NUTRITIONAL AND SOCIOCULTURAL SIGNIFICANCE OF *BRANTA CANADENSIS* (CANADA GOOSE) FOR THE EASTERN JAMES BAY CREE OF WEMINDJI, QUEBEC

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ABSTRACT

The nutritional and sociocultural significance of Canada Goose was documented through field research in Wemindji, Quebec and laboratory analyses (proximate composition, trace elements, fatty acids and heavy metals) at McGill University. Consumption of different parts varies by age/gender groups. Cooked flesh samples contained 25.04-36.46 g/100g protein, 6.19-26.35 g/100g fat, 5.58-11.68 mg/100g iron, 2.77-4.81 mg/100g zinc, 4.91-27.59 mg/100g calcium and 0.22-0.75 mg/100g copper. Lung and liver samples contained high amounts of iron (44.24 and 49.18 mg/100g, respectively). Canada goose provides lower amounts of saturated fatty acids and higher amounts of monounsaturated and polyunsaturated fatty acids as compared to lard. Heavy metal content of Canada goose was found to be very low, with exception of several samples containing high lead levels. Canada goose is a highly valued food, providing important amounts of energy, protein, iron, zinc and copper. This resource also has significance in spiritual, cultural and social life of the Cree.

RESUME

La signification socioculturelle et nutritionelle de la bernache du Canada a été etudiée dans la communauté de Wemindji, Québec et les analyses de laboratoire ont été faites à l'université de McGill. Les échantillons de chaire cuite ont montrés en protéines de 25.04 - 36.46 g/100g, 6.19 - 26.35 g/100g en graisses, 5.58 - 11.68 mg/100g en fer, 2.77 - 4.81 mg/100g en zinc, 4.91 - 27.59 mg/100g en calcium et 0.22 - 0.75 mg/100g en cuivre. Le niveau de fer était très élevé dans les poumons et le foie (44.24 et 49.18 mg/100g respectivement). Comparé au lard, la graisse de la bernarche du Canada contient moins de acides gras saturés mais plus de acides gras mono-insaturés et poly-insaturés. A l'exception de quelques échantillons riche en plomb, la bernache du Canada contient très peu de métaux lourds. Pour les Cris, la bernache du Canada est une source alimentaire de grande valeur, fournissant des quantités importantes d'énergie, de protéines, de fer, de zinc, et de cuivre. Cette source alimentaire joue également un rôle dans le vie spirituelle, culturelle et sociale des Cris.

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This thesis is dedicated to Cree children of Wemindji, as well as my own children. May the knowledge of the past be carried with you always.

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1. INTRODUCTION

The Eastern James Bay Cree of Québec have relatively recently incorporated market food into their traditional food system. Nonetheless, traditional food remains an important part of their diet and culture. *Branta canadensis* (Canada Goose) has been, and remains, an important traditional food resource which is harvested during two important cultural events - the spring and fall goose hunts. When sustenance is acquired directly from the local environment, the traditional food system lies at the core of culture and is intimately tied to political, social and spiritual life. Each animal or plant species holds a unique place and the knowledge surrounding its use is essential to the continuity of cultural practices and traditions.

To assess individual or group nutritional status from dietary data, nutrient composition data of traditional food are needed. Nutrient composition data for *Branta canadensis* are lacking from current literature. Also needed are knowledge of sociocultural traditions surrounding food use. The present study takes a unique holistic look at the significance of this particular species through the documentation of traditional food use and compilation of nutrient composition data of food samples.

Two field research periods were undertaken in Wemindji, Québec, corresponding to goose harvesting season. Ethnographic information was documented through researcher participant-observation and informal interviews of community members. Collected food samples were analysed for proximate composition (moisture, protein, fat, ash, carbohydrate by difference and energy), trace elements (iron, zinc, calcium, copper) and fatty acids. In addition, to investigate risk of contamination, heavy metal (lead, mercury, arsenic, cadmium) content of goose samples was determined.

2. LITERATURE REVIEW

2.1 Background of the Eastern James Bay Cree

2.1.1 History of the Eastern James Bay Cree

The term "Cree" originates from *Kristineaux*, a French version of *Kenistenoag*, which designated a portion of North American Indians known today as Cree (White, 1971; Jenness, 1977). Archaeological evidence suggests that Cree ancestors inhabited the James Bay region of Québec for at least 5000 years, following retreat of the glaciers (Price, 1979; Feit, 1986; Bearskin et al., 1990; INAC, 1990). The Algonquian language group including Cree, Montagnais, Naskapi and Micmac First Nations can be traced back chronologically to the Shield Archaic culture of prehistoric times (Price, 1979; Wright, 1979).

Prior to European contact, the Eastern James Bay Cree were nomadic hunter-gatherers, following a seasonal pattern adapted to their subarctic environment. Generally, this consisted of disbanding into small winter hunting groups which traveled in large territories in search of game, such as caribou and moose. Summer months provided a more reliable supply of resources, including fish, birds, small game and plant food, permitting people to congregate into larger groups and participate in social events and cultural ceremonies (Clermont, 1974; Wright, 1979; Francis and Morantz, 1983; Feit, 1986; Bearskin et al., 1990). Trade was practiced between inland and coastal Cree, as well as between Cree and other native groups (Rogers, 1970).

In the early 1500's the fur trade was secondary to the fishing industry in North America and the search for the North West passage to China by both the English and French (Creighton, 1957; Cooke, 1964; Kenyon, 1986). By the late 1500's, the fur trade became an important independent industry, and consequential in the historical period of Indigenous Peoples of Canada. First European contact with the Cree was recorded in 1611 by Henry Hudson on the Eastern James Bay coast. However, encounters with Europeans were probably infrequent prior to the establishment of trading posts in the region (Rogers, 1963; Preston, 1981; Price, 1979). Initially, the Cree were indirectly involved in the fur trade as Montagnais served as middlemen (Preston, 1981; Indian File, 1984). Direct involvement occurred as the English established trading posts in Cree territory (Creighton, 1957). The first Hudson Bay Company (HBC) trading post, known as Fort Charles, was built in Waskaganish in 1668 (Indian File, 1984). Preston (1974) explains that trading posts were often erected at sites traditionally used for summer gathering by the Cree. In some instances, Cree bands shifted summer locations to combine trade with social gathering. Trade relations with the HBC increased the concentration of Cree at summer gatherings (Bernier, 1967).

The traditional lifestyle remained relatively unchanged for the majority of the Eastern James Bay Cree as they began trading with Europeans. In exchange for furs and bush food given to the English, the Cree acquired metal tools, including knives, axes, pots, guns and ammunition (Price, 1979). Prior to the nineteenth century, food was generally not a European trade item although the Cree did obtain quantities of alcohol and tobacco (Ornstein, 1976; Price, 1979; Francis and Morantz, 1983).

The degree and rate of cultural change was variable among the Cree as contact with white traders augmented. Inland Cree, referred to by the English as trading Indians, maintained their traditional lifestyle to a greater extent as they visited posts for only short periods of time to trade (Morantz, 1982). They remained subsistence hunters and traded furs to obtain European goods which saved time and facilitated hunting efforts, or to acquire luxury items, such as beads.

The Cree referred to as "Homeguard Indians" were encouraged to remain close to trading posts to secure food for white traders and thus experienced a greater degree of cultural change. This group may have originated from Cree whose traditional hunting area was based, at least part of the year, along the Eastern James Bay coast (Morantz, 1982). Russell (1975) explains that the Homeguard grew increasingly dependent on post provisions since participation in post duties prohibited travel inland when coastal resources were scarce. In times of need they were given food (namely oatmeal) and were the first to work as seasonal employees for trading posts during the eighteenth century (Ornstein, 1976; Francis and Morantz, 1983). Initially the Homeguard harvested geese and other bush food such as ducks, fish and rabbits, for the post. Later, they were employed to hay, cut wood and to work as guides in the fur brigade, bringing supplies to inland posts (Ornstein, 1976; Morantz, 1980). Their lifestyle gradually shifted to a mixed economy of seasonal employment and subsistence hunting. Preston (1974) uses the term "posting" to describe the gradual trend towards spending longer periods of time at the trading post and depending more on its supplies. The posting process may have been hastened by declines in animal species used for food and fur, and epidemics of smallpox and measles in the early 1800's (Rogers, 1963; Preston, 1974). Descendants of post Indians and white traders (mixed blood Indians) were influenced by European lifestyle to the greatest degree (Morantz, 1980).

The early twentieth century proved difficult for the Cree due to decline of the fur trade, the decrease of important traditional resources including caribou and beaver, and further outbreaks of disease. This "starvation period" precipitated federal government intervention in the region (Tanner, 1977; Vincent and Bowers, 1988). Although Cree culture was modified via the adoption of European trade goods, change during fur trade relations were generally directed by the Cree. Later, missionaries and government representatives forced cultural change which had substantially more negative effects on Cree culture and society (Morantz, 1982). Forced enrollment of Cree children in residential schools interfered with traditional instruction (Wintrob and Sindell, 1970). Increased alcohol consumption and disease epidemics were also important factors in the disruption of traditional Cree lifestyle.

Present day communities, in general, developed at HBC trading posts but were not used as permanent settlements by the Cree until after 1940. A major shift towards sedentary village life had occurred by 1971, when over one third of the population remained in communities year round (Salisbury, 1986). Contributing factors included social welfare and other transfer payments which began in the 1930's, obligatory schooling started in the 1950's, and increased participation in wage employment (Berkes and Farkas, 1978; Price, 1979). Housing development and a rigid administrative band system with band lists have further contributed to this process (Bernier, 1967).

Despite the many cultural changes experienced, the Cree have remained relatively close to their traditional lifestyle, obtaining much of their food from hunting, fishing and gathering (Price, 1979; Hoffer, Ruedy and Verdier, 1981; Vincent and Bowers, 1988). Feit (1978) reported that in the 1960's 82% of food consumed by Waswanipi Cree was derived from the bush. Knight (1968) noted that despite a high percentage of Waskaganish Cree with cash incomes (from wage employment, transfer payments and trapping), the majority of food was still obtained from traditional pursuits (in Price, 1979). In fact, much of the income was used for outfitting, as modern equipment such as guns, ammunition, fuel, outboard motors, snowmobiles and air transport were incorporated in traditional hunting activities (Elberg et al., 1975; Berkes and Farkas, 1978; Feit, 1986; Salisbury, 1986).

The 1970's launched a new era of contact between the Cree and white people as northern Québec development augmented by way of forestry, mining and most notably the Hydro-Québec hydroelectric project. Prior to this, Cree communities were relatively independent from one another; the struggle against hydroelectric development led to the creation of a territorial Cree Nation and the Grand Council of the Crees of Québec (Salisbury, 1986; Vincent and Bowers, 1988). The Cree were able to obtain a temporary court injunction against the project, but it was quickly overturned, the justification being that the interest of southern Québec superseded that of the sparse population occupying the area (Vincent and Bowers, 1988; Diamond, 1990). Continued resistance by the Cree and Inuit resulted in a settlement between Aboriginal Peoples, the provincial and federal governments, Hydro-Québec, the Société d'énergie de la Baie James, and the Société de Développement de la Baie James in the form of the James Bay Northern Québec

Agreement (JBNQA) signed in 1975 (JBNQA, 1975; Price, 1979; Preston, 1981). The agreement divides the land into three sectors: Category I land held by Cree communities represents about 5,500 km^2 (<2%); Category II land which measures approximately 70,000 km^2 (23%), where Cree hunters have exclusive hunting and fishing rights; and the majority, Category III land, where precedence is given to the Cree for subsistence activities. In exchange for cash compensation ($136.6 million for the Cree), Category II and III lands are subject to development by the Crown (Scott, 1992). The Cree were given the right to self government and control over education, health and social services with the formation of various Cree Boards. Hunting, fishing, and trapping rights were guaranteed over a defined territory and a hunting lifestyle was encouraged via the Income Security Program (ISP). This program provides economic security to cover traveling expenses and to purchase market food, supplies and equipment needed while in bush camps (Berkes and Farkas, 1978; Feit, 1982). As a result, the number of Cree who participate in a hunting way of life has increased since the 1970's (Berkes and Farkas, 1978; Robinson, 1985; Feit, 1986; Salisbury, 1986).

Although the JBNQA has been recognized as a landmark native settlement, some feel that government has fallen short in the realization of many portions of the agreement (Vincent and Bowers, 1988; Diamond, 1990). La Grande complex flooded an area of 10,500 km^2 and has had negative consequences beyond the obvious loss of traditional land, including methylmercury contamination of fish in reservoir areas (Diamond, 1990). Increased contact with southern Québec, access to television and increased incomes have increased the degree of consumerism and debt accumulation (Vincent and Bowers, 1988; Bernard and Lavallée, 1993). Roads and airports have made access and travel easier causing local depletion of wildlife resources (Richardson, 1991).

2.1.2 Present Day Cree Communities

The Eastern James Bay Cree of northern Québec inhabit an area of approximately 300,000 km^2 based in 9 communities (Robinson et al., 1995). Presently, there are five coastal communities including Whapmagoostui (Great Whale), Chisasibi (Fort George), Wemindji (Paint Hills), Eastmain and Waskaganish (Rupert House); and four inland communities including Nemaska, Waswanipi, Mistissini and Ouje-bougoumou (Figure 1). The Cree population of 12,035 is distributed disproportionally among the settlements, with the largest populations residing in Chisasibi and Mistissini, and the smallest in Nemaska and Eastmain (Hydro-Quebec, 1996). In coastal communities, the Cree make distinctions between Coasters, families who hunt in territories close to the James Bay coast, and Inlanders, those families whose hunting territories are further inland (Bearksin et al., 1990).

The Cree Nation of Wemindji was established in 1959 following its relocation from Old Factory Island, which lies south of its present location (Bearskin et al., 1990). The Old Factory HBC trading post founded in 1685 closed after only a few years, but reopened in 1935. Wemindji is located at the estuary of the Maquatua River and includes 513 km^2 of Category I land and over 4000 km^2 of Category II land (JBNQA, 1975). The community is accessible by air and has recently gained an unpaved access road connected to the main highway. Commercial food may be purchased at the Northern store, at various community restaurants, from grocery stores in Radisson or ordered from a grocery store in Val D'or. Wemindji has a population of 1173, with 66% under 30 years of age (Creenet, 1996). For most people, Cree is their mother tongue and English, rather than French, is their second language due to historical contact with the HBC (Bearskn et al, 1990; Santé Québec, 1994). Cree is the language of instruction until grade 3 and English thereafter at the Maquatua Eeyou School, which houses both an elementary and high school.

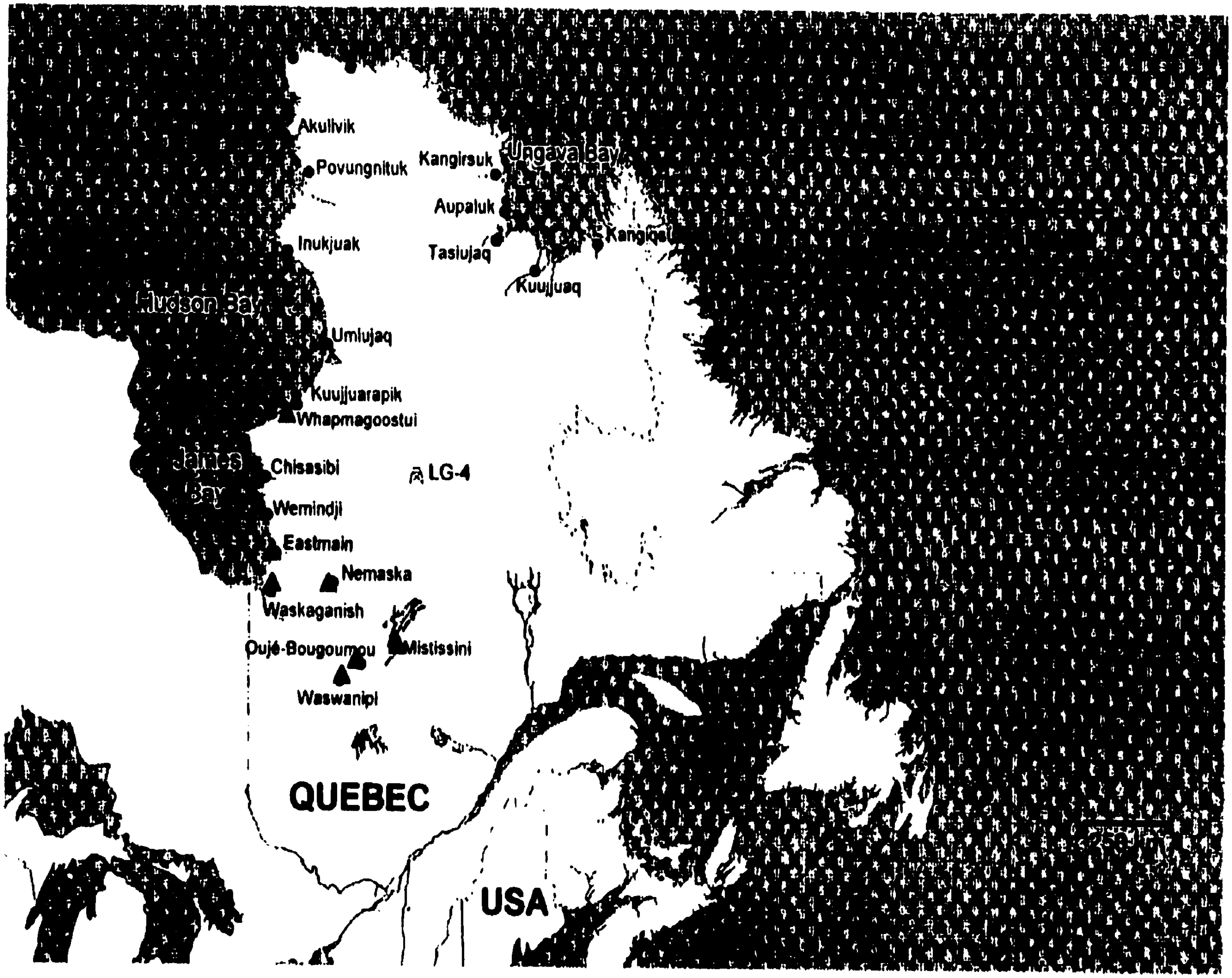

Figure 1: Cree and Inuit Communities in Northern Quebec

2.1.3 Subsistence Patterns

The traditional subsistence pattern of the Eastern James Bay Cree was based on the consumption of meat, fish, and fowl, supplemented by plant food, such as wild berries (Berkes and Farkas, 1978; Bearskin et al, 1990). Peoples' movements were directed by seasonal location of diverse resources used for food and habiliment. Food species of the region include large game (caribou, moose and bear); small game (beaver, porcupine and rabbit); birds (ptarmigan and grouse); waterfowl (geese, ducks and loons); fish (whitefish, burbot, trout, char, pike, sucker, sturgeon and doré); sea mammals (seal and beluga); and plants (labrador tea, wild berries and roots). The pre-contact diet had a notably low carbohydrate content, as for most subarctic Aboriginal Peoples (Young, 1979). This traditional food system is considered to have been nutritionally adequate, so long as sufficient resources were available (Sinclair, 1953; Young, 1988; Health Canada, 1994). Preserved food (frozen in snow, dried and smoked) was used to buffer periods of food shortage; this was particularly important during spring break-up (of ice) and fall freeze-up due to restricted movement (Elberg et al., 1975).

