	3	21	124	496	920	307	152	66	144
1793	Potatoes, mashed	1	7	600	600	600	600	0	43	155
1616	Cnd fruit (heavy syrup)	1	7	556	556	556	556	0	40	143
2165	Spag.w/meatballs&tom.sce	1	7	550	550	550	550	0	39	142
1324	Milk, evaporated	5	36	5	246	376	75	88	27	64
2075	Cream of Chicken Soup	1	7	372	372	372	372	0	27	96
2159	Spaghetti noodles	3	21	38	150	263	88	47	19	42
850	Sweet corn, canned	1	7	255	255	255	255	0	18	66
587	Chocolate	4	29	11	65	188	47	21	13	24
2230	Sugar, white	7	50	8	65	183	26	19	13	19
505	Butter	4	5	5	45	95	24	15	7	13
929	Coffee whitener	2	14	20	55	75	38	18	5	15
1241	Lard	4	29	10	15	55	14	2	4	6
1872	Rice, white	1	7	38	38	38	38	0	3	10
581	Caramel candy	1	7	37	37	37	37	0	3	10
461	Bread, enriched white	1	7	23	23	23	23	0	2	6
2456	Wheat flakes	1	7	14	14	14	14	0	1	4
Total		14	100	255	4346	21186	1513	1103	1513	1103

Appendix

Weight Data for Dene/Metis Adults Living in Fort Good Hope, N.W.T. (June, 1990)

Sex	Y.O.B.	Mean Wt. (kg)	St.Dev. (kg)	No.in Mean
M	1971	R	R	R
M	1971	62.2	0.0	1
F	1971	52.9	0.0	2
M	1971	60.6	0.0	3
M	1971	70.7	0.0	3
F	1971	54.7	0.0	3
F	1971	48.9	0.0	3
M	1971	64.2	0.0	3
M	1971	62.1	0.0	3
M	1971	82.0	0.0	2
F	1971	55 8	0 0	3
M	1970	M	M	M
F	1970	57.7	0.0	2
F	1970	M	M	M
M	1970	63 1	0.0	1
M	1970	63 2	0.0	3
M	1970	65.2	0.0	2
M	1970	72 0	0.0	1
F	1970	56.7	0.0	1
M	1970	104.7	0.0	3
F	1970	56.1	0.0	2
M	1970	57.0	0.0	2
M	1970	90.6	0.0	3
M	1970	69.5	0.0	3
F	1970	M	M	M
M	1969	58.6	0.0	3
F	1969	M	M	M
F	1969	61.0	0.0	1
M	1969	68.5	0.0	3
F	1969	R	R	R
F	1969	M	M	M
M	1969	R	R	R
M	1969	57.9	0.0	1
F	1969	R	R	R
F	1969	62.0	0.0	3
F	1968	M	M	M
M	1968	R	R	R
F	1968	61.8	0.0	1
F	1968	52.8	0.0	2
F	1968	65.2	0.0	3
M	1968	86.1	0.1	2
F	1968	54.1	0.0	2
M	1967	68.4	0.0	3
M	1967	76.5	0.0	3
M	1967	66.4	0.0	2
M	1967	73.2	0.0	2
M	1967	70.8	0.0	1
M	1967	59.6	0.0	2
F	1967	84.5	0.0	1
M	1954	63.2	0.0	2
M	1954	53.6	0.0	2
M	1954	73.0	0.0	3
M	1953	75.4	0.0	3
F	1953	55.0	0 0	3
F	1953	59 6	0 0	2
F	1953	M	M	M
M	1953	R	R	R
M	1953	M	M	M
M	1953	74.6	0 0	2
F	1952	58 0	0 0	1
M	1952	86 0	0 0	2
F	1951	R	R	R
M	1951	63 5	0 0	2
M	1951	R	R	R
M	1951	67 5	0	2
F	1951	58 0	0 0	3
M	1951	73 3	0 0	2
M	1951	88.3	0.0	3
F	1951	R	R	R
M	1951	M	M	M
F	1951	82.5	0.0	3
F	1950	59.3	0 0	2
M	1949	69 9	0 0	2
F	1949	M	M	M
F	1949	R	R	R
F	1948	58.3	0.0	2
F	1948	61.7	0 0	2
M	1948	M	M	M
M	1948	78 3	0 0	3
M	1948	73.9	0.0	1
M	1947	66 0	0 0	2
F	1947	R	R	R
F	1947	R	R	R
M	1947	R	R	R
M	1946	73.9	0 0	1
M	1946	69.8	0.0	2
M	1946	60.7	0 0	3
M	1945	M	M	M
M	1945	89.2	0.0	2
M	1945	94.4	0.0	2
M	1945	85.7	0.0	3
F	1945	M	M	M
F	1944	83.6	0.0	1
M	1944	77.1	0.0	2
M	1944	R	R	R
F	1944	68.5	0.1	2
M	1944	73.4	0.0	2
F	1943	R	R	R

Appendix 9 cont.