Cree subsistence economy was supplemented by participation in the fur trade. Homeguard Cree, described as specializing in goose and seal hunting, and summer fishing, consumed some post rations (Tanner, 1977). Inlanders, before the 20th century, were not dependent on post provisions and even in the early 1900's would take flour only as a contingency ration. From the beginning of the fur trade to about 1850, it was generally the Cree who provided food for European traders rather than the antithesis (Morantz, 1982). By the end of the nineteenth century, the Cree began incorporating non-native food resources such as flour, oatmeal, sugar, lard and tea into their diet (Berkes and Farkas, 1978). European food was used primarily as protection against food shortage and only gradually became part of the regular diet (Winterhalder, 1981).

Despite dietary change, bush food remains an important part of contemporary Cree economy and may provide most of the population's protein requirement as well as other important vitamins and minerals; traditional resources also help to offset the high cost of market food, which may be up to 50% higher than in southern Québec stores (Salisbury, 1986). Elberg et al. (1975) characterized subsistence in Wemindji as "based upon bush food" supplemented by purchased market food and noted that this was representative of all Cree communities. Presently the Cree participate to varying degrees in the harvesting and consumption of traditional food (Feit, 1982; Delormier, 1993). The Cree maintain a strong desire to continue traditional practices and favor bush food, as do many northern communities (Elberg et al., 1975; Bone, 1992). Harvesting of bush food is a social and cultural activity central to the Cree traditional way of life (Usher, 1976). The diversity of land-based food resources was broader prior to the use of mechanized transportation and increased availability of market food (Winterhalder, 1981). In 1980, Smith explained that the Cree were consuming large quantities of sugar, candy and salt, and few fruits and vegetables. The importance of market food such as white bread, bannock[1], french fries, lard, chicken eggs, sugar and candy has been documented (Delormier, 1995).

The procurement of bush food continues to follow a seasonal pattern. The spring migratory waterfowl hunt may be supplemented by fishing and trapping. Fishing, which is conducted year-round, becomes predominant in late summer, along with the gathering of wild berries. The return of wild geese from northern breeding grounds marks the end of summer and time for the fall goose hunt. During this period hunting of bear and porcupine, and some trapping of fur bearing animals takes place. Trapping is intensified during winter months and is supplemented by ice fishing, and hunting of rabbits, grouse, and ptarmigan (CTA, 1989).

The sharing of bush food is considered central to Cree ideology and remains

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[1] Although bannock is considered a traditional food due to cultural significance, ingredients used for its preparation are purchased market food items (flour, lard, baking powder, salt).

important socially and economically (Feit, 1982). Priority is accorded to elders and anyone in need; in the past this was expressed as the need for food, but today as the need for bush food in particular (Tanner, 1979; Adelson, 1992). Feit (1986) estimates that about half of all bush food harvested is distributed amidst a complex social network. Sharing functions to strengthen bonds of kinship, friendship and of the community as a whole (Bernier, 1967). The type of sharing or exchange which transpires depends on the type of animal (and hence the season) and the social connection between the two parties (Bernier, 1967; Craik, 1974). A decrease in the extent of sharing, particularly outside the immediate family, has occurred as compared to the past and the sale of bush food has become an additional mode of distribution (Craik, 1974; Adelson, 1992; Delormier, 1993).

2.1.4 Dietary Change

Non-directed dietary change associated with the influx of market food into a traditional food system may have far-reaching effects on culture, including the nutritional status of community members. The present century has witnessed a decline in the use of traditional food and an increased incorporation of market food in the diet of Canadian native peoples (Wein, 1986). In general, members of younger generations consume greater quantities of market food as compared to their older counterparts. This may be expected as exposure to market food at an early age has fostered change in food preferences. Different dietary patterns among various age groups may be translated to disparate nutritional profiles with possible health consequences.

Wein et al. (1991a) documented that younger native people in Fort Smith, Northwest Territories (NWT) and Fort Chipewyan, Alberta were consuming traditional food less frequently and in smaller quantities than elders. As such, younger people had a higher percentage of their dietary energy from carbohydrate and a lower percentage from protein (Wein et al., 1991b). Wein and Freeman (1992) demonstrated that Inuvialuit children from Aklavik, NWT had higher preference for store-bought food as compared to adults. Dietary research among Nuxalk women of British Columbia showed that taste preference was the most important factor influencing food use and documented that older women used more traditional food species than younger women (Kuhnlein, 1992).

Among Baffin Island Inuit, younger people were also found to consume less traditional food as compared to older generations; concerns related to nutritional consequences of consuming lower quality market food were raised by researchers (Kuhnlein et al., 1995a). Market food contributed higher amounts of carbohydrate, PUFA, SFA, calcium and sodium to the diet, while traditional food provided more dietary protein, iron, vitamin A, copper, phosphorus, magnesium and zinc (Kunhlein et al., 1996). Similarly, among Sahtu Dene/Métis of the NWT it was found that younger people (≤40 years of age) consumed significantly greater quantities of market food as compared to those ≥ 40 years of age. Since the nutrient contribution of traditional food differs from market food it was explained that nutritional health may be compromised, particularly for nutrients such as iron and zinc (Kuhnlein et al., 1995b; Morrison et al., 1995).

In northern Québec, the shift from a local autonomous hunting and gathering lifestyle to greater dependence on market products has been relatively recent due to isolation of the area. As such, dietary patterns have been altered dramatically in a relatively short period of time. Displacement of the Cree traditional food system is multifaceted. A major factor has been the shift from nomadism to settlement living. Wage employment has contributed by reducing time available for harvesting and by providing income to purchase store-bought food. Increased access into the region by road and air has facilitated the availability of market food. Mass media has served to increase acceptability of market food. As taste preference for certain bush food declines among members of younger generations, loss of knowledge related to harvesting and preparation of wild food occurs. Delormier (1995) recorded one of the reasons for decreased use of bush food as "children prefer market food". Resource depletion, particularly close to settlement areas, has also contributed to the breakdown of the traditional food system. Issues of methylmercury in fish from reservoir areas has been instrumental in the decreased use of fish (Dumont and Kosatsky, 1990).

It has been recognized that wild meat is nutritionally superior to domesticated meat and contains less saturated fats (Crawford, 1968; Berkes and Farkas, 1978; Eaton and Konner, 1985; Health Canada, 1994). In addition, consumption of all edible parts of an animal, including organs and fat, can contribute to a healthy diet (Health Canada, 1994). Despite the fact that hunter-gatherer subsistence was generally derived from only two of the four food groups of Canada's food guide (meat and alternatives; vegetables and fruits), it has been considered superior to the typical North American diet (Eaton and Konner, 1985).

Selected market food which supplements or replaces traditional food is generally low in cost, highly processed and high in carbohydrate content; these store-bought food items are frequently of lower nutrient density as compared to bush food (Bone, 1992). The resulting diet is often higher in saturated fat, sucrose and energy. Accompanying detrimental lifestyle changes may include decreased exercise, increased alcohol consumption, cigarette smoking, and drug use (Health Canada, 1994)

Dietary change has been associated with nutritional deficiencies among Indigenous Peoples of Canada (Wein, 1986). Limited nutritional studies conducted among the Cree have indicated risk of deficiency for vitamin A, vitamin C, calcium and zinc (Vivian et al., 1948, Hoffer et al., 1981; Thouez et al., 1989; Delormier, 1995). The increase in dental caries can be attributed to increased consumption of refined sugar products. The contribution of a modified diet and lifestyle to the increased prevalence of "western" diseases such as obesity, non-insulin dependent diabetes mellitus (NIDDM), cardiovascular disease and some cancers has been recognized (Young, 1987; Lavallée and Robinson, 1990; Bearskin et al., 1990; Health Canada, 1994; Wilson, 1994). Lavallée and Robinson (1990) describe the prevalence of obesity among the Eastern James Bay Cree as epidemic. Thouez et al. (1990) note that the increased prevalence of obesity, diabetes and high blood pressure among northern Québec Cree and Inuit is not surprising in light of the dramatic increased use of highly processed market food.

Benefits of traditional food to overall health transcend pure nutritional value, since harvesting activities favor physical, social and psychological well-being. Bush life has been recognized as beneficial due to availability of fresh nutrient dense food, increased exercise, and decreased alcohol consumption (Robinson, 1985). O'Dea (1984) demonstrated that a return to a traditional lifestyle and diet could improve control of diabetes among Australian Aboriginal people. However, a similar study among the Cree did not show significant results in diabetic control, probably due to large quantities of store-bought food taken to bush camps (Robinson et al., 1995). For Aboriginal Peoples, bush food and activities surrounding its procurement, preparation and consumption are an essential link to cultural identity and community health (Kuhnlein, 1983).

2.2 *Branta canadensis (Canada Goose)*

2.2.1 Canada Goose as a Traditional Food Resource

Canada goose has been and continues to be an important traditional food resource for the Eastern James Bay Cree (Hanson and Currie, 1957; Elberg et al., 1975; Berkes, 1978). Poulin and Lefebvre (1993) describe the native waterfowl harvest as the most important traditional activity along the James Bay coast. Canada geese are harvested in spring (April/May) and again in fall (September/October) as they enter the region during migrations; Cree terms for April and September are *nischibiisim* (goose month) and *mishikumaayaawbiisim* (month of the goose migration) respectively (CTA, 1989). Waterfowl comprises the main protein source during these periods (Boyd, 1977). Seasonal surplus of harvested geese are stored and can last until the following goose hunt (Elberg et al., 1975). The Cree look forward to goose harvesting season not only because of the delicious geese they will eat but also due to their importance as cultural events (Preston, 1978). Along the coast, even those who remain in the settlement year-round travel to bush camps to hunt geese (Robinson, 1985). Full-time employees join the hunt despite the fact that economically it may be disadvantageous (Preston, 1978).

"Goose break" (vacation granted to school children and full-time employees during goose hunting season) allows the family to participate together in these special cultural occasions (Salisbury, 1986). Murdoch (1975) noted that "goose break" was beneficial to the physical and social well-being of children. Traditionally, boys began hunting birds at 4 or 5 years of age and obligatory schooling delayed the transfer of traditional knowledge vital to the continuation of Cree culture. The incorporation of "goose break" allowed boys to engage in the first kill ceremony once again at an early age (Wintrob and Sindell, 1970).

Prior to European contact, geese were harvested by the Cree using bow and arrow and by snare, net, bola or crossbow; geese were acquired at closer range than with shotguns and exceptional skill and knowledge was required (Preston, 1975; Berkes, 1978). This ancestral technology was replaced by firearms beginning in the eighteenth century, although bow and arrows were still used to some degree up until the early twentieth century (Rogers, 1970; Preston, 1981; Berkes, 1982).

Russell (1975) explains that geese were also an important food resource for European traders during the 1700's. One of the primary purposes for establishing Rupert House post in 1776 was to supply geese for the Eastmain trading post. For every 20 geese harvested, the Cree were given one beaver's worth of trade goods, including cloth, guns, knives and tobacco. In addition, hunters would receive ammunition, and gifts such as alcohol and coats, and successful hunters could obtain credit for the coming winter months (Russell, 1975; Francis and Morantz, 1983). Women were compensated for plucking and cleaning geese, and feathers were used as a separate trade item (Francis and Morantz, 1983; Kenyon, 1986). Goose feathers and down were traditionally used by the Cree for bedding (Hanson and Currie, 1957).

Goose hunting is the most cooperative Cree hunting activity and thus goose camps are generally larger than typical hunting groups (Scott, 1986). In a given territory the hunt is coordinated by the goose shooting boss whose experience is critical to minimize disturbance among the geese and to ensure hunting success (Scott, 1986; CTA, 1989). Use of a territory for the purpose of hunting geese involves both family and friendship ties (Scott, 1983). Hunting strategies are variable depending on season, weather conditions and concentrations of geese (Scott, 1979). Hunters will differentially kill birds which are known to contain more fat: adult birds are favored over younger ones, and females distinguished by their shorter necks are sometimes harvested over males (Scott, 1983).

Spring migration lasts approximately 6 weeks, from mid-April until the end of May (Craik, 1975). During the spring goose hunt, inland families join coastal families in goose camps. In the past, inland families did not participate to any great extent since departure from and return to coastal areas from winter camps occurred at times which were inconsistent with goose harvesting. Inlanders began participating in the spring goose hunt in the mid 1960's (Berkes, 1978, 1982).

Elberg et al. (1975) describes spring as the "wealthiest season because of the abundant harvests of geese". Due to restricted movement during spring break-up prior to mechanized transportation, migratory waterfowl were very important to the Cree as a seasonal food resource (Elberg et al., 1975). Delormier (1993) documents a taste preference for spring Canada goose as compared to fall Canada goose among the Cree.

Harvesting of Canada geese in fall may last up to 9 weeks, beginning at the end of August and lasting until October. The degree of community participation is not as extensive as compared to the spring hunt, since Inlanders are likely to depart for winter camps prior to arrival of the geese (Craik, 1975).

Data collected from 1972-73 to 1978-79 by the James Bay Northern Québec Native Harvesting Research Committee (JBNQNHRC) estimated an annual harvest of 63,136 Canada geese by the Eastern James Bay Cree. This amounted to 45% of all waterfowl and 70% of all wild geese harvested[2] by the Cree. Canada goose was estimated to amount to 16% of the total food weight available from wildlife harvests. The majority (58%) of Canada geese were procured during the spring hunt. The total annual Canada goose harvest for Wemindji was estimated at 9,069, accounting for 52% of waterfowl and 74% of geese harvested. Canada goose amounted to 20% of the total food weight available from harvests for the Cree of Wemindji[3] (JBNQNHRC, 1982). An assessment of harvests undertaken by Scott in 1975-76 in Wemindji documented that Canada goose harvests were underestimated by the study, suggesting an even greater importance of this resource to some Cree communities (JBNQNHRC, 1982).

The importance of Canada goose was documented in a dietary study (24

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[2]Other geese harvested by the Cree include Brant (*Branta bernicla*) and Snow Geese (*Anser caerulescens*).

[3]These figures were based on an estimated live goose weight of 3.05 kilograms (6.7 lbs) and edible weight of 2.14 kilograms (4.7 lbs); (68% edible portion).

hour recalls and food frequency questionnaires) conducted among Cree women from the communities of Wemindji and Eastmain (Delormier, 1995). In 24 hour recalls recorded in summer, Canada goose was shown to be the top source of energy (11%), fat (14.3%), protein (19.1%), and iron (34.2%) for the total diet. This was based on an average consumption of 70 g of Canada goose flesh per day, although there was a considerable range of intakes. Winter 24 hour recalls showed that Canada goose was consumed to a lesser degree, at a mean of 12 g/day; Canada goose flesh provided 2.3% of energy, 3.4% of fat, 4.2% of protein and 6.6% of iron to the total diet. In 24 hour recalls Canada goose flesh was mentioned by 52 of 132 women (30.8%) in summer, and by 7 of 87 women (9.9%) in winter. In food frequency questionnaires administered to Cree women covering April-June, 1994, and October-December, 1994, Canada goose was mentioned 98.5 % and 90.8% respectively, making it the most important traditional species cited. Its nutritional impact during these periods, which include goose harvesting season, would likely be more significant than was evidenced by 24 hour recalls during winter and summer.

The Cree consume not only the flesh of geese, but also heart, liver, gizzard, lungs, intestine, feet and head (JBNQNHRC, 1982; CTA, 1989). The fat is collected, boiled and stored for later use (Tanner, 1979). The most important cooking method remains the traditional cooking of whole geese on the open fire, although, geese may also be oven roasted or boiled. The primary mode of preservation is freezing and prior to the widespread home use of electricity, communal freezers were used (Adelson, 1992). Traditionally, geese were dried by the Cree for preservation purposes and this is still practiced to some degree (Delormier, 1993). HBC employees introduced salting of geese to the Cree (Hanson and Currie, 1957; Russell, 1975). Parts of the goose may be differentially consumed according to gender and age. Breasts, backbone, and intestines have been cited as being women's food, and legs and wings as men's food; feet and heart are considered more appropriate for elders (CTA, 1989; Delormier, 1993).

2.2.1.1 Social and Cultural Importance of Canada Goose

The sociocultural significance of harvesting geese is evident in numerous social customs. The cultural tradition of sharing ensures that those who are not successful in hunting or do not participate in hunting activities will still partake in the consumption of this favored resource (Weinstein, 1976; Salisbury, 1986). The season's first kill of geese will be cooked and distributed among all goose camp members in a ceremonial feast; only after this may a hunter accumulate geese for his own family (CTA, 1989; Scott, 1989). The Cree not only participate in the sharing of food but also equipment, knowledge of hunting and opportunities to kill geese during the hunt (Craik, 1975; Scott, 1986, 1989). The family's catch will be further shared in the settlement, especially during feasts, such as birthdays or weddings, when goose is the food of choice (Murdoch, 1975; Delormier, 1993).

Canada goose holds an important symbolic place in the Cree culture. As with other traditional food, "religion was intimately connected with the food quest" (Rogers, 1970). Its symbol is at the core of many life cycle rituals including the walking-out ceremony (an ancient Cree tradition which "symbolizes a child's introduction to Cree society"), marriage and at death, when a hunter's soul may be transferred to a goose (Pachano, 1984; Scott, 1989). A boy's first goose kill is celebrated with a feast and the goose head is dried and decorated (Murdoch, 1975; Preston, 1975, 1978). This occasion remains very important in contemporary Cree culture although it is less common to see preparation of goose heads (Preston, 1975). Wintrob and Sindell (1970) describe this ceremony as a "vital part in development of self-esteem and in consolidating an image of oneself as a hunter and trapper".

2.2.2 Biology of Canada Goose

Branta canadensis belong to the family classification of *Anatidae*, which includes ducks, geese and swans. Canada geese are characterized by black feet, tails, and necks (with white cheeks), and brownish-grey bodies (Kortright, 1967;

Owen, 1980). Canada geese are further divided into subspecies, although the distinctions are controversial and mixing between subspecies occurs (Ogilvie, 1978). Nonetheless, *Branta canadensis interior* is the largest population of Canada goose frequenting the Eastern James Bay coast. Smaller quantities of *Branta canadensis canadensis* and *Branta canadensis hutchison* are also found in the region (Reed et al., 1996). The Cree identify three types of Canada geese which correspond well with scientific classification (Berkes, 1982). Band recovery studies show that the majority of migrant Canada geese harvested along the Eastern James Bay coast are part of the mid-Atlantic flyway population (Reed, 1991). This population has been reported to breed in Northern Québec (Ungava Peninsula) and Labrador, and winter in the Delmarva Peninsula, an agricultural area encompassing Delaware, Maryland, and Virginia, USA (Hindman and Ferrigno, 1990). A small portion of Canada geese using the Eastern James Bay region are associated with the Southern James Bay and Mississippi Valley Populations. More recently, Giant Canada geese (*Branta canadensis maxima*) have begun penetrating the region to molt; these geese originate from their reintroduction into the Great Lakes region (Thomas and Prevett, 1982). These geese are also referred to as resident Canada geese, defined as geese nesting below the 47° latitude (Hindman and Ferrigno, 1990).

Canada geese are the most abundant species of goose along the Eastern James Bay coast. They utilize the region as a major feeding and resting ground on their spring migration north to breed and during fall migration to southern wintering grounds (Curtis, 1976; Ogilvie, 1978). Inland rivers and lakes of the region are used to a lesser degree by waterfowl (Poulin and Lefebvre, 1993). The weather, in part, governs the amount of time that geese spend in the area; for example, a late spring snow melt or late freeze-over in fall may extend the stop-over period (Thomas and Prevett, 1982).

Canada geese are herbivores, grazing in fields and pastures in southern wintering grounds, and feeding on marsh vegetation and berries of the James Bay coast during migration (Curtis, 1976; Thomas and Prevett, 1982). In the James Bay area they consume vegetation including *Carex paleacea*, *Triglochin palustris*; *Equisetum spp* and berries (Thomas and Prevett, 1982; Poulin and Lefebvre, 1993; Reed et al., 1996). Reed et al. (1996) reported that of the food species consumed by Canada geese, 80% in spring and 50% in fall originated from salt marshes, stressing the importance of this habitat for Canada goose populations.

Canada geese mate at 2 to 3 years of age and will remain together for life (about 10 years); they will, however, re-mate following the death of a partner (Savage, 1985; Shaw, 1988; Harvey and Bourget, 1995; USFWS, 1996). They have an average of 4 to 8 goslings per year and both parents care for their young (Ducks Unlimited, 1996). The young learn migration routes from their parents and thus remain with them until they return to breeding grounds the year following their birth (Savage, 1985). The parents then go on to nest while their young molt their feathers. Adults enter a molting period following hatching of the new brood and remain flightless for a month (USFWS, 1996).

2.2.3 Management of Canada Goose Populations

Proper management of wildlife species is essential to guarantee continued use of wild food. Benefits to the health of Indigenous Peoples resulting from consumption of fresh, highly nutritious traditional food depends on continued access to native harvests (Penn and Feit, 1973). Decreased availability of important game places pressure on government agencies to apply conservation measures which may conflict with traditional practices and compromise consumption levels of traditional food. Market food which replaces these food items may be lower in essential nutrients, thus decreasing the nutritional well-being of people consuming them.

Ecologically adaptive practices are embedded in local Cree tradition in relation to resource management of waterfowl. They are based on ensuring short and long term success in the hunt. Many of these traditions have been documented in a report entitled "Cree Trappers Speak" (CTA, 1989). One of the main principles is to minimize the degree of disturbance among the staging geese. This is actualized by refraining from harvesting in major feeding areas, on calm days, after sunset or before sunrise. The collection of goose eggs, disturbance of nests, shooting out of range, and the harvesting of flightless molting birds is discouraged. During the hunt the Cree will attempt to leave one adult parent to care for their young (Berkes 1978).

Adherence to traditional practices is the responsibility of the goose shooting boss and permission to hunt in a given area must be acquired from him. He ensures that hunters enjoy equal opportunity during the hunt and makes daily decisions relating to hunting sites and strategies to be used (Scott, 1986). Rotation of hunting sites is practiced to let geese rest and feed.

Hunting success in Cree ideology is not governed by the hunter but by the animal hunted. For this reason, hunters must show respect to the animals that provide food for their families. Geese are highly appreciated animals, admired for their social habits, intelligence and loyalty to mates and young (Scott, 1983; Preston, 1978). Proper conduct while harvesting, transporting harvested birds, portioning, consumption, and disposal of waste is essential. Harvesting is prohibited on Sunday; this practice originates from the Church's historical influence in Cree territory. Geese are tied by their necks and carried back to the camp over the hunter's shoulder. Women cut the wings off the body rather than breaking them off. The bones and trachea of geese may be hung from trees, perhaps to discourage dogs from eating them (Preston, 1975; CTA, 1989). The wasting of Canada geese is considered disrespectful and thus complete use of harvested birds is encouraged.

Numbers of geese harvested during a given year by the Cree not only depends on the size of the goose population but also on the weather and the organization of the hunt. Some pressures on the traditional system have occurred recently as the authority of the goose boss is refuted by young Cree hunters

(Berkes, 1978). Increased numbers of hunters in a given area resulting from increased population, recent Inlander participation in hunt, and increased mobility have complicated the organization of the hunt. Nonetheless, Berkes (1978) maintains that numbers of geese harvested by Cree hunters is limited due to finite number of hunting sites available. This results in comparable total harvests but fewer geese harvested per hunter.

The subsistence waterfowl harvest has been recognized as being relatively small compared to recreational hunting, nonetheless native peoples' contribution to declines in waterfowl populations has been questioned (Boyd, 1985). Harvests of wild geese by Canadian Indigenous Peoples have been documented as accounting for 7% of the total kill from hunters (Canada and USA). In Eastern James Bay the subsistence harvest is more significant, and may account for one sixth of the total kill (Boyd, 1977). The influence of the subsistence harvest on population dynamics of Canada geese is not novel, since the Cree have always been harvesting geese (Reed, 1991).

The US-Canada Migratory Birds Convention Act of 1916 imposes a closed season for the hunting migratory waterfowl between March 10th and September 1st. This directly conflicts with spring and summer subsistence harvests by Canadian Indigenous Peoples. In general, native people have ignored this ban and attempts to stop off season harvesting in the north have not occurred (Boyd, 1977; Berkes, 1978). The JBNQA recognizes the right of Cree and Inuit to harvest at all times of the year and a 1997 amendment to the Migratory Birds Convention Act acknowledges privileges given under the agreement. The JBNQNHRC (1982) ascertained a level of about 64,000 Canada geese annually which would be guaranteed for the Cree under the JBNQA. This guarantee is, however, subject to deliberation when goose populations are assessed to be in danger of decline (JBNQA, 1975).

The Migratory Birds Convention Act gives control of migratory species to the federal government, in contrast to other wildlife resources which fall under provincial jurisdiction (Boyd, 1977). Flyway councils, created in the 1930's, furnish recommendations to the federal government departments: the Canadian Wildlife Service (CWS) and United States Fish and Wildlife Service (USFWS). At the local level, the Hunting, Fishing and Trapping Coordinating Committee (HFTCC) provides advise in relation to subsistence hunting to Cree authorities. The Cree Trapper's Association, with local community officers, is involved in monitoring and research of wildlife resources (CRA, 1996a).

Canada goose populations were at a low in the 1940's but have since increased their numbers dramatically, achieving a high of over one million birds in the early 1980's. This substantial population increase is considered to be a result of conservation measures taken, such as providing bird sanctuaries and food, and from changes in agricultural land use (Harvey and Bourget, 1995; Berkes, 1978; Malecki et al., 1988). Canada geese have also undergone a northern shift in wintering habits, currently wintering in more northern states (Delaware, Maryland, Virginia) and less in southern areas (North and South Carolina). This has occurred due to adaptation to favorable agricultural areas (Malecki et al., 1988).

Since the 1980's the size of the migratory Canada goose population of the Atlantic flyway has declined. Breeding pair surveys in northern Québec indicate that the numbers of nesting Canada geese have decreased by 75% from 1988 (118,00 pairs) to 1995 (29,000 pairs). Based on these surveys, the migrant Canada geese population for 1995 was estimated at 305,000 individuals (Harvey and Bourget, 1995). Recent declines have been attributed to a poor reproduction season in 1992 (due to climatic factors) and hunting pressure (CRA, 1996a). Concurrently, resident Canada goose and snow goose populations have increased (Harvey and Bourget, 1995; CRA, 1996a; Hindman and Ferrigno, 1990). A 1996 breeding pair survey showed improvement in population status with 46,058 pairs, an increase of 57% from the previous year (Harvey and Bourget, 1996). A nesting survey conducted in 1996 showed improvement in nesting success (proportion of nests from which at least one gosling leaves the nest) since 1992; in 1992 there was a recorded nest success rate of 25% and in 1996 this increased to a 85% success rate. Predation by Arctic fox and bad weather are recognized as factors involved in nest failure (Reed and Hughes, 1997). Difficulty in providing accurate data from sighting or aerial surveys has been documented (Bromley et al., 1995; Shaeffer and Jarvis, 1995). Bromley et al. (1995) suggest that in years when geese are successfully nesting, visibility may be reduced causing poor estimates of population status.

In 1995, an indefinite ban on sport hunting of migratory Canada geese in Canada and the United States was introduced in response to the significant decrease of breeding pairs since the 1980's (CRA, 1996a). In addition, the Cree were asked to decrease the annual harvest to less than that guaranteed by the JBNQA. Cree response in the form of the Canada Goose Resolution '96 indicated a regional plan of reducing harvests to half of the 1995 harvest (CRA, 1996b).

The dynamics of Canada goose populations are complex and result from the sum of factors affecting both mortality and reproductive success. Hunting is recognized as the main cause of mortality among Canada geese (CRA, 1996a). Some have also recognized the significance of lead poisoning from ingested shot (Savage, 1985; Berkes, 1978; Scheuhammer and Norris, 1995). Bellrose (1959) estimates that between 2 to 3% of waterfowl are killed annually from lead poisoning (in Scheuhammer and Norris, 1995). Other factors include decrease in habitat, adverse weather conditions, pollution, predation and pressure from other species or subspecies (Berkes, 1978). Molting giant Canada geese may augment pressure on migrant nesting geese by competing for food (CRA, 1996a). Breeding success as well as the proportion of the population breeding varies greatly from one year to the next (Poulin and Lefebvre, 1993).

Since the James Bay coastal region is recognized as a vital staging ground for Canada geese, preservation of this habitat is fundamental to the management of Canada goose populations (Reed et al., 1996). Although long term environmental effects of the hydroelectric development on the region are unknown, decreased salinity along the coast has occurred and may affect the vegetation which geese rely on (Reed et al., 1996). However, Lalumiere et al. (1994) showed that no change has occurred in the density of eelgrass in the region (in Poulin and Lefebvre, 1993). In addition, it has been suggested that the reservoirs may be used as resting sites during migrations. Expected impacts from hydroelectric reservoirs are decreased numbers of breeders and breeding success, and the influx of non-breeders into areas of nesting since reservoirs are congruous for molting (Boyd, 1977; Poulin and Lefebvre, 1993). Natural changes in the coastal area occur by isostatic rebound and can also affect waterfowl habitats (Reed et al., 1996). The size of waterfowl populations in northern Québec may also depend on disturbance by human activity, airplanes and helicopters (Craik, 1975; Poulin and Lefebvre, 1993).

The need for increased cooperation between government agencies and native groups in issues relating to resource use has been recognized (Reed, 1991; Berkes, 1978). Cree intrinsic knowledge of local environment and goose behavior may be an essential component for successful management strategies. A recent survey of Cree hunters revealed that they have observed a decline in migrant Canada geese and an increase in giant Canada geese in the region. Recent cooperative monitoring studies (goose band recoveries and head measurements) demonstrated that many Canada geese harvested by the Cree are resident geese (Hughes et al., 1997). Cree hunters have also described changes in migration patterns and have attributed them to the presence of reservoirs and increased air and ground disturbance. Decreased trapping was suggested as causing an increase in the number of predators. The geese were also said to spend less time stopping over and fly at night more often than they have in the past. The Cree adhere to the view that there are natural population cycles which may also be in play. Some argue that wildlife management practices such as the use of neck bands and egg counts may be detrimental to geese (CRA, 1996a). The detrimental effects of neck bands has recently been corroborated by Castelli and Trost (1996) who documented that survival rates of leg and neck banded geese (69%) were lower than those with leg bands alone (83%).

Management of Canada goose populations, both traditional and those practices imposed by government agencies, ultimately affect the amount of geese available for food use. The nutritional impact of a decreased availability of Canada geese for the Cree population is largely unknown. However, increased consumption of market food may occur with its associated nutritional and sociocultural consequences.

2.2.4 Literature Values of Nutrient Composition for *Branta canadensis*

The nutrient composition data to-date in the literature for Canada Goose are shown in Table 1. Data published for roast wild goose in Native Foods and Nutrition (Health Canada, 1994) were, in fact, obtained from the United States Department of Agriculture (USDA) Handbook No. 8 (1979) and are predicated on roast domesticated goose. These data are computed values based on nutrient composition of raw domesticated goose without skin multiplied by retention values of cooked duck and cooked duck skin derived from Paul and Southgate, 1978. Similarly, in the Nutrient Value of Alaska Native Foods compiled by Nobmann (1993), the data given for *Branta canadensis* were derived from the USDA Handbook No.8 (1979) for raw domesticated goose flesh, with the exception of iron, thiamin, riboflavin and niacin obtained from Heller and Scott's The Alaska Dietary Survey 1956-1961, (1969). These data are even less useful for the evaluation of dietary information since they are based on uncooked samples. Kuhnlein et al. (1994) published nutrient values for dried Canada goose collected in the NWT and demonstrated that this food item contained high levels of fat, protein, iron and zinc.

Biological studies investigating nutrient composition of Canada geese focus on change which occurs in relation to physiological status. Although limited in value for food composition data bases since they do not pertain to cooked edible portions, they lend insight into dynamics of nutrients, particularly in relation to seasonal change. Rosser and George (1985) estimated iron content of pectoralis (breast)

Table 1: Literature Values for Nutrient Composition for *Branta canadensis* (Per 100g)

	Wild Goose Roast Flesh + Skin Health Canada, 1994	*Branta canadensis* Raw Flesh Nobmann, 1993	Canada goose Flesh Heller & Scott, 1969	Canada goose meat, smoke/dried Kuhnlein et al., 1994
N	N/A	N/A	N/A	2
Energy (Kcal)	303	161	N/A	634
Energy (Kj)	1269	N/A	N/A	2652
Moisture (g)	N/A	68.3	N/A	4 ± 2.3
Fat (g)	22	7.13	N/A	54 ± 21
Protein (g)	24	22.75	N/A	34 ± 16
Ash (g)	N/A	N/A	1.6	2 ± 0.9
Calcium (mg)	14	13	N/A	23 ± 0.4
Iron (mg)	2.8	5.6	5.6	12 ± 3.9
Zinc (mg)	N/A	N/A	N/A	5 ± 1.8
Copper (mg)	N/A	0.3	N/A	0.7 ± 0.35
Vitamin A (RE)	21	N/A	N/A	N/A
Vitamin C (mg)	N/A	N/A	N/A	N/A
Thiamin (mg)	0.08	0.28	0.28	N/A
Riboflavin (mg)	0.32	0.46	0.46	N/A
Niacin (mg)	9.6	9.3	9.3	N/A

N/A: Not Available

muscle of Canada geese at 9.5, 13.6 and 10 mg/100g for pre-molting, molting and post-molting birds, respectively. The concentration of iron was found to increase significantly during molt due to muscle atrophy, although overall iron content was not significantly different during the three periods.

Numerous biological studies have documented change in the annual cycle of total body weight, fat, water and protein in Canada geese (Raveling, 1979; McLandress and Raveling, 1981; Mainguy and Thomas, 1985; Murphy and Boag, 1989; Bromley and Jarvis, 1993: Gates et al., 1993). During spring migration geese accumulate body reserves needed for breeding and thus arrive in the James Bay region at their maximum annual weight (Hanson, 1962). Geese which will breed generally contain more body fat than non-breeders (Thomas and Prevett, 1982). Fat reserves are used during migration and breeding to meet additional nutritional needs (Austin, 1993). Weight gain results primarily from an accumulation of fat, although some protein and moisture is also acquired. Nesting precipitates a large amount of weight loss and this effect is amplified in female geese compared to males. Weight (primarily fat) is recovered quickly following hatching of goslings and is lost again between October and December. Lipid has been cited as the only nutrient whose measurement is associated with seasonality in Canada geese (Gates et al., 1993). Differences in nutrient reserves of subspecies of Canada geese may occur; *Branta canadensis interior* has been reported to contain approximately 20% more abdominal fat as compared to *Branta canadensis maxima* (Mainguy and Thomas, 1985).

Literature values for the fatty acid composition of *Branta canadensis* is shown in Table 2. As shown palmitate (C16:0) is the most important saturated fatty acid (SFA) , oleate is the most significant monounsaturated fatty acid (MUFA) and linoleic acid (C18:2) is the prominent polyunsaturated fatty acid (PUFA). Appavoo et al. (1991) published a fatty acid profile on dried Canada goose sampled in the Northwest Territories. The P:S:M ratio showed higher amounts of MUFA as compared to SFA. Austin's (1993) results, derived from raw subcutaneous Canada

Table 2: Literature Values for Fatty Acid Composition of *Branta canadensis*

		Appavoo et al., 1991 Dried Meat g/100g	Austin, 1993 Raw Subcutaneous Fat g/100g	Thomas & George, 1975 Depot Triglycerides % Total Fatty Acids			
				Premigrant	*Postmigrant*	*Post reproductive*	
						Male	*Female*
		Mean ± SD	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
N		**2**	**12**	**8**	**7**	**3**	**4**
SFA	C14:0	0.3 ± 0.08	0.3 ± 0.04	0.37 ± 0.03	0.23 ± 0.03	0.36 ± 0.09	0.4 ± 0.04
	C16:0	10.8 ± 3.07	14.5 ± 2.03	24.75 ± 0.41	24.28 ± 0.80	16.85 ± 1.83	21.59 ± 2.00
	C18:0	2.9 ± 0.53	5.7 ± 0.80	4.91 ± 0.41	5.10 ± 0.31	3.60 ± 0.16	4.95 ± 0.47
MUFA	C14:1	nd	N/A	N/A	N/A	N/A	N/A
	C16:1	1.4 ± 0.52	2.0 ± 0.28	4.18 ± 0.46	2.53 ± 0.34	2.48 ± 0.18	3.35 ± 0.45
	C18:1	18.1 ± 5.66	34.5 ± 4.81	45.79 ± 1.26	54.49 ± 0.68	34.1 ± 4.88	49.00 ± 5.86
	C20:1	nd	N/A	N/A	N/A	N/A	N/A
	C22:1	nd	N/A	N/A	N/A	N/A	N/A
ω-3 PUFA	C18:3	0.5 ± 0.17	N/A	N/A	N/A	N/A	N/A
	C18:4	nd	N/A	N/A	N/A	N/A	N/A
	C20:5	nd	N/A	N/A	N/A	N/A	N/A
	C22:5	tr	N/A	N/A	N/A	N/A	N/A
	C22:6	nd	N/A	N/A	N/A	N/A	N/A
ω-6 PUFA	C18:2	3.1 ± 0.49	12.9 ± 1.79	19.15 ± 1.11	12.82 ± 1.11	30.38 ± 2.68	18.65 ± 3.00
	C18:3	N/A	1.8 ± 0.26	0.86 ± 0.16	0.55 ± 0.02	12.23 ± 3.11	2.07 ± 0.66
	C20:2	nd	N/A	N/A	N/A	N/A	N/A
	C20:3	nd	N/A	N/A	N/A	N/A	N/A
	C20:4	0.2 ± 0.08	N/A	N/A	N/A	N/A	N/A
	C22:4	nd	N/A	N/A	N/A	N/A	N/A
P:S:M		**0.3 : 1 : 1.4**	**0.7 : 1 : 1.8**	**0.7 : 1 : 1.7**	**0.5 : 1 : 1.9**	**2.0 : 1 : 1.7**	**0.8 : 1 : 1.9**

nd = non detectable

tr = trace

N/A: not available

goose fat, showed proportionally greater amounts of PUFA and MFA when compared to results from Appavoo et al. (1991). Austin (1993) reported no differences in fatty acid composition between male and female Canada geese. Thomas and George (1975), however, found significant differences in 18 carbon fatty acids between the sexes but only during post-reproduction, perhaps from diversion of fatty acids to egg production. P:S:M ratios were shown to vary seasonally, particularly in relation to the amount of PUFA.