Weight Data for Dene/Metis Adults Living in Fort Good Hope, N.W.T. (June, 1990)

Sex	Y.O.B.	Mean Wt. (kg)	St.Dev. (kg)	No.in Mean
F	1967	50.4	0.0	3
F	1966	57.9	0.0	3
F	1966	M	M	M
M	1966	63.8	0.0	1
F	1966	54.8	0.0	2
M	1966	M	M	M
F	1966	59.3	0.0	3
M	1966	74.6	0.0	2
F	1965	50.8	0.0	3
M	1965	57.5	0.0	2
M	1965	97.2	0.0	3
M	1965	77.0	0.0	2
M	1965	77.2	0.0	3
M	1965	59.5	0.0	3
F	1965	52.7	0.0	2
M	1965	67.7	0.0	1
F	1965	55.5	0.0	2
F	1965	80.9	0.0	2
M	1965	64.3	0.0	2
M	1965	61.8	0.0	2
M	1964	65.2	0.0	2
F	1964	80.1	0.2	3
M	1964	62.9	0.1	2
F	1964	63.1	0.0	3
F	1964	R	R	R
F	1964	53.4	0.0	2
M	1963	77.8	0.0	3
F	1963	51.4	0.0	3
F	1963	54.3	0.0	3
M	1963	66.8	0.0	3
M	1963	66.6	0.0	2
M	1963	73.5	0.0	3
F	1963	49.5	0.0	2
F	1963	51.6	0.0	2
F	1963	54.6	0.0	2
F	1963	54.7	0.0	1
F	1962	56.4	0.0	3
F	1962	66.7	0.0	2
M	1962	52.1	0.0	2
M	1962	57.8	0.0	2
F	1962	M	M	M
F	1962	73.0	0.0	2
M	1962	76.5	0.0	3
M	1962	R	R	R
M	1962	65.2	0.0	3
F	1961	50.8	0.0	3
F	1961	60.0	0.0	2
M	1961	M	M	M
F	1961	M	M	M

Sex	Y.O.B.	Mean Wt. (kg)	St.Dev. (kg)	No.in Mean
F	1943	60.7	0.1	2
F	1943	R	R	R
F	1942	M	M	M
F	1942	60.9	0.1	2
M	1942	M	M	M
M	1942	89.7	0.0	3
F	1942	77.8	0.0	3
F	1941	M	M	M
M	1940	78.2	0.0	2
F	1940	R	R	R
M	1940	89.1	0.0	2
M	1940	56.5	0.0	2
F	1940	54.7	0.0	3
M	1939	52.2	0.0	2
M	1939	67.3	0.0	2
M	1939	88.6	0.0	2
F	1939	60.8	0.0	3
M	1939	M	M	M
M	1939	M	M	M
F	1939	73.8	0.0	2
F	1938	63.1	0.0	2
F	1938	55.3	0.0	2
M	1938	95.5	0.0	1
F	1938	38.6	0.0	2
M	1938	52.7	0.0	3
F	1938	M	M	M
F	1937	56.9	0.0	2
F	1937	58.2	0.0	3
M	1936	80.1	0.1	2
M	1936	87.2	0.0	3
M	1936	R	R	R
F	1936	R	R	R
M	1936	M	M	M
M	1936	64.7	0.0	3
F	1936	51.0	0.0	2
M	1936	M	M	M
M	1934	82.6	0.0	2
F	1934	M	M	M
M	1934	98.3	0.0	2
F	1934	66.7	0.1	3
M	1934	82.1	0.0	3
F	1933	M	M	M
F	1933	M	M	M
M	1933	72.3	0.0	3
F	1933	47.6	0.0	1
F	1932	58.9	0.0	1
F	1932	53.7	0.0	1
M	1932	M	M	M
F	1932	M	M	M

Weight Data for Dene/Metis Adults Living
in Fort Good Hope, N.W.T. (June, 1990)