2.3 Role of Nutrients in Health

Traditional food (*iiyiyuu miichim*) is considered crucial in the Cree notion of health. The consumption of bush food contributes not only to physical well-being, but also to mental and spiritual health (Adelson, 1992). It has been recognized that Cree health is contingent upon continued access to bush food (Penn and Feit, 1973).

2.3.1 Protein

Humans are composed of approximately 18% protein, half of which is located in skeletal muscle. Protein is a structural part of all cells and serves a wide variety of bodily functions including regulation (hormones, enzymes) and immunity (antibodies). Dietary protein provides nitrogen and essential amino acids which cannot be synthesized by the body (NRC, 1989; HWC, 1990). In comparison to other macronutrients (fat and carbohydrate), protein reserves do not exist in the human body.

Protein requirements are influenced by age, gender, physiological state, environment, activity level, and dietary supply of other nutrients and energy (Gibson, 1990; Berdanier, 1995). Recommended nutrient intakes (RNI) of protein are based on nitrogen-balance and factorial studies corrected for digestibility and protein quality. They are predicated on the assumption that energy requirements are already being met. It is currently recommended that adults obtain 13 to 15% of dietary energy from protein (HWC, 1990).

The ancestral Cree diet is assumed rich in protein since nourishment was derived primarily from animals, birds and fish. In winter, when plant material was scarce and animals were slender, reliance on lean meat may have caused some nutritional stress, as suggested by Speth and Spielmann (1983). They suggest that a very high protein diet increases metabolic rate and may also suppress hunger, resulting in insufficient energy intake. Hunter-gatherer subsistence strategies may have emerged to maximize fat and carbohydrate intake during lean months.

2.3.2 Fat and Fatty Acids

Dietary fat is a source of essential fatty acids (linolenic acid C18:3n3; linoleic acid C18:2n6) and fat-soluble vitamins (A,D,E,K). It is a concentrated source of energy (9.02 kilocalorie/gram) and functions in satiety and palatability of food (HWC, 1983). The FAO Expert Committee recommends a minimum level of 15% dietary energy from fat. Consumption of excess dietary fat is associated with risk of obesity and certain cancers. Obesity, in turn, is associated with increased risk of non-insulin dependent diabetes mellitus (NIDDM), hypertension and gall bladder disease (HWC, 1990; Jonnalagadda et al., 1996). Thus, it is currently recommended that total fat should not exceed 30% of dietary energy.

Tanner (1979) contends that "fat is always the most significant part of an animal for the Cree". Selective preference for animals high in fat, including Canada goose, has been documented (Tanner, 1979; Scott, 1983; CTA, 1989). Traditionally, animal fat (particularly bear and goose fat) was rendered and stored meticulously. Goose fat was used as a coastal trade item which could be exchanged for inland resources (Preston, 1981). These cultural practices conform with adaptive strategies to a high protein, low fat, low carbohydrate diet suggested by Speth and Spielmann (1983). Currently, traditional fat remains an important part of the Cree diet as it improves the flavor and texture of meat (Adelson, 1992).

In light of increased prevalence of obesity and related conditions such as diabetes and cardiovascular disease among native populations, the value of traditional fat in the diet has been questioned. Yet, these fats may contribute nutrients, such as fat-soluble vitamins and fatty acid profiles not available in commonly consumed market fat, such as lard (Health Canada, 1994). Delormier (1995) demonstrated that the main source of fat in the diet of Cree women consuming both market and traditional food was provided by market sources. She suggests that any reduction of dietary fat should be focused on market sources, rather than highly prized traditional fat.

Clearly, it is not only the amount of fat but also the type of fat in the diet which is relevant to health. It is recommended that SFA should total no more than 10% of dietary energy due to increased risk of heart disease and some cancers (HWC, 1990). Individual SFA's, however, have disparate effects on health; lauric (C12:0), myristic (C14:0) and palmitic (C16:0) which increase serum triglycerides and LDL cholesterol are considered risk factors for CVD, whereas stearic acid (C18:0) is now considered neutral (Jonnalagadda et al., 1996). MFA and PUFA are more favorable as compared to SFA because they tend to lower LDL cholesterol levels (McBean, 1992).

Increased amounts of omega-3 (ω-3) fatty acids in the diet have been associated with beneficial health effects for CVD, cancer and inflammatory diseases (McNamara, 1992). Health benefits of ω-3 fatty acids originate from their ability to compete with ω-6 fatty acids for enzymatic systems during prostaglandin synthesis (Jonnalagadda et al., 1996). Balance between ω-3 and ω-6 fatty acids is needed for platelet function, blood flow, blood viscosity, membrane fluidity and monocyte function, important in the etiology of certain disease states, such as atherosclerosis. In addition, studies have shown that ω-6 fatty acids can be tumor promoting (Jonnalagadda et al., 1996). Simopoulos (1991) stresses the importance of distinguishing between these two classes of PUFA's since their metabolic functions are distinct and opposing. It has been suggested that humans have evolved from a diet with a ω-3: ω-6 ratio of 1:1 (Eaton and Konner, 1985; Simopoulos, 1991). Modern western diets have ω-3: ω-6 ratios ranging from 0.1:1 to 0.07:1. Although the optimum ω-3: ω-6 fatty acid ratio is unknown, Health and Welfare Canada (1990) currently suggests a range of 0.25:1 to 0.1:1.

Recently, the consumption of trans fatty acids (TFA) has been linked to increased risk of heart disease. TFAs contain double bonds with a trans configuration as opposed to a cis configuration. Fatty acids with trans double bonds more closely resemble SFA due to closer alignment of fatty acid chains (Lichenstein, 1995). Natural sources are found in beef and dairy products, although the majority of TFAs in the diet are derived from food items containing hydrogenated fats.

Hydrogenated products, such as margarine and vegetable shortening, have been promoted as substitutes for butter and lard to decrease total SFAs in the diet (Willett and Ascherio, 1994). Hydrogenation transforms liquid oils into semi-solid fats, rendering them less susceptible to oxidation, and thus increasing the shelf life of food products. This chemical process adds hydrogen to fatty acids, increases the proportion of SFAs and MUFAs, and converts cis to trans double bonds.

Willett et al. (1993) estimated mean daily intake of TFAs to be 4 grams/day from food frequency questionnaires administered to a sample of 85,095 American nurses in 1980. Data from the US food supply (disappearance and availability data) has shown consumption of TFAs to be higher, ranging from 8 to 12 g/day or approximately 10% of total dietary fat (Enig et al.,1990; Hunter and Applewhite, 1986). Although the amount of TFAs consumed remains controversial, it is generally agreed that the quantity varies greatly depending on individual dietary patterns. In general, as consumption of processed food increases, the amount of TFAs in the diet rise (Lichenstein, 1995).

Although risk associated with consumption of TFAs is controversial, there is some evidence to support the hypothesis that TFAs contribute to the etiology of cardiovascular disease. In a prospective study, Willett et al. (1993) showed that consumption of TFAs was correlated with risk of coronary heart disease in women. An international investigation of eight European countries and Israel (the EURAMIC study), however, did not show a significant difference in risk for acute myocardial infarction when correlated with adipose tissue TFA content (Aro et al., 1995). A clinical study of 58 healthy adults demonstrated that TFAs increased LDL cholesterol (Judd et al., 1994). In 1996, the American Society for Clinical Nutrition (ASCN) and the American Institute of Nutrition (AIN) published a position paper on TFAs. TFAs were recognized as increasing total and LDL cholesterol, although current recommendations to limit saturated fat remained the priority. It was stated that more research on TFAs was needed prior to any changes to recommendations concerning fat consumption. Health and Welfare Canada (1990) recommended that current consumption levels (although amounts are largely unknown and vary between individuals) of TFAs should not be exceeded.

2.3.3 Trace Elements

Quantities of essential trace elements (for example iron, zinc, calcium, and copper) available from diet are contingent upon food composition and physiological status of individuals. Bioavailability of trace elements is subject to solubility of food as well as synergistic and antagonistic effects of other food constituents. An individual's absorption rate will vary according to need and metabolic interactions (WHO, 1996)

2.3.3.1 Iron (Fe)

Iron is an essential nutrient, occurring as a component of hemoglobin, myoglobin, and various enzymes in the body. The human body contains approximately 4 to 5 grams of iron; 80% is found in hemoglobin which functions in the transport of oxygen and carbon dioxide to and from tissues. Symptoms of iron deficiency include anaemia and accompanying decreased immune function and work capacity (NRC, 1989; HWC, 1990).

Iron is present in food in two forms: heme iron in meat products and nonheme iron from plant foods. Heme iron has greater bioavailability, although vitamin C improves nonheme iron absorption in the body. Iron regulation is at the level of the intestine and absorption rates vary according to individual need. Requirements, established to conserve iron stores, are based on the calculation of obligatory losses, growth, and additional factors adjusting for variability. Women have greater losses of iron due to menstruation and thus have higher RNI's. Excess iron negatively affects the digestive system but results from supplementation and not from dietary sources (HWC, 1983).

2.3.3.2 Zinc (Zn)

Zinc is an important micronutrient functioning in the metabolism of macronutrients and nucleic acids as a component of over 200 enzymes. Zinc is essential for growth and development, reproduction, immunity and genetic expression. The body contains approximately 2 grams of zinc, of which 90% is contained within the skeleton and skeletal muscle. Zinc is highly concentrated in the eye and seminal fluid (WHO, 1996). A deficiency of zinc may cause slowed growth and healing, anorexia and poor sense of taste (NRC, 1989; Gibson, 1990; HWC, 1990).

Zinc requirements vary with age, physiological status, and factors which increase or decrease absorption (HWC, 1983). Diets are categorized according to zinc bioavailability, as high, moderate or low, generally in relation to dietary content of phytates and calcium salts. Availability of dietary zinc depends on interactions with protein, fibre, phytates and other minerals (NRC, 1989; WHO, 1996). RNI's are based on obligatory losses, growth requirements, maintenance, metabolism, and factors accounting for individual variability and absorption rate. Zinc is comparably non-toxic although large doses (from supplementation) may cause copper deficiency (HWC, 1983; WHO, 1996).

2.3.3.3 Calcium (Ca)

The majority of body calcium (approximately 1200 grams in adults) is found in the skeleton (99%). The remainder is implicated in essential metabolic processes such as activation of enzymes, nerve transmission, blood clotting, membrane transport and hormonal function. Calcium is regulated hormonally via intestinal absorption, mobilization from skeleton and kidney excretion. Consequently, the body may adapt to a large range of intakes (HWC, 1990).

Concern for adequate calcium intakes is related to increased risk for development of osteoporosis. Calcium deficiency, however, has never been proven as the cause of this condition (Spencer and Kramer, 1988). There have been indications that some dietary patterns, particularly those high in protein and phosphorus, may warrant higher calcium requirements (HWC, 1983). Spencer and Kramer (1988) showed that dietary protein per se has no negative effects on calcium status, and adverse outcomes occur only with purified proteins.

Traditional diets of northern Canadian populations were devoid of dairy products, which provide the majority of calcium in Western diets. Health and Welfare Canada (1990) recognizes that dietary patterns of some cultures containing much lower amounts of calcium have no negative nutritional consequences. Nonetheless, they contend that World Health Organization guidelines of 400-500 mg of calcium per day may not be adequate for Canadians.

2.3.3.4 Copper (Cu)

Copper is an essential component of various metalloenzymes in the body, which function in metabolic processes, such as cell respiration and energy utilization. The adult human body contains 50 to 120 mg of copper, with highest concentrations in liver and brain. Copper deficiency, although uncommon, is generally associated with iron or zinc supplementation. Symptoms include hypochromic anaemia, decreased white blood cell count and bone defects (NRC, 1989; HWC, 1990). Copper toxicity is quite rare; nonetheless, acute poisoning will cause nausea and vomiting, and chronic toxicity affects the liver resulting in jaundice, hepatitis and cirrhosis (WHO, 1996).

Copper is widespread in human food resources and good sources include seafood, organ meats, legumes and nuts. Diets containing more than 100 to 150 grams of protein per day enhance the availability of copper (WHO, 1996). RNIs have not been set for this essential element because of uncertainty in determining true requirements. Based on metabolic and balance studies, it is recommended that adults consume about 2 mg/day (NRC, 1989; HWC, 1990).

2.4 Health Risk of Heavy Metals

Natural concentrations of heavy metals (for example, mercury, cadmium, lead and arsenic) in the environment generally cause no ill effects to biological systems. Human activities, however, such as mining, can increase concentrations to potentially harmful levels. Diet may be the primary source of exposure to heavy metals for human populations, with the exception of peoples living in proximity to highly contaminated areas (WHO, 1996). Interpretation of risk from dietary data is difficult, due to the various forms of the elements found in food and other dietary factors which affect toxicity. Trace element deficiencies and heavy metal-trace element interactions influence toxic effects of heavy metals (Goyer, 1995). For Indigenous peoples, risk related to heavy metal contamination of traditional food must be weighed against nutritional and cultural benefits of their continued consumption (Dumont and Kozatsky, 1990; Wein, 1994; Belinsky et al., 1996). Fish species consumed by the Cree contribute important amounts of high quality protein, MUFAs, PUFAs and ω-3 fatty acids; a general decrease in consumption of fish due to presence of mercury in several species deprives people of these beneficial nutrients (Belinsky et al., 1996).

2.4.1 Mercury (Hg)

The Canadian shield has a relatively high concentration of natural environmental mercury. Industrial (mining, pulp and paper mills) and agricultural (mercurial fungicides) use has caused contamination in human food resources (HWC, 1979; deVries, 1997). Mercury is found in its elemental form and as inorganic and organic compounds (eg. methylmercury). Inorganic compounds containing mercury are not readily absorbed (at a rate of approximately 10%), while the most toxic form, methylmercury, is absorbed at a rate of 85 to 95%. Inorganic compounds tend to accumulate in kidneys while organic compounds, having the ability to cross the blood-brain barrier, accumulate in the central nervous system and brain. All forms of mercury cross the placenta and enter breast milk (WHO, 1996; deVries, 1997).

Toxic effects include numbness, fatigue, and problems of psychomotor development in children. FAO/WHO Expert Committee recommends that diet contains no more than 3.3 μg/kg body weight/week for methylmercury and 5 μg/kg body weight/week for total mercury (WHO, 1996). To ascertain potential contamination in meat products, the Agri-Food Safety division of Agriculture Canada has set an action level for mercury at 0.5 μg/g of fresh tissue (Salisbury et al., 1991).

Methylmercury exposure in Cree communities has been an issue since the 1970's, due to high reliance on fish. Initially, explanations for elevated exposure were related to contamination from a pulp and paper plant located on the Bell River (Usher et al., 1995). Later, researchers discovered that Hydro-Québec reservoirs were responsible for release of naturally occurring environmental mercury. Methylation of released mercury from bacterial activity resulted in methylmercury bioaccumulation in fish. The length of time needed for flooded areas to return to normal mercury levels is currently unknown; estimates have ranged from 5 to 150 years (Tremblay et al., 1993). Predatory fish consumed by the Cree have been shown to have methylmercury levels 4 to 10 times that of other fish species (Penn, 1978). Piscivorous fish, such as lake trout (*Salvelinus namaycush*) and pike (*Esox lucius*), have been shown to have levels which surpass the WHO guidelines of 0.5 μg/g wet weight (Smith et al., 1975; Brouard et al., 1990; Belinsky et al., 1996).

2.4.2 Cadmium (Cd)

Cadmium is naturally present in the environment, although anthropogenic activities have increased environmental sources by way of metal production, fuel, waste disposal and sewage sludge (NRC, 1994). Food is the major source of cadmium for humans, unless exposed from living or working in contaminated areas (NRC, 1994; deVries, 1997). Other sources include air, water and cigarette smoking. Land mammals usually have cadmium concentrations relative to their proximity to industrial sources of cadmium (NRC, 1994). Most food contains less than 0.15 mg/kg, although kidneys may contain 0.5 mg/kg and shellfish may be as high as 1 - 2 mg/kg (WHO, 1996).

Although cadmium is not absorbed to a large extent, danger of toxicity arises from accumulation in the body over time, primarily in kidney and liver. Signs of cadmium toxicity include kidney dysfunction and resulting bone deformities (osteoporosis and osteomalacia) from loss of calcium. Danger of toxicity is greatest when cadmium is inhaled, and may result in bronchitis, lung infections and emphysema (WHO, 1996). Cadmium exposure may also be linked to lung and prostate cancer (NRC, 1994).

Following cadmium analysis of moose and caribou organs in Québec, the Québec Ministry of Leisure, Fish and Game warned Cree communities in 1987 to refrain from consuming liver and kidney from these animals. Most hunters ignored the advise and the Cree Regional Health Authority requested that risk assessment for cadmium be conducted (Usher et al., 1995). Archibald and Kosatsky (1991) calculated that exposure from cigarette smoking was high among the Cree, but that regular consumers of liver and kidney may have weekly exposures of cadmium above the WHO limit of 450 µg/week. Nonetheless, they advised no change from regular consumption patterns until dietary information was collected and a more reliable risk/benefit assessment was carried out.

The FAO/WHO maximum tolerable weekly level has been set at 7 g/kg body weight/week (WHO, 1996). Agriculture Canada's action level for cadmium is set at 1 µg/g of wet tissue (Salisbury et al., 1991). Adequate mineral status, including iron, zinc and calcium, has been shown to be protective against the negative effects of cadmium (WHO, 1996; deVries, 1997; Goyer, 1995).

2.4.3 Lead (Pb)

Lead is an environmentally ubiquitous metal. Widespread industrial use has increased its availability and potential health risk to humans and wildlife (Jaworski, 1978). Increased awareness of its toxic effects has discouraged its use as an ingredient in commodities such as gasoline, paint and ammunition (Scheuhammer and Norris, 1995).

Symptoms of chronic lead poisoning include irritability, neuropathy, nephropathy, anorexia and anemia. Lead toxicity results in disruption of enzymatic function caused by the breakdown of sulfur-hydrogen bonds (USFWS, 1986). Acute lead poisoning may cause a burning sensation in the mouth, mental dysfunction, and even paralysis (Signet/Mosby, 1987). Even at very low levels, lead may evoke symptoms of toxicity and the most significant effect of lead for the general population may be increased blood pressure (WHO, 1996). Since lead passes through the placenta and breast milk, and since children absorb and retain it to a greater degree than adults, lead toxicity in children is of great concern (WHO, 1996; deVries, 1997). Susceptibility to lead poisoning is influenced by dietary factors. In humans, nutrients such as calcium and iron have shown protective effects by decreasing absorption of lead (Mushak and Crocetti, 1996; Goyer 1995).

Waterfowl are a potential source of lead for populations consuming migratory birds as a major portion of the diet. This may be from direct ingestion of lead pellets or minute particles of lead shot contained within the bird's tissue, or indirectly from consumption of lead poisoned birds. Lead bioaccumulates in waterfowl following ingestion of lead pellets and/or fishing weights (Scheuhammer and Norris, 1995). Lead pellets remain in the gizzard where they break down into soluble lead and are absorbed by tissues. Highest concentrations of lead in contaminated waterfowl are found in bone, liver and kidney (USFWS, 1986; CWS, 1996).

Agriculture Canada has set an action level for lead at 2 μg/g of fresh tissue (Salisbury et al., 1991). A Provisional Tolerable Weekly Intake (PTWI) of 25 μg/kg body weight has been established by the World Health Organization (1993) and is speculated to be about 5 times the average North American exposure level (Scheuhammer and Norris, 1995).

2.4.4 Arsenic (As)

Arsenic is a metalloid found most often as a compound containing sulphur or other metals. It is found naturally in the environment and human applications have included production of metals, glass, pesticides, herbicides, and pharmaceutical drugs (HWC, 1993). It has been suggested that arsenic may be an essential micronutrient for humans although this has not been proven. Nonetheless, the typical diet would provide minimal amounts to fulfill any requirement (WHO, 1996). Contaminated water can contribute significant exposure to human populations (WHO, 1996). Arsenic is found in high concentrations in seafood but in forms which are not bioavailable or as organic compounds which are readily eliminated (HWC, 1993).

Inorganic arsenic is more toxic than organic forms of arsenic (Schroeder, 1975; WHO, 1996). It is not readily eliminated from skin or hair and chronic ingestion may cause keratization and pigmentation of the skin, and an increased risk of skin cancer (HWC, 1993; WHO, 1996). Lung cancer has been correlated with inhalation of inorganic arsenic in smelters. An acute dose of arsenic will affect the liver, kidney and digestive tract causing nausea, vomiting and diarrhea (NRC, 1978). The provisional safe exposure level has been established at 15 µg/kg body weight/week although differences in the metabolic effects of various arsenic compounds make risk assessment difficult (WHO, 1996). Agriculture Canada's action level for food is set at 2 µg/g wet weight (Salisbury et al., 1991).

Arsenic is present in lead shot in a concentration of 0.23% to 1.47% by weight, to aid in the formation of round pellets. Hall and Fisher (1985) conducted a study to determine whether other metals contained in lead shot bioaccumulate in waterfowl following ingestion. A positive correlation between concentrations of lead and arsenic were found in some species of duck under investigation. Tucker (1972) suggested a possible interaction between arsenic and lead which increases lead toxicity (in Hall and Fisher, 1985).

2.5 Food Nutrient Composition Data

Food composition data are fundamental to comprehensive investigations of human nutrition. The validity of dietary intake studies depend not only upon reliable dietary collection methods but also on accurate nutrient composition data of foods (Dwyer, 1991; Greenfield and Southgate, 1992). For this reason, the importance of each step taken during the generation of nutrient data must not be overlooked.

Sampling includes the selection, collection and preparation of food items which will be used for nutrient composition analyses. Foods selected should be consumed most often and/or in the greatest quantities by the population in question (Smith, 1991; Greenfield and Southgate, 1992). When food samples are meant to represent dietary components of another culture, knowledge of food habits is essential. A cultural definition of edible portion is critical and people should be consulted for details on food preparation (Cashel, 1990; Cunningham, 1990).

Ideally, as many samples as possible are collected to represent the food's inherent variability in terms of nutrient composition. Unfortunately, extensive sampling from the environment suggests untenable expense of time and resources. In addition, the variations of nutrients are often unknown and differ from nutrient to nutrient (Horowitz, 1991; Greenfield and Southgate, 1992). Sample size, in actuality, is commonly chosen by experience, or governed by what is available. The use of replicated samples of an individual food item is favored since it is more reliable than single samples and provides information on variability. A single composite sample is commonly used as it uses less resources, is convenient when only small amounts of each food unit are available, and is still representative. It does not, however, give information on variability (Cunningham, 1990; Greenfield and Southgate, 1992). Random sampling is preferable, although convenience sampling is acceptable, and often unavoidable, for wild foods (Greenfield and Southgate, 1992). Samples should be handled efficiently, and stored properly to minimize contamination and nutrient loss. Proper identification, coding and record keeping are fundamental to all sampling procedures.

A laboratory sample is defined as sample material in the state in which it arrived in the laboratory. Laboratory samples become analytical samples as they are trimmed, cooked and otherwise altered to represent units of consumable food (Greenfield and Southgate, 1992). These samples must be completely homogeneous to obtain analytical portions which render reliable results. Representativeness of the analyzed food will be defined by preparation of the analytical sample (Cashel, 1990).

Variability reported for nutrient composition data is a function of true variation of food samples, and sampling and analytical errors; this variation will differ according to the food item and from nutrient to nutrient (Dwyer 1991; Horowitz, 1991; Smith, 1991; Stewart, 1991; Greenfield and Southgate, 1992). Food is known to vary in nutrient composition according to region, season, maturity and physiological state. Sampling errors can result from sample collection (ie not representative) and poor transport, handling, preparation or storage. Analytical errors result from instrumental and analyst bias.

Quality control is fundamental to the generation of nutrient composition data to identify, prevent and correct errors. This includes careful sampling technique, diligent laboratory practices and the use of quality assurance techniques during analyses (Greenfield and Southgate, 1992). Replicate assays conducted on each individual sample controls for quality by assessing the accuracy and precision of results. When replicates do not concur within a specified limit, further analyses should be conducted so that requirements are met. Quality assurance includes the use of blanks and standards which are analyzed along with samples. House standards are large amounts of homogenous food product used in a laboratory on an ongoing basis. Certified or standard reference materials may be purchased from national or international institutes. The accuracy of laboratory analyses may also be evaluated through the use of interlaboratory investigations (Greenfield and Southgate, 1992).

3. RATIONALE, OBJECTIVES AND HYPOTHESES

3.1 Rationale

Nutritional studies rely on nutrient composition data of food items consumed by the population under investigation (Greenfield and Southgate, 1992). For Indigenous Peoples, nutritional values for many land-based traditional resources are lacking from food composition data bases which compromise comprehensive investigations of health and nutrition (Berkes and Farkas, 1978; Smith, 1980; Kuhnlein, 1986; Wein, 1986; Johns et al., 1994; Kuhnlein and Receveur, 1996). The contribution of traditional food to health may be of particular importance for cultures, such as the Cree, replacing local food resources with lower quality, highly processed market food. Nutrient data on organ meats are important since they are generally high in specific nutrients, such as iron, and are consumed on a regular basis by the Cree. Since information on the nutrient composition of *Branta canadensis* is lacking in the current literature, this new information will allow assessment of nutritional contribution of this resource to the traditional and contemporary Cree diet. Health professionals and researchers, as well as community members themselves will be able to better interpret individual or group dietary information. For comparative purposes, analogous parts of domesticated goose (*Anser anser*) were analysed along with Canada goose samples. This was of interest since these are the nutrient values currently used in the literature for Canada goose.

Information related to total fat, as well as fatty acids is compelling in light of the contemporary view of the health benefits of limiting fat intake, particularly saturated fats. Health professionals may advise people to reduce their fat intake, without taking into account nutritional benefits of traditional fat (fat-soluble vitamins and favorable fatty acid profiles) or its cultural importance. This has presented a dilemma for the Cree since goose fat, as well as other traditional fat, has been highly prized. Market fat, in particular lard and shortening, have been documented to be used to a greater degree than traditional fat, such as goose fat by the contemporary Cree (Santé Québec, 1994). Delormier (1995) documented that for Cree women consuming both traditional and market food, the majority of fat was derived from market food items. Since the Cree have been alerted to health effects of obesity and diabetes, there is a need to view important traditional food species, including Canada goose, in the context of current public health advice. Nutritional impacts of the different fat sources currently consumed must be addressed.

Improved knowledge of nutritional components of traditional diets lends further insight into the protective aspects against the so-called industrialized diseases, such as diabetes, cardiovascular disease and cancer. Among native peoples of Canada, the value of maintaining traditional aspects of food consumption patterns has been recognized (Wein, 1986; Kuhnlein, 1992). Documented nutrient data of traditional food species may allow health professionals to better advise people in terms of dietary prevention and treatment of various disease states. In the case of nutritional deficiencies, some traditional food may be of benefit and easily adopted as a part of diet therapy due to cultural acceptability.

Data pertaining to heavy metal content will allow health professionals to better assess risk related to the consumption of wildlife species. Specific high risk groups, such as pregnant women and children, may benefit from knowledge relating to heavy metal contamination of traditional food. In instances where traditional food is found free of heavy metal content, fears related to consumption of contaminated food may be alleviated. Mercury and cadmium have been particularly recognized as heavy metal components in the Cree traditional food system (Dumont and Kosatsky, 1990; Archibald and Kosatsky, 1991). Lead poisoning of waterfowl species harvested by the Cree has also been documented (Scheuhammer and Norris, 1995).

An adequate evaluation of traditional resources for a culture must encompass the sociocultural traditions which surround its use (Usher, 1976). To impart cultural relevance to nutrient data, collection of ethnographic information is essential. Particularly important is documented information related to food preparation, cooking, portioning and consumption patterns. To create appropriate analytical samples, information on serving portions and parts of the resource regularly consumed is necessary.

Qualitative information can assist future dietary research among the Cree as it may foster a better understanding of food patterns which are disparate from the culture of those studying the Cree. Ethnographic information related to gender and/or age differences in consumption of Canada goose may allow a more accurate assessment of nutritional status, as well as be helpful when directed dietary change is warranted.

The documentation of traditional food systems is vital as rapid culture change among Canadian native peoples places in peril traditional knowledge surrounding food use. As members of younger generations shift to modern lifestyles, essential information related to harvesting and preparation of traditional food disappears. In this respect the documentation of the traditional use of Canada geese may benefit future generations of Cree as well as contribute to our understanding of human food knowledge (Kuhnlein and Receveur, 1996). Both cultural and nutritional impacts of local food species allow insight into the various ways in which humans adapt to their environment.

3.2 Objectives

1. To determine the nutrient composition of the edible portion of various parts of *Branta canadensis* (Canada goose), including proximate composition (moisture, protein, crude fat, ash, carbohydrate by difference and energy), trace elements (iron, zinc, copper, calcium) and fatty acids of both raw and cooked samples.

2. To determine the content of heavy metals (Hg, Cd, Pb, As) in Canada goose.

3. To determine differences, if any, in nutrient composition between Canada goose and domesticated goose (*Anser anser*).

4. To determine differences, if any, in nutrient composition of fall Canada goose as compared to those harvested in spring.

5. To determine differences, if any, in nutrient composition in female Canada goose as compared to male Canada goose.

6. To determine difference, if any, in fatty acid composition of rendered Canada goose fat as compared to market fat used within the community.

7. To document patterns of harvesting, preservation, cooking and consumption of Canada goose among the Cree, as well as sociocultural traditions surrounding its use.

3.3 Hypotheses

1. Nutrient composition of Canada geese harvested in spring is significantly different from Canada geese harvested in fall.

2. Nutrient composition of male Canada goose is significantly different from female Canada goose

3. Nutrient composition of Canada goose (*Branta canadensis*) is significantly different from domesticated goose (*Anser anser*).

4. The fatty acid profile of rendered Canada goose fat is significantly different from lard.

4. METHODOLOGY

The nutritional and sociocultural importance of Canada goose was documented using two complementary techniques. Qualitative data collection during field research was essential for the generation of culturally applicable nutrient data and provided invaluable ethnographic information. Laboratory analyses at the CINE laboratory provided data on nutrient composition and heavy metal content of collected food samples.

4.1 Project Approval

Ethics approval was obtained from the Human Ethics Review Committee of Macdonald Campus of McGill University (Appendix A). Community approval for the project was attained through Council resolution (Appendix B) and a research agreement was signed with the Cree Nation of Wemindji. A scientific permit for the collection of wildlife species was obtained from the Canadian Wildlife Service of Environment Canada (Appendix C).

4.2 Documentation of Ethnographic Information

Field research was conducted in Wemindji, Quebec during fall 1995 (September 19th to October 4th) and spring 1996 (May 4th to 27th). The investigation was carried out both in the village of Wemindji and in a bush camp outside the community. Qualitative data were collected by researcher participant-observation and informal interviews of community members. In addition, at the request of an elder, ethnographic information was recorded on audiocassette and later translated from Cree to English. Qualitative information pursued encompassed food use patterns associated with Canada goose including harvesting, preparation, preservation, cooking, portioning, and consumption. Social and ceremonial facets related to the use of Canada goose were also explored. Extensive field notes were recorded during research periods. Cree terms were obtained from the Cree Lexicon (1987) or from Cree community members.

4.3 Samples

4.3.1 Sample Collection and Storage

Data on collected samples were recorded on the Eastern James Bay Canada Goose Sampling Data Sheet (Appendix D). The number of geese obtained was determined by what was available at the time of collection. Both male and female geese were sampled during the spring collection period. Geese were sexed by cloaca examination, as described by Hanson (1967). Various body measurements (weight; head, culmen, beak and tarsus length) were taken by procedures cited in Dzubin and Cooch (1992) to ascertain subspecies classification.

Fall samples were immediately placed in a household freezer. In the spring goose camp, samples were buried in snow until it was feasible to transport them to the community of Wemindji and place them in a household freezer. Samples were transported to Montreal frozen and were kept frozen after arrival. Goose samples were stored in a -20°C laboratory freezer and goose fat in a -80°C freezer. For comparative purposes 2 domesticated geese (*Anser anser*) were purchased frozen from a Maxi grocery store (Fauberg de l'Ile, Pincourt, Quebec).

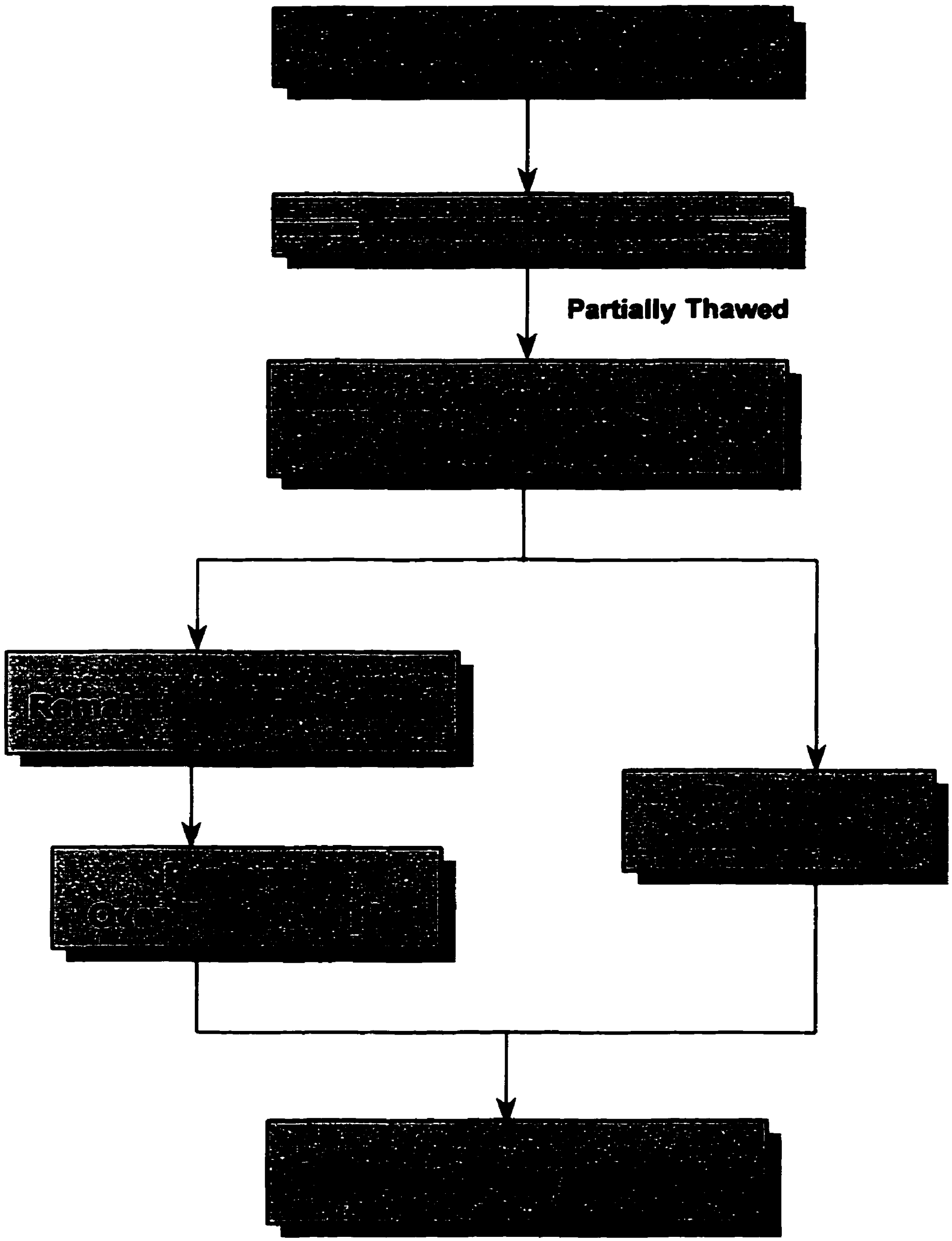
4.3.2 Sample Preparation

A summary of preparation of whole geese is shown in Figure 2. Analytical samples were selected to best represent contemporary consumption patterns of the Cree, as documented in section 5.1.4.

In the spring goose camp, whole raw Canada geese were plucked and partially cleaned on site; for details on these procedures see section 5.1.3. The geese were then placed in labeled plastic bags and buried in snow. Organ meats were placed in labeled plastic whirlpak bags and stored with the geese. One fall Canada goose was plucked and cleaned at the CINE laboratory and the other was received previously prepared.