Sex	Y.O.B.	Mean Wt. (kg)	St.Dev. (kg)	No.in Mean
F	1961	79.2	0.0	1
M	1961	59.2	0.0	2
M	1961	75.8	0.0	2
M	1961	71.9	0.0	3
M	1960	70.2	0.0	2
M	1960	M	M	M
F	1960	56.1	0.0	3
F	1960	60.1	0.0	2
M	1960	57.9	0.0	3
F	1960	54.1	0.0	1
M	1960	M	M	M
F	1960	47.8	0.0	2
M	1960	76.6	0.0	3
F	1960	52.0	0.0	3
M	1960	82.1	0.0	2
F	1960	77 3	0.0	3
M	1960	63.7	0.0	3
F	1959	44.0	0 0	2
F	1959	M	M	M
M	1959	59.8	0.0	1
F	1959	62.6	0.0	2
M	1959	65.5	0.0	2
F	1958	61.3	0.0	2
M	1958	75.4	0.1	3
M	1958	87.3	0.0	2
M	1958	72.5	0.0	3
M	1958	M	M	M
F	1957	68.8	0.0	2
F	1957	65.2	0.0	1
F	1957	74.5	0.0	1
F	1956	R	R	R
F	1956	50.7	0.0	2
M	1956	84.8	0.1	2
M	1956	69.7	0.0	3
M	1956	79.8	0.1	2
F	1956	50.1	0.0	1
M	1956	95.8	0.1	3
F	1955	59.4	0.0	1
F	1955	M	M	M
F	1955	53.7	0.0	2
F	1955	R	R	R
M	1955	63.6	0.0	2
M	1955	74.7	0.0	2
F	1954	55.2	0.0	2
M	1954	R	R	R
M	1954	70.4	0.0	1
M	1954	59.6	0.0	2
M	1932	98.9	0.0	2
M	1932	61 7	0.0	3
M	1931	77.8	0.0	3
F	1931	81.9	0.0	3
F	1930	55.6	0.0	2
M	1930	M	M	M
F	1930	48.8	0 0	2
F	1930	R	R	R
M	1930	R	R	R
M	1929	R	R	R
F	1927	70.8	0 0	2
F	1927	R	R	R
M	1926	63.8	0 0	2
F	1926	M	M	M
F	1924	M	M	M
F	1923	M	M	M
M	1923	67.6	0 0	2
M	1922	M	M	M
F	1921	56.4	0.0	2
M	1921	80.8	0 1	2
F	1920	R	R	R
F	1920	51 7	0 0	3
M	1919	68.7	0.0	3
M	1919	78.2	0.0	2
M	1918	M	M	M
M	1917	M	M	M
M	1917	66.8	0.0	3
F	1916	R	R	R
M	1916	56.2	0 0	3
F	1913	M	M	M
M	1912	M	M	M
F	1912	R	R	R
F	1911	66.4	0.1	3
F	1911	40.1	0 1	3
F	1910	R	R	R
F	1910	42.6	0.0	3
F	1910	51.9	0.0	3
M	1910	88.4	0.0	1
F	1910	62.8	0.0	3
F	1908	62.4	0.0	3
M	1908	M	M	M
M	1906	61.4	0.1	2
M	1905	59.1	0.0	3
M	1905	57.9	0.0	3
F	1903	55.6	0.0	3
M	1902	R	R	R
F	1900	M	M	M
F	1900	M	M	M

Appendix 10

Weight Data for Dene/Metis Adults Living
in Colville Lake, N.W.T. (June, 1990)

Sex	Y O.B.	Mean Wt. (kg)	St.Dev. (kg)	No. in Mean
F	1969	57.6	0.0	2
M	1965	76.1	0.0	3
M	1964	68.4	0.0	2
M	1964	69.9	0.0	2
F	1963	61.6	0.0	1
F	1962	59.3	0.1	2
F	1962	51.1	0.0	3
M	1961	82.0	0.0	2
M	1959	70.2	0.0	2
M	1958	83.8	0.0	1
F	1957	55.3	0.0	2
M	1948	66.8	0.0	3
F	1948	55.8	0.0	2
M	1944	63.5	0.0	1
M	1941	82.6	0.0	2
F	1940	53.6	0.0	1
F	1940	86.6	0.0	1
F	1939	52.6	0.0	2
M	1939	71.3	0.0	1
M	1937	68.1	0.0	3
F	1936	74.5	0.0	1
M	1934	82.2	0.0	2
M	1932	71.0	0.0	3
F	1931	80.3	0.0	2
M	1930	55.8	0.0	2
M	1929	49.2	0.0	2
F	1928	R	R	R
M	1928	74.4	0.0	2
M	1926	M	M	M
M	1925	71.0	0.0	3
F	1908	98.9	0.0	1
F	1908	45.7	0.0	2
F	1905	48.8	0.0	2
M	1901	47.5	0.0	1

Key:

M = difficult to reach (missing)
R = refused to participate
A = "awkward" to measure (infants, crying children, physically challenged)