Each whole goose was removed from the freezer, thawed and prepared for analysis separately. The goose was placed in the refrigerator (2-4°C) to partially

Figure 2: Summary of Preparation of Samples



thaw for approximately 48 hours in its original wrapping. Refrigerator temperature was verified at regular intervals. In a partially thawed state, the small feathers were singed with a propane torch and wiped clean with a cloth, as is done by the contemporary Cree. The head, feet and wings were removed, placed in plastic bags and returned to frozen storage. Organs (heart, liver and gizzard) were removed, weighed, placed in labeled whirlpak bags and returned to frozen storage; intestines were previously removed and frozen.

Samples to be analyzed in a raw state were removed. The remainder of the goose was oven roasted covered in a 4 liter Visions Oval roaster at 350°F for approximately 2 hours. Oven temperature was monitored with an oven thermometer. A meat thermometer was inserted in the inner thigh of the roasting goose. The goose was deemed cooked when the thermometer reached a temperature of 200°F. The goose was removed from the oven and left to cool for approximately one-half hour. Analytical samples were severed from the goose and the carcass was retained for determination of edible portion. Laboratory samples which underwent the above procedures included 2 domesticated geese, 2 fall Canada geese and 6 spring Canada geese; 1 fall goose and the domesticated geese were obtained plucked and cleaned.

For control of mineral contamination, after cooking each laboratory sample the roaster was washed with Sparkleen laboratory detergent (Fisher Scientific), rinsed with tap water, followed by distilled water and then soaked overnight in an acid bath. It was then rinsed with distilled water and Nanopure water, and placed in the Fisher Scientific Isotemp drying oven (Model 655F) at 120°C for several hours until dry.

Analytical samples were obtained from two additional Canada geese and boiled in Nanopure water for 1 hour in the roaster. Samples of dried Canada goose skin/flesh were divided in half. One half was boiled in the roaster in Nanopure water and the other half was analyzed in its original state.

Organ meat including liver, heart, intestine and gizzard collected from the spring geese were composited since insufficient sample was available to conduct analyses separately. Gizzards and intestines were cleaned of their contents prior to compositing. Livers and hearts were cut in half to create 2 composite analytical samples; 1 was analyzed raw and the other was oven roasted at 350°F. Intestines were divided into 3 composite samples; 1 was analyzed raw, 1 boiled and the third fried in raw abdominal Canada goose fat. Gizzards were also divided into 3 composite samples; 1 was analyzed raw, 1 boiled and the third oven roasted.

Homogenization of analytical samples was conducted immediately following preparation whenever possible. In some instances, samples were returned to the freezer for a maximum of 24 hours prior to homogenization. Each analytical sample was cut up into small pieces, placed in Nalgene jars and homogenized with an Osterizer Classic Blender. Following homogenization of each sample, blender parts were washed with Sparkleen soap, rinsed with tap water, distilled water, Nanopure water, and then dried. A small amount of sample was placed in 60 milliliter (ml) nalgene jars, flushed with nitrogen and placed in the -80°C freezer for the purpose of fatty acid analysis. The remainder was left in 250 or 125 ml nalgene jars and returned to the -20°C freezer for storage.

During analytical sample preparation, latex gloves, stainless steel instruments and Nanopure water were used to prevent metal contamination. Analytical samples were assigned a laboratory code according to standardized guidelines (Appendix E).

4.4 Determination of Edible Portion

Prior to homogenization, the weight of each portion with and without waste material (bones) was recorded. Edible portion for each part was calculated by subtracting the weight of waste from its total weight. Edible portion for whole Canada goose was estimated by summing the edible portion of each part, including the carcass. Percent edible portion was calculated by dividing edible weight by the whole weight of the goose prior to plucking and cleaning.

4.5 Nutrient Composition Analyses

4.5.1 Proximate Analysis

Disposable latex gloves were worn throughout proximate analysis. Weights were taken on an analytical balance (Sartorius Universal) to 4 decimal places. A house standard of homogenized salmon flesh (Onchorhynchus sp.) was used as a control for all assays. Replicates with a coefficient of variation (CV) of over 10% were deemed unacceptable and further replicates were run. A summary of steps taken during proximate composition analyses are shown in Figure 3.

4.5.1.1 Moisture Analysis (Lyophilization)

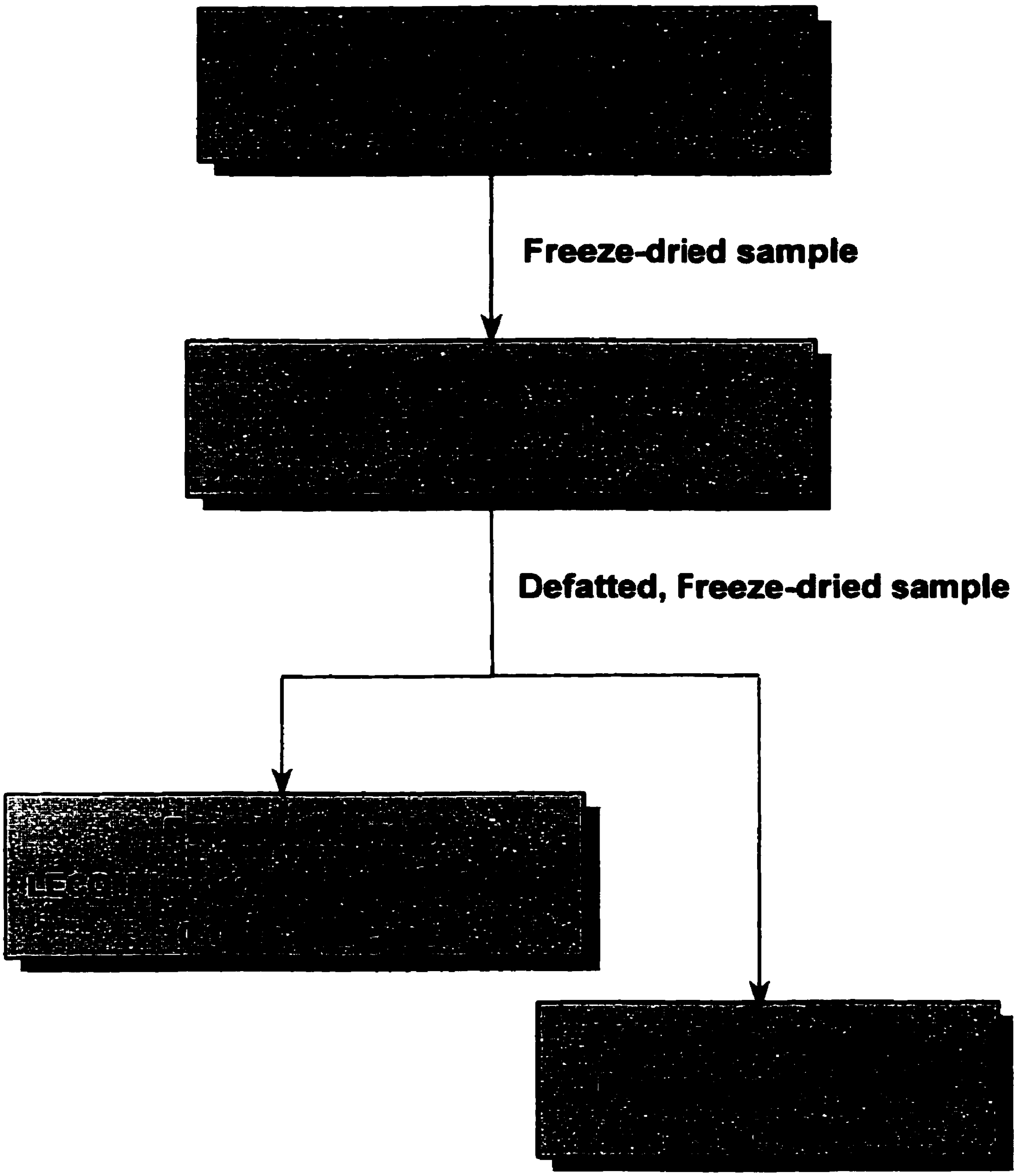
Moisture content was determined in triplicate using the Flexi-Dry microprocessor controlled bench top lyophilizer (FTS Systems Inc, Stone Ridge, NY). House standards included with each batch had a CV of less than 1%.

Pre-labeled aluminum weigh boats were placed in the drying oven overnight at 120°C. They were subsequently transferred to a dessicator, allowed to cool and weighed. Homogenized samples were removed from the freezer, left to partially thaw at room temperature and then mixed with a stainless steel spatula to allow sublimed moisture to recombine. Approximately 10 to12 grams of homogenate was weighed into each weigh boat and placed in the -80°C freezer for 30 minutes to prevent splashing during the lyophilization process. Weigh boats were then transferred to the lyophilizer containers and freeze-dried for a minimum of 72 hours.

Following lyophilization, weigh boats were transferred to a dessicator and then weighed. Several samples from each batch were transferred to the vacuum oven for 1 hour at 23 Hg pressure at 60°C to verify completeness of the lyophilization process. Replicates were ground together using a Black & Decker grinder. After grinding each sample the grinder was wiped clean with kimwipes, rinsed with Nanopure water and then with methanol. The freeze-dried homogenates were then placed in labeled plastic jars and returned to the -20°C freezer.

Moisture determination of samples of fat was conducted in duplicate in the

Figure 3: Summary of Proximate Analysis



vacuum oven; these data were necessary for calculation of fatty acids. In addition, the sample of raw skin was spoiled in the lyophilizer due to its high fat content and re-analyzed in the vacuum oven. Approximately 4 to 5 grams of sample were weighed into pre-labeled, pre-weighed aluminum weigh boats and placed in the vacuum oven at 60°C. After 24 hours samples were transferred to a dessicator, allowed to cool and then weighed.

4.5.1.2 Crude Fat Determination

Total crude fat was determined in duplicate using an automatic soxhlet extraction system (Soxtec HT6, Tacater AB, Hoganas, Sweden). Petroleum ether (Certified ACF, Fischer Scientific) was used as the extraction solvent. House standards were run in duplicate on a daily basis and had a CV of less than 5.5%.

Extraction cups containing 4 to 5 boiling chips were placed in the drying oven for 1 hour, transferred to a dessicator to cool, and then weighed. Extraction thimbles were placed in the drying oven for one-half hour, and then transferred to a desiccator to cool. Approximately 2 grams of freeze-dried homogenate was inserted into each tarred thimble and a cotton plug was placed over the sample. Pre-weighed extraction cups were filled with 40 ml of petroleum ether. Extraction cups and thimbles with sample were then installed in the extraction unit. Thimbles were boiled in solvent for 25 minutes at 110°C and thereafter placed in the rinsing position for 30 minutes. Condensers were then closed to collect solvent and the unit was placed in evaporation mode for 5 minutes. Extraction cups were removed and placed in the drying oven for 30 minutes at 110°C, transferred to a desiccator to cool and then weighed. Several high fat samples required double or triple extractions prior to the complete removal of fat. Freeze-dried de-fatted samples were removed from the thimbles, placed in plastic containers and returned to the -20°C freezer. Solvent was recycled for subsequent fat extractions. Extraction cups were soaked in soapy water, scrubbed, rinsed with distilled water and oven dried for 1 hour between runs.

4.5.1.3 Protein Determination

Nitrogen content of samples were determined using the LECO FP 428 Nitrogen Determinator System (Leco Corp, ST Joseph, MI). Protein was calculated automatically using a conversion factor of 6.25. Analyses were performed in triplicate of approximately 0.100 grams of freeze-dried de-fatted sample. The samples were weighed into tin foil cups, carefully folded and loaded into the auto-sampler of the instrument. The salmon control standard had a CV of less than 1% and the instrument was calibrated on a daily basis with blanks and nicotinic acid.

4.5.1.4 Total Ash Determination

Total ash was determined in triplicate using the Isotemp muffle furnace (Fisher Sci, Montreal, QC). Salmon control standards were run with each batch and had a CV of less than 3.5%.

Crucibles were soaked in an acid bath (10% Hydrochloric acid) overnight, rinsed with distilled water, and then dried in the oven at 200°C overnight. Thereafter, crucibles were transferred to a dessicator, left to cool and weighed. Approximately 0.500 grams of freeze-dried, de-fatted sample was placed into each crucible and placed in the furnace at 550°C for 48 hours. Following ashing, crucibles were transferred to a dessicator to cool and were then weighed.

4.5.1.5 Calculation of Carbohydrate Content

Carbohydrate content of flesh samples was assumed to be zero. Carbohydrate content of organ meats was determined by difference using the following equation:

100-(% moisture + % crude fat + % protein + % ash)

4.5.1.6 Calculation of Energy

Energy was calculated in kilocalories according to Watt and Merrill (1979) using the following equation:

(% protein X 4.27) + (% fat X 9.02) + (% carbohydrate X 3.87)

Kilojoules were calculated by multiplying kilocalories by a factor of 4.12.

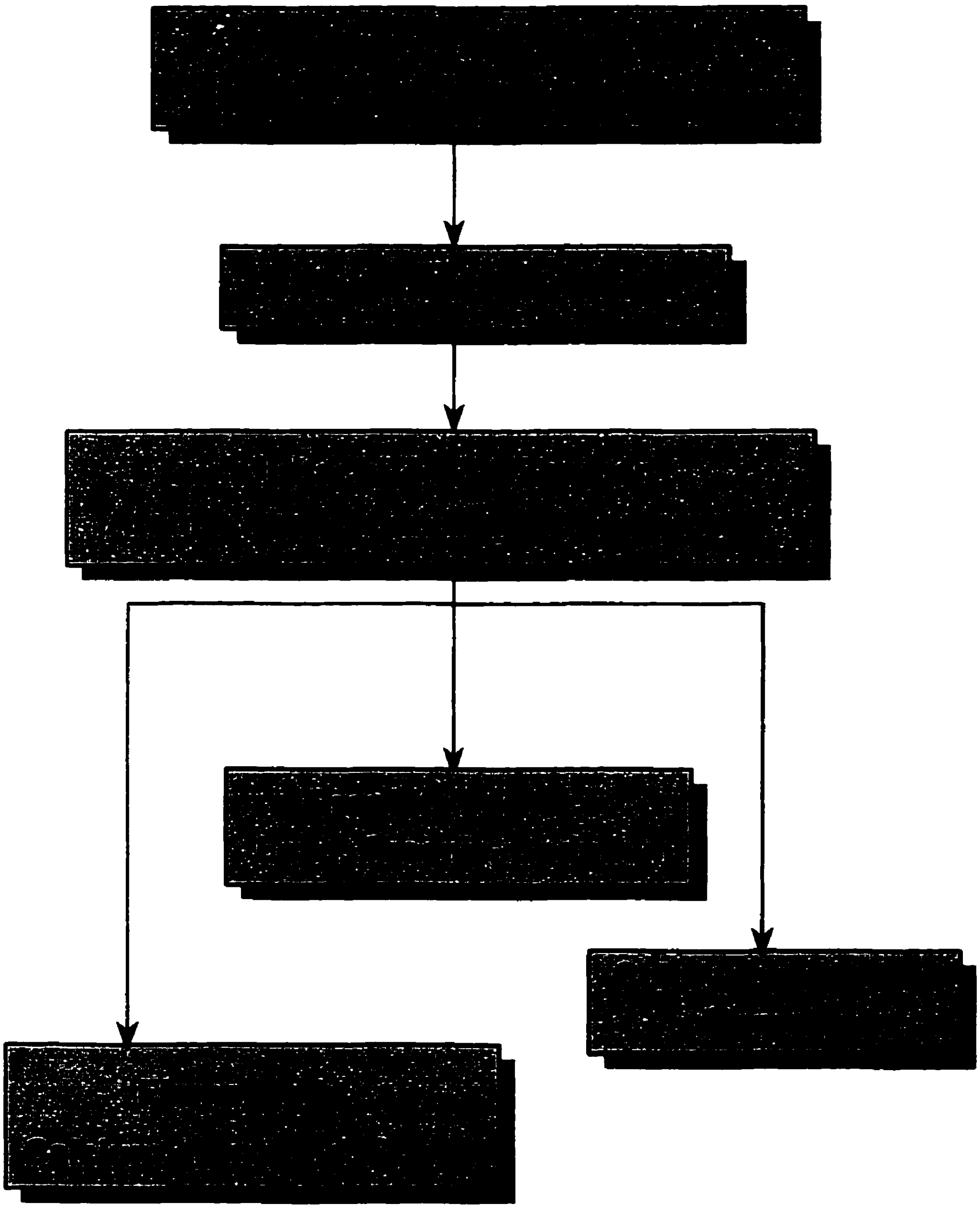
4.5.2 Mineral Analyses

A summary of mineral analyses can be seen in Figure 4. Mineral analyses were performed with a Hitachi Z-8200 Zeeman polarized atomic absorption spectrophotometer (Nissei Sanyo Ltd, Mississauga, ON). Calcium, iron, zinc and copper content of samples were determined by atomic absorption spectrophotometry (AAS) using flame mode. Lead, arsenic, cadmium and a few copper samples were determined by graphite-furnace or electrothermal AAS. Several samples containing high amounts of lead were re-run using the flame mode. Mercury was analyzed by cold vapor method using 10% stannous chloride in 20% v/v HCl as a reducing agent. Lathenum (11000mg/ml La in 5% HNO_3) was added as a modifier for calcium analysis. Nickel and palladium were used as modifiers for arsenic and lead analysis.

All fall samples were analyzed for the aforementioned elements. Iron, zinc, calcium and copper content was also determined for all spring analytical samples. For heavy metals (lead, arsenic, mercury and cadmium) a random sample for 2 of the 6 whole spring Canada geese was taken. However, following preliminary analysis of lead, high values found in some samples led to the decision to complete the remainder of samples. Further analyses of arsenic were also taken since samples containing high amounts of lead were also found to contain detectable levels of arsenic.

Powder-free disposable latex gloves were worn during all operations. Analyses were run in duplicate and two readings of each replicate were taken. Approximately 0.3500 grams of freeze-dried goose homogenate was weighed into

Figure 4: Summary of Mineral Analysis



acid-washed labeled 50 ml boiling tubes. Each tube was filled with 8 ml of 70% weight/volume (w/v) nitric acid (Fisher Scientific; Trace metal grade) and covered with glass condenser bulbs. They were left at room temperature to predigest overnight. The tubes were then placed in a Thermolyn Dri-Bath to digest; the temperature was gradually raised during a 3 hour period, held for 5 hours at 100°C and then allowed to cool to room temperature overnight.

The digest was transferred to a 25 ml volumetric flask using a pasteur pipette and brought up to volume (25 ml) by adding Nanopure deionized water. The mixing of acid and water causes heating and increased volume. For this reason, the volumetric flask was cooled to room temperature by placing it in a beaker of cold tap water for several minutes. The deficit of volume was made up with Nanopure water. The nitric acid concentration of each sample digest was consequently approximately 22% w/v. The contents of the volumetric flask were transferred to 50 ml snap-cap polypropylene vials. Following the processing of each replicate, the volumetric flask was rinsed 3 times with 10% w/v nitric acid.

A slight variation in sample preparation was implemented for spring samples. The digest was warmed prior to its transfer into the 25 ml volumetric flask to dissolve any solid fat. This procedure minimized error due to loss of original weight in high fat samples.

Calibration curves were prepared using 1000 ppm stock solutions for each mineral. To monitor metal recovery certified reference materials were analyzed with each sample batch. Standard reference material(SRM) used included oyster tissue (SRM 1566a) and bovine liver (SRM 1577b) from the National Institute of Standards and Technology (NIST) and dogfish muscle (DORM-2) from the National Research Council of Canada (NRCC). The mineral content of standard reference materials fell within 1 standard deviation of certified values, with the exception of bovine liver (SRM 1577) during calcium analysis, which fell within 2 standard deviations of its certified value.

Samples were re-analyzed if the relative standard deviation (RDS) of the two measurements was greater than 10%, the CV of the replicates was greater than 10% or if the value was out of calibration range. In addition, when standard reference material produced values which were contrary to expected values project samples were re-run.

The limit of detection (LOD) has been defined as the lowest concentration of the element which is statistically different from a blank (Currie, 1978). The criterion of 3 standard deviations of the blank has been utilized. However, it is not possible to use 1 set of LOD values for all analyses due to slight variations in blank values and analytical conditions. For calculation purposes, replicates which fell below the detection limit were assigned a value of half the detection limit.

4.5.3 Fatty Acid Analysis

Lipid extracts of fresh samples were prepared using a modified version of methods used by Folch et al. (1957). Samples containing approximately 2 grams of flesh and 0.5 grams of fat were weighed into 50 ml screw cap centrifuge tubes. Eighteen ml of $CHCl_3$/MeOH(2:1) containing 0.01% BHT was added to the tube which was sonicated for 30 minutes and then let to stand for a minimum of 30 minutes. Five ml of saturated NaCl was added to each tube, which was subsequently centrifuged at 2000 rpm for 5 minutes. The upper aqueous layer was removed with a pasteur pipette and the remaining layers were filtered through a bed of glass wool and Na_2SO_4 into 15 ml screwcap centrifuge tubes.

Fatty acid methyl esters (FAME) were prepared in duplicate by a modified boron tri-fluoride-methanol method of Morrison and Smith (1964). Two ml of the chloroform extract were pipetted into pre-weighed 15 ml centrifuge tubes. One ml of surrogate solution (C17:0 in hexane 1 mg/ml) was added to one replicate for each sample to evaluate the derivatization process (ie. quality control samples). Organic solvents were then evaporated with dry nitrogen and the tubes were re-weighed to calculate the amount of lipid residue to determine appropriate quantities of methylating reagents. To each tube 0.5N NaOH in methanol was added and the tubes were heated for 10 minutes in a 100°C water bath and then cooled. BF_3-methanol was added to each tube which were re-heated for 5 minutes in a 100°C water bath. Appropriate amounts of hexane and NaCl were added and the tubes were centrifuged at 2000 rpm for 5 minutes. The upper hexane layer was pipetted into vials and the remainder was discarded.

Approximately 100 μl of quality control samples were added to gas chromatographic (GC) vials. To their replicates 5 μl of internal standard (C17:0 methyl ester in hexane 50 mg/ml) was added to GC vial inserts and the hexane was evaporated. To each vial insert, 250 μl of the FAME sample was added.

Hexane extracts were analysed by capillary gas chromatography (GC) using a Supelcowax -10 fused silica capillary column (30m x 0.32 mm ID, and 0.25 mm film thickness) on a Varian Star 3400 CX gas chromatograph (Varian Inc., Walnut Creek, CA). One μl of sample was injected by the Varian 8200 CX autosampler in split mode (1:50 split ratio). The fatty acids were quantified on the Varian Chromatographic Star Work Station Software (Ver-4) using 3 and 4 point calibration curves. Recovery of a standard solution (C17:0 in hexane) was greater than 98%.

4.6 Data Management and Statistical Analysis

Ethnographic data were documented with extensive field notes. The field notes were then transposed to a word processing program (Word Perfect 6.1; Novell, Inc 1994; Orem, Utah) upon arrival in Montreal.

Laboratory data were managed using Excel 95 (Version 5; Microsoft Corporation 1985 -1993, USA). Descriptive statistics, including means, standard deviations and coefficient of variations were applied to the data using Excel. Nutrient tables were generated using Excel.

Student t-tests were used to test the significance of differences between species (*Branta canadensis* versus *Anser anser*), sex (male versus female Canada geese) and season (fall versus spring Canada geese) using SAS (version 6, SAS Institute, Inc.; Cary, NC.) with an alpha level of 0.05. Following this a Bonferonni test was applied to lower the alpha level, given the multiple t-tests applied to the data. Student t-tests were also performed to determine differences in fatty acid profiles between rendered goose fat and lard. Due to small number of samples used for statistical analysis, statistically significant differences, or lack thereof, are considered exploratory. A post hoc Pearson's correlation was performed to look at the relationship between mean values of lead and arsenic.

5. RESULTS

5.1 Ethnographic Information

Nutritional benefits of continued consumption of traditional food have been documented (Penn and Feit, 1973; Wein, 1994; Kuhnlein and Receveur, 1996). Determinants of food selection include personal preference as well as social, cultural and environmental forces (Reaburn et al., 1979). Field research periods during goose hunting season provided qualitative information related to food use.

5.1.1 Lifestyle Related to Food Use

Cree homes in Wemindji are now equipped with modern equipment of the average Canadian household. Kitchens are furnished with stoves, microwaves, refrigerators and freezers for preparation and preservation of both market and traditional food. In spite of conveniences of modern life the Cree maintain their "traditionality", which is intimately tied to harvesting, preparation and consumption of bush food. Tepees (*michawap*) are built in spring adjacent to community houses and are dismantled at the end of November for winter months. They are shared by several households of an extended family for the preparation of harvested food and serve as a distinct locale where Cree customs are practiced. The distinction between tepee and house is manifest both in physical appearance and in the conduct of people. As tepees lack furniture, people abide on the floor, which is lined with evergreen boughs. This fragrant floor helps to absorb fat and blood during food preparation, and can be replaced when needed.

Living conditions in the goose camp were characteristically more simple by virtue of the lack of electricity and absence of modern appliances. The camp was composed of several extended families that resided in wood cabins or canvas tents. Dwellings were heated by wood stoves and water was obtained from nearby lakes and melted snow. Goose camps foster living conditions that are more communal as compared to village life. People living in 3 or 4 separate households in Wemindji shared sleeping quarters in the camp. The tepee was the central locale where all camp members assembled for food preparation and for socializing. Partitioning of space within the tepee mimicked the camp's division in terms of living arrangements (Figure 5). The tepee was thoroughly cleaned out every Saturday by removal and replacement of balsam and spruce boughs, which lined its floor. Food was cooked on the open wood fire or on Coleman camping stoves. In the past, tepees were said to have been larger and also used as sleeping quarters.

Meal patterns in the goose camp were somewhat variable and the difference between meals and snacks were not clearly distinguishable. In the morning hunters were most often observed consuming a typical North American breakfast of bacon and eggs. The midday meal consisted of both traditional and market food. It was often composed of roasted dried goose meat and children frequently roasted hotdogs. The evening meal usually consisted of harvested waterfowl which were prepared by women prior to the men's return from the hunt. Geese were roasted in the tepee and often brought back to the family dwelling for consumption. Although harvested waterfowl was the principal food item consumed in the camp there was a substantial quantity of market food used, particularly by younger members of the camp. The variety of market food was extensive and included eggs, bacon, ham, pork chops, hot dogs, hamburgers, various canned meat, oranges, apples, canned mandarins, potatoes, bread, macaroni and other pasta, sugar, flour, tea, evaporated milk, chips, soda pop, punch drinks, candy, chocolate bars, and packaged cakes.

Existence for the Cree fluctuates between two ways of life, from town to country. The bush experience constitutes a fundamental ingredient for continuity of Cree culture. Bush life provides opportunity for elders to pass on vital traditional knowledge in a setting which is conducive for active cultural participation. Cree values and beliefs are acquired along with technological skills for the harvesting and preparation of traditional food. In addition, certain aspects of camp life renders it beneficial to community members. In the village, alcohol is available despite its status as a "dry" community. Bush life is recognized as an alcohol-free environment, and there is a precept that hunting is not permitted under the influence

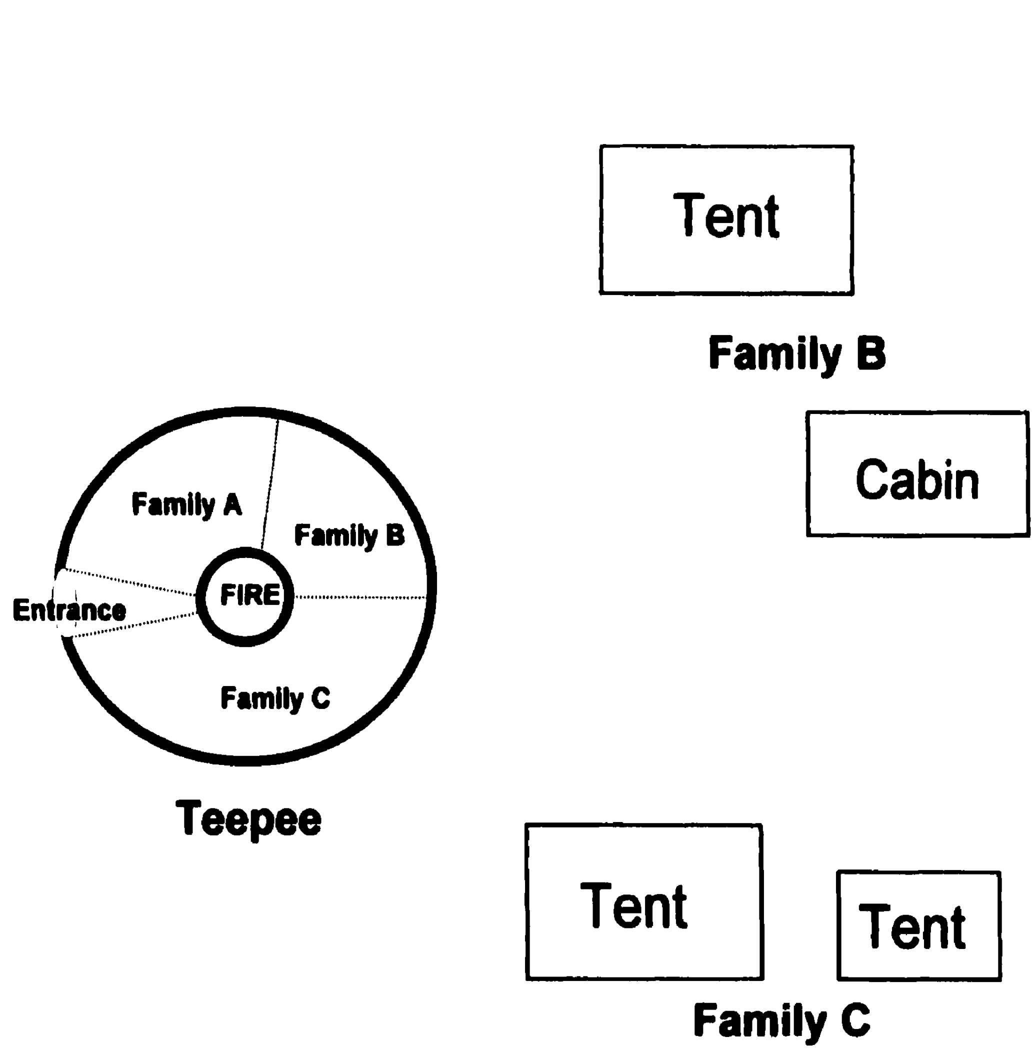


Figure 5 :Social Organization of a Goose Camp, Spring 1996

of alcohol. Physical labour in camp includes activities such as carrying water and chopping firewood, as well as those activities related to the harvesting of traditional food.

5.1.2 Harvesting of Canada Goose (*nisk*)

The hunting of Canada geese (or *nuutaaschaau*) is conducted from goose camps located along the James Bay coast. Hunters may also harvest waterfowl from inland camps and on day trips from the community if they are unable to journey to a goose camp. It was said that these hunting sites are not as successful for the harvesting of waterfowl as compared to coastal goose camps. Communication between bush camps and from camps to the community is serviced by bush radio, which is run through a dispatcher in Wemindji.

In fall, men frequently take short hunting trips to harvest geese, leaving the rest of the family in the community. Some families travel to goose camps during the one-week "goose break", while a smaller number of Cree spend an extended period of time in camps. Goose camps along the coast are accessible by boat during this period.

The spring goose hunt enjoys a much larger participation rate leaving the community essentially deserted during the three-week "goose break". The Maquatua Eeyou School closes allowing children to join their families in goose camps and many full-time employees obtain vacation time for this important cultural event. For some Cree, it is the only time a prolonged period is spent in the bush.

In early spring, the Cree travel to goose camps by snowmobile. Women and children, and their belongings are transported in attached sleighs. As long as the ice is safe for travel, people return to the community by snowmobile to buy supplies and food, take showers, and store geese in household freezers; these trips were often organised on Sunday since the hunting of waterfowl is not permitted. To return to Wemindji by snowmobile departure from the camp occurs before the close of goose season. By the end of goose break the ice is usually too treacherous to travel on and thus the majority of people use the helicopter service organised by the Cree Trappers Association (CTA). A minority of people remain in camps, continue to hunt geese and loons, and return to the community by boat when the ice has cleared from the bay. Snowmobiles are brought back to the community by boat and boats are transported to camps by snowmobile. Roadside and inland camps are accessible by motor vehicle and the CTA's local fur officer assists families by transporting members to these camps by truck.

The sexual division of labour is distinct and the hunting of waterfowl is a man's responsibility. Stories, however, of women who hunt geese were related. Moreover, women do not customarily go with their husbands when hunting, as it is believed to bring bad luck. Many of the older women had never in their lifetimes accompanied men on hunting trips. Some younger men who expressed being less superstitious than elders, have brought their wives hunting on occasion.

Canada geese are harvested using shotguns. One elder spoke of the past when geese were harvested using bow and arrow. His grandfather explained to him that people were able to procure more geese using bow and arrows because they would not miss as often as with firearms. Goose decoys (*nischihkaan*), which are purchased or propped-up harvested geese, aid in the hunt. Geese are said to always face the wind and thus decoys are placed and moved accordingly. *Chihtuuhiischaau* refers to the act of calling Canada geese and some Cree are recognised for their skill at calling geese. Different calls are used for the different goose species to attract them into shooting range.

Goose harvesting is a co-operative hunting activity. The goose boss (*basshchichaauchimaaw*) controls the distribution of hunting sites and chooses hunting strategies for the entire camp on a daily basis. The goose boss is obliged to provide equal opportunity for all hunters. This may be difficult since some sites are superior to others and not all the camp's hunters can occupy the same site simultaneously. Decisions are made according to the weather, season and stage of the goose migration. Geese are said to fly only when it is windy and thus the hunt is best conducted when there is wind; the wind also helps to muffle gunfire which would otherwise disturb main flocks of geese.

Different hunting sites warrant the use of different hunting strategies. Several strategies were described during research periods: In early spring small ponds on the bay (either natural or man-made) are encircled by hunters who conceal themselves behind snow blinds. Geese will not land unless they spot open water so hunters may break up the ice to create ponds. Decoys are placed in the water and hunter's calls attract the geese down as they fly by. As geese descend to feed, the circle of hunters harvests them. Another strategy is practised once large numbers of geese have moved into feeding grounds and conditions are ideal. A few hunters gently scare the geese away and they are harvested as they land in small groups in surrounding areas. Hunters expressed anticipation for the moment when this strategy would be used. Another hunting site used was referred to as the flyway and was accessible on foot from the camp. It was located on a hill devoid of trees on both sides creating a trail which geese tend to be drawn into after leaving their feeding ground. Hunters build blinds from evergreen branches and geese are shot as they fly overhead. Further detailed accounts of Cree goose harvesting strategies may be found in Scott's The Semiotics of Material Life among Wemindji Cree hunters, 1983.

A hunter must recoup the bird after it is shot, which may land quite a distance from the hunting site. Most geese are wing-shot and thus may not be dead upon landing. When a hunter has recovered a bird which is not dead he kills it by pressing his knee on its breastbone. This was said to stop the heart from beating. When the goose has landed in water it is shaken to expel accumulated water. The hunter inspects the goose's fat content by removing a small amount of feathers from the abdomen and pinching the area. This action is referred to as *kuchischaau* and if the goose is fat the hunter will say *wiiyou* (it is fat). Some Cree explained that feathers must be hidden from sight, perhaps beneath ground moss, while others indicated that these feathers are tossed in the air to show the hunter's respect for the goose. Two large feathers from each wing are then used to tie the wings together. The geese are then fastened together by their necks with a cord called *paayikuminaapihchikin*. Geese are customarily carried over the hunter's shoulder into the tepee, although within the community of Wemindji geese may be carried home in a backpack. The hunter places his catch in the section of the tepee occupied by his wife, mother (if he is not married), or other woman who is responsible for preparation of the geese he has procured. An unmarried woman without sons may take responsibility for an unmarried hunter's catch, such as her nephew's. The hunter's wife (or mother) is now responsible for decisions regarding cooking, preservation and distribution of the geese. When a family has too many geese to process, another family who has been less successful may be asked to pluck some of them. In exchange they receive gifts of harvested geese.

5.1.3 Preparation of Canada Goose

Preparation of waterfowl is the responsibility of women. Men can perform these tasks, if they are stranded in the bush and must prepare food for themselves, but it is ordinarily women that carry out these duties. Plucking and cleaning geese is long and tedious work, and women spend much of their time in the goose camp at this function. Older female children were observed to care for toddlers and infants while their mother worked. Female children were observed to help their mothers to some degree on a voluntary basis. A Cree woman described nine steps involved in the preparation of geese:

1. Remove large feathers
2. Remove intestines and gall bladder
3. Pluck the goose
4. Take off the wings
5. Singe the bird
6. Clean out the innards
7. Clean the gizzard
8. Clean the intestines
9. Make goose grease

Primary processing includes plucking the large feathers from the tail and wings and removal of gall bladder and intestines. It is conducted the same day the geese are killed. When there are many geese primary processing may last until after midnight and on these occasions men may help with removal of large feathers. However, plucking is clearly women's work and men were never observed helping with any other processing procedures. Large feathers located on the wings and tail are plucked promptly because they are more difficult to remove with the passage of time. The term *minikunaapitaau* refers to the action of pulling out wing feathers. First, medium-sized feathers from each side of the wing are removed and then the large feathers are pulled out. Occasionally, wing feathers are left on and the wing is broken off to manufacture a household brush. These brushes are used for dusting and are replaced periodically as they become worn out. Tail feathers are removed in a similar manner, with medium feathers taken out first and then the large ones. Feathers and down from the belly area are plucked and the goose is placed aside until all birds have reached this point of processing.

The next step, referred to as *pikuchaashwaau,* is to make a vertical incision in the abdominal region and remove the gall bladder (*wiisuupui*) and intestines. These organs may rupture from gunshot and are removed promptly to prevent their emptied contents from spoiling the bird. Intestines were removed manually from the body cavity by detachment from the gizzard at one end and the cloaca at the other. They were placed in a large container filled with snow to cool until further processing. The gall bladder (attached to the liver) was located, pulled out with the fingers, and discarded. Considerable care must be taken so that it is not broken as it is being pulled out. Partially formed eggs were removed and discarded, although people had consumed them in the past. One woman divulged that as a child she had eaten goose eggs despite the fact that they were not considered good for children. Finally, a wooden stick or large feather was used to close up the stomach by puncturing the skin at several points along the incision. Alternately, a paper towel was placed in the opening to prevent leakage of blood and fat. The geese were placed in a cool spot until the following day when subsequent preparations were made for cooking or preservation. In the camp, geese were placed along the tepee wall with their belly's up and tails facing the wall. Each woman kept careful track of the amount of geese she had processed.

Pishkunaau refers to the action of plucking a goose. In preparation to be cooked or preserved, the entire goose (except for the wings and head) is plucked. Geese vary greatly in terms of their ease of being plucked. The skin of a difficult goose tends to tear as feathers are pulled out. Female and young geese were cited to be easier to pluck as compared to male and older geese. Less experienced "pluckers" (such as children) were supplied with geese that were easier to pluck.

The feathers (*upiiwiih*) and down (*umaashtimipiiwaan*) were separated and conserved for personal use or may also be sold. Feathers which have blood or fat attached to them are discarded. The down is used to fabricate pillows and warm blankets (comforters). In the past, the Cree used feathers to make mattresses. The feathers of spring geese are favored over those from fall geese, which are sometimes discarded. Fall geese are inclined to have lice and this may contribute to the likelihood that feathers are thrown away. Women make an effort to pluck as many harvested geese as possible prior to freezing since feathers are not usable once the geese have been frozen. Mistissinni Cree were said to immerse the geese in boiling water and then pluck them; this makes plucking easier but renders the feathers useless. Down was often used to clean blood from the birds or trays which women were using. Women dampened their hands with water to remove the down which adhered to clothes and the tepee floor.

Once plucked, the wings were taken off the geese. The largest wing bone was left attached to the body and became part of the breast portion. A slice was made in the skin and flesh around the wing bone adjacent to the goose's body. The flesh was pushed away exposing the bone and the wing was broken off. Next, the goose was singed to eliminate tiny feathers which cannot be removed manually. This process (*pihtaau)* was accomplished by slowly swinging the goose through the flames of the open fire while holding its feet with one hand and a bannock stick (which had been forced through its "cheeks") with the other. Alternately, the geese were burnt with a propane torch as they were suspended by their necks with a cord. The burnt debris was then rubbed off with a cloth or paper towel. After this, the organs and fat were removed from the goose's belly. The abdominal fat, liver, gizzard and heart were set aside in a large container of snow to cool and reproductive organs were discarded. The feet were severed just above the knee joint and put aside. The head was removed with approximately half of its neck. To do this, an incision was made in the neck to expose the oesophagus, which was pulled out and thrown away. Another slice was made on the neck and the skin was pushed up towards the head. The trachea was pulled from the body cavity, detaching it from the bronchial tubes but leaving it adjoined to the head. The head was then broken off by cutting on opposite sides of the neck a few inches above the body. The neck portion, still attached to the body, was tucked under the skin of the bird and the skin was secured with a thin skewer or tied with a string. Heads, feet and wings were stored in a cool place and were either placed in frozen storage or prepared for cooking or drying at a later time.

5.1.3.1 Roasted on the Open Fire

Fire roasted goose is the preferred cooking method among the Cree of Wemindji. *Sikipwaau* means to roast on the open fire and *iyishkutaau* refers to the act of hanging a goose over the open fire. Prior to roasting the goose, pieces of lung were pulled out and rubbed over the bird. This was done to improve the taste and to brown the bird while it was roasting. The goose was said to cook faster when its lungs are removed. A small amount of salt was often sprinkled inside the goose and on one occasion an onion was placed in the body cavity prior to cooking. The belly was shut with a thin stick (*chipwaaskuhiikinaahtikw*), made of either wood or metal. These skewers are purchased (wood or metal) or may be whittled by men. All openings must be shut tightly to prevent air from entering the body during the cooking process. Wing bones were tied using one of three techniques: One practice was to fasten a string around the entire body (Figure 6a). A second approach was to tie the wing bones together in front of the goose with a string (Figure 6b). The third method was to tie the wing bones close to the body with the string used to tie the neck opening (Figure 6c). A larger stick was pried through the legs and tail area of the goose. A hook (*sikipwaachikin*) was secured in the tail region and was attached to a roasting string, referred to as *sikipwaanaahtikw* (Figure 6). The string was suspended from wooden poles above the hearth. The height of the roasting goose was adjusted using slip knots in the roasting string.

When many geese were roasted a circle was formed around the fire. A pan was placed beneath each bird to collect its drippings and a small amount of water was added to the pan to prevent the fat from burning. The drippings collected during the cooking process were used as a sauce for served portions of roast goose. Men were said to take drippings with them on hunting trips. The roasting goose was spun (*chiinikwaanaapihchaahwaau*) by skilfully nudging it with a bannock stick (*booskan*). When almost ready, the goose was removed from the hook, turned upside down and hung in the opposite direction for a brief period of time. The goose was said to be ready when steam is observed escaping from its body. Upon completion, the roasted goose was removed from the hook and placed in a large pan to cool. The entire roasting process required two hours, plus or minus one half-hour. Cooking time depends on the size of the goose, the strength of the fire and the amount of time the goose spends spinning; the more the goose is spun the faster it will cook.

5.1.3.2 Oven Roasted

Canada geese are also oven roasted, particularly during winter months when tepees are not erected. The goose is placed in a roasting pan and is cooked covered at 350°F for approximately 2 hours, depending on its size. Some Cree remove the cover at the end of the cooking period to brown the bird.

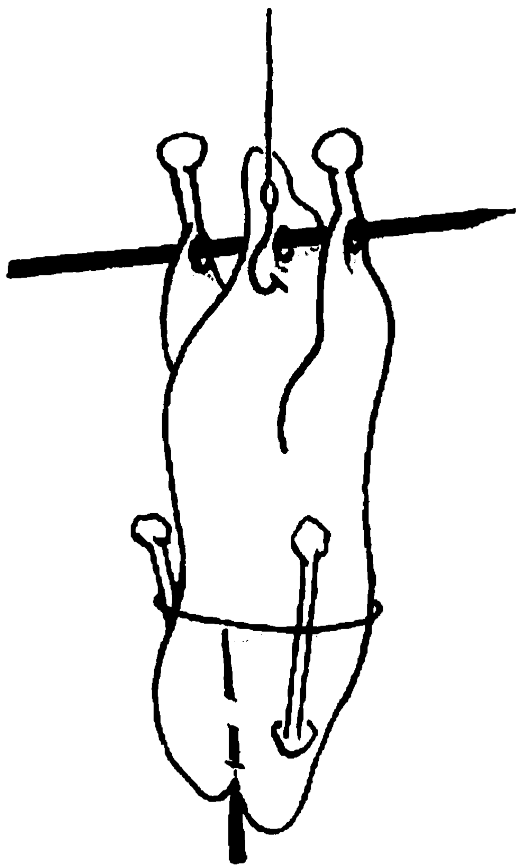


Figure 6a

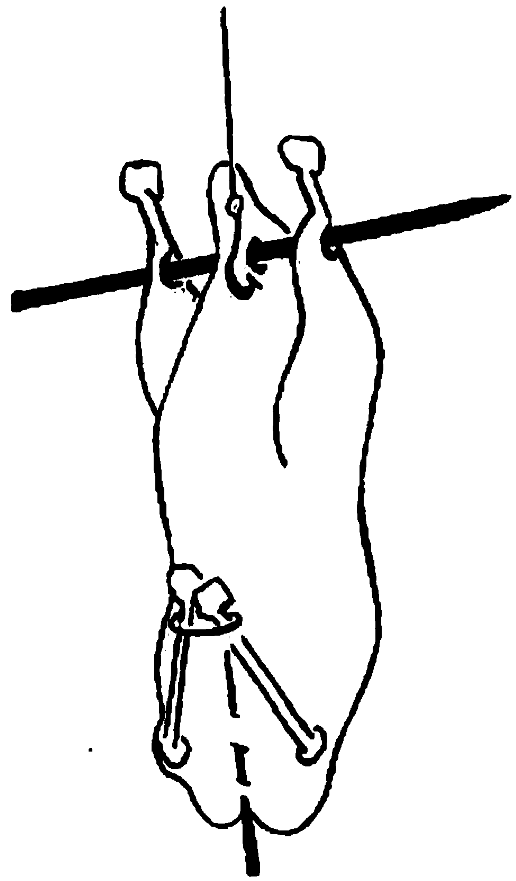


Figure 6b

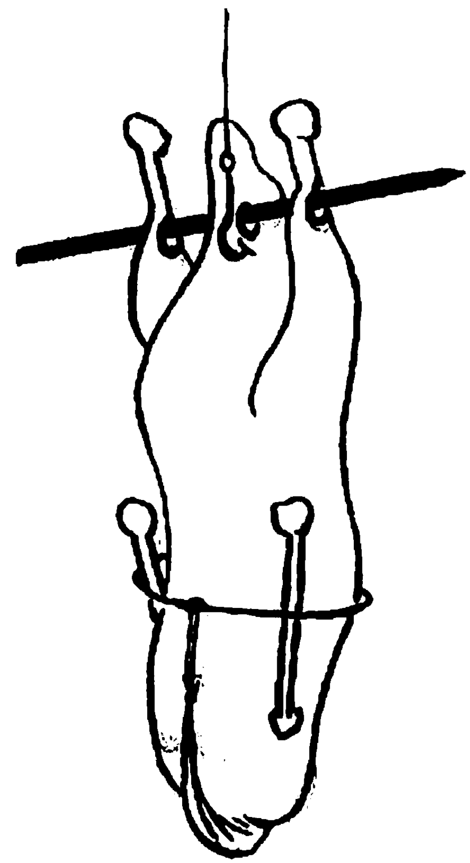


Figure 6c

Figure 6: Alternative Methods of Fire Roasting Goose

5.1.3.3 Boiled

Boiled goose (*pikaahaau*) is also popular among the Cree despite a distinct preference for roast goose. When goose is boiled it is cut up into consumable portions, placed in water and boiled. The broth of Canada goose is referred to as *niskaapui*. Salt, pepper, and perhaps onions are used as seasonings and dumplings or potatoes are later added to the soup. It was mentioned that people sometimes boil goose because it cooks faster.

One woman described the process of marinating the goose in salt prior to cooking it. The goose is cut up, placed in salt-water overnight and boiled the following day. Goose was said to be more tender when prepared in this manner.

5.1.3.4 Preparation of Heads, Feet and Wings

Wings and heads were plucked by immersing them in boiling water for several minutes and then removing the wet feathers manually. De-feathered heads and wings are termed *piskutiwaasaawaanh*. Wings were dipped in boiling water affixed to a bannock stick and heads by holding the trachea. Wings were also observed to have their feathers burnt off in the fire. The heads are further processed by splitting open the beak and removing the oesophagus. A slit is made from the head to the bottom of neck to detach the trachea. The trachea (*ukuhtaakin*) of many geese were tied together and hung from a tree. The beak was then broken off and this action is referred to as *minikutaahwaau*.

Wings (utihkun), feet (*usit*) and heads (ushtikwaan) were rinsed in water prior to further preparation. These parts are often boiled together as soup. Other goose parts, such as gizzards and stripped carcasses, may be cooked along with these parts. Rice, oats, macaroni or other pasta may be added to the soup. Wings were also roasted on the open fire by being placed on a bannock stick.

5.1.3.5 Preparation of Organ Meat

Goose hearts (*utaahii*) were the first organ meats to be consumed following processing of geese, perhaps due to ease of preparation. Hearts from several geese were inserted on a bannock stick, alone or with other organ meats, and roasted on the open fire. When a goose is oven roasted the heart is likely to be roasted along with the bird. Goose hearts may also be boiled. They are consumed in both seasons and seem to be enjoyed by all.

The gizzard (*utisii*) warrants more preparation prior to cooking as compared to the heart. It was cut down the middle and opened to empty out food and sand. The inner lining (*piihtuutisaan*) was scraped off with a knife and the gizzard was thoroughly rinsed in water. Partial slices were made to thin the flesh; it was said to render it more tender. Gizzards were fire roasted on a bannock stick, seasoned with salt and pepper. The gizzard may also be boiled, perhaps with intestines or feet. If a goose is oven roasted, the gizzard may be roasted along with the bird. Gizzards are consumed both in spring and fall.

Goose liver (*uskun*), along with other organ meats, from several geese may be attached to a bannock stick and fire roasted. Livers may also be pan-fried. Stuffing for oven roast goose was said to be made using fried liver, onions and store-bought bread. Boiled goose livers are used to make a cold snack dish mixed with wild berries, such as cranberries or blueberries. Goose liver is consumed more often in spring since it was said by some Cree to have an inferior taste in fall. Livers may, consequently, be thrown out or fed to the dogs. Some Cree expressed their dislike for the taste of liver and for this reason even spring goose livers are sometimes discarded.

To prepare intestines (*ootishi*) for consumption the pancreas was peeled away and discarded; it was said to have a bad taste. Intestines (or guts), are cleaned by slicing along its length, squeezing out its contents and thoroughly rinsing in water. Older women spoke of consuming both fried and boiled intestine, although younger people had only tasted fried intestines. Both adults and children were observed snacking on intestines fried in goose fat. They were very well-done and had a crunchy texture. Although some Cree consume intestines during both goose harvesting seasons, others mentioned a dislike of fall intestines because of their inferior taste and tougher texture. Intestines from spring geese were said to be better tasting, more tender, more nutritious and cleaner (due to the goose's diet of berries in fall, intestines may have a dirty appearance).

Lung tissue was pulled out prior to fire roasting and spread over the goose. Older women consumed the remaining portions of lung tissue attached to the bird's ribs. Younger women expressed a dislike for lung (*uhpinh*), while elders had a strong preference for it. When geese are placed in frozen storage the lungs may or may not be removed and discarded, depending on personal preference. When geese are oven roasted, the lungs may be cooked inside.

5.1.3.6 Preparation of Rendered Goose Fat

Rendered goose fat (*nishchipimii*) was produced from fat collected from the abdomen (*upiimiyuuch*) of many geese. In the goose camp, the raw fat was soaked for an extended period of time in cold water (melted snow) to remove blood and other impurities. Pieces of solid fat were taken one by one to detach attached tissue and to squeeze out excess water. The fat was then placed in a large caste iron pot with a small amount of water. The pot was hung over the hearth to simmer and it was stirred periodically with a bannock stick. After several hours, the liquid fat was taken off the fire and put aside. A piece of skinless dried goose leg was added to the hot oil for approximately one hour; this was said to add flavour to the finished product. Later, the leg and charred tissue was removed from the fat with a perforated spoon. The pot was covered and left to cool until the following day. The goose fat, still in a liquid state, was strained into a large container with a cloth to screen out remaining impurities. It was then placed in storage pots and left to harden. A traditional throat sac was manufactured for the storage of goose fat by an elder. A goose oesophagus was inflated, tied at each end with string and hung to dry. Rendered goose fat was later poured into it and the elder contended that this improved the taste of the rendered fat. Goose fat is stored in a cool place and may be frozen if a large quantity has been produced.

Rendered goose fat is used to enhance the taste and texture of low fat traditional meat, such as rabbit, ptarmigan, or dried meats including goose. As it is solid fat, it can be used as a spread for bannock. Bannock and dumplings may be prepared using goose fat, although the majority of Cree currently use market fats, such as lard or shortening. Goose fat was said to give bannock a slightly different taste. It is also used as an ingredient in *pimihkaan*, a dish prepared from a mixture of dried/smoked fish and rendered fat (either goose or bear). This dish is frequently served at feasts and may be used as a spread for bannock. It is consumed as a cold snack or stored in the freezer to be eaten frozen. Another snack dish mentioned was one made from a mixture of goose fat, goose liver, and wild berries.

Aside from its use in the Cree diet, goose fat has several non-food functions. One of these is the tanning of moose hide. Rendered goose fat is also used for medicinal purposes. When children have a cold or a cough, the grease is heated and rubbed on the chest. It may also be administered orally for a cough. One Cree woman explained that she preserved goose fat solely for its medicinal role.

In the past, all goose fat was conserved and utilised. Presently, preparation of rendered goose fat is not practised to as great an extent. One woman mentioned that although she still retains all the goose fat, she may feed most of it to her dogs, mixed with boiled oats. In the goose camp, it was observed that younger women often gave the raw fat to an elder. Some of the young women indicated that they did not prepare goose fat because they felt it was a great deal of trouble and were concerned that it would make them fat. Some Cree mentioned that they do not appreciate the taste of goose fat, although elders are said to have a strong preference for it. Rendered goose fat is presently produced more often in spring although in the past it was routinely manufactured in both seasons. Today, the most popular market fat used is lard, followed by shortening and other fats/oils; these have replaced traditional fat for various preparation and consumption practices.

5.1.4 Portioning and Consumption

The seasonal importance of consuming Canada goose was often expressed by community members. It is clearly one of the favourite traditional food items consumed. Cree cultural norms govern the consumption of Canada goose. Nonetheless, as with other aspects of Cree society, some degree of change has occurred in light of the influx of Euro-Canadian influences.

Cooked goose is invariably cut into eight or ten pieces for consumption. This includes two legs, two breast portions (which includes the wing bone), the collar, the breastbone, the top back portion which includes the neck and the bottom back portion. Two other boneless pieces are often produced from in between the leg and breast portions on each side (Figure 7). First, each side is cut off of the goose. This side portion (*nibidaiwashikin*) is either cut in half to create the leg (*huupuunuum*) and breast (*utimin*) portions or in three to make a leg, a boneless middle piece and breast portion. The remaining carcass is cut down each side to separate the front from the back of the goose. The collar is then removed, leaving the breastbone (*uspisakin*), also referred to as Noah's Ark. The back is separated creating two more parts, a back part containing the neck and the lower back portion (*ushukan*).

Different parts of the goose are portioned according to age and gender groups. Social customs associated with consumption patterns may have been more strictly adhered to in the past. Most Cree agreed that although there are pieces considered more appropriate for certain gender/age groups, these are not restrictive and all are free to eat any part of the goose. Nonetheless, goose legs are generally reserved for the men, who are served first. This is because men always receive the pieces they prefer, which often includes the leg. One informant noted that children may consume any portion except for the man's part. The breast is likely to be served to boys (sons) and the collar to both male and female children. Young children often receive the boneless portion from between the leg and breast portions which may be cut up into small pieces. The breastbone, back portions and lungs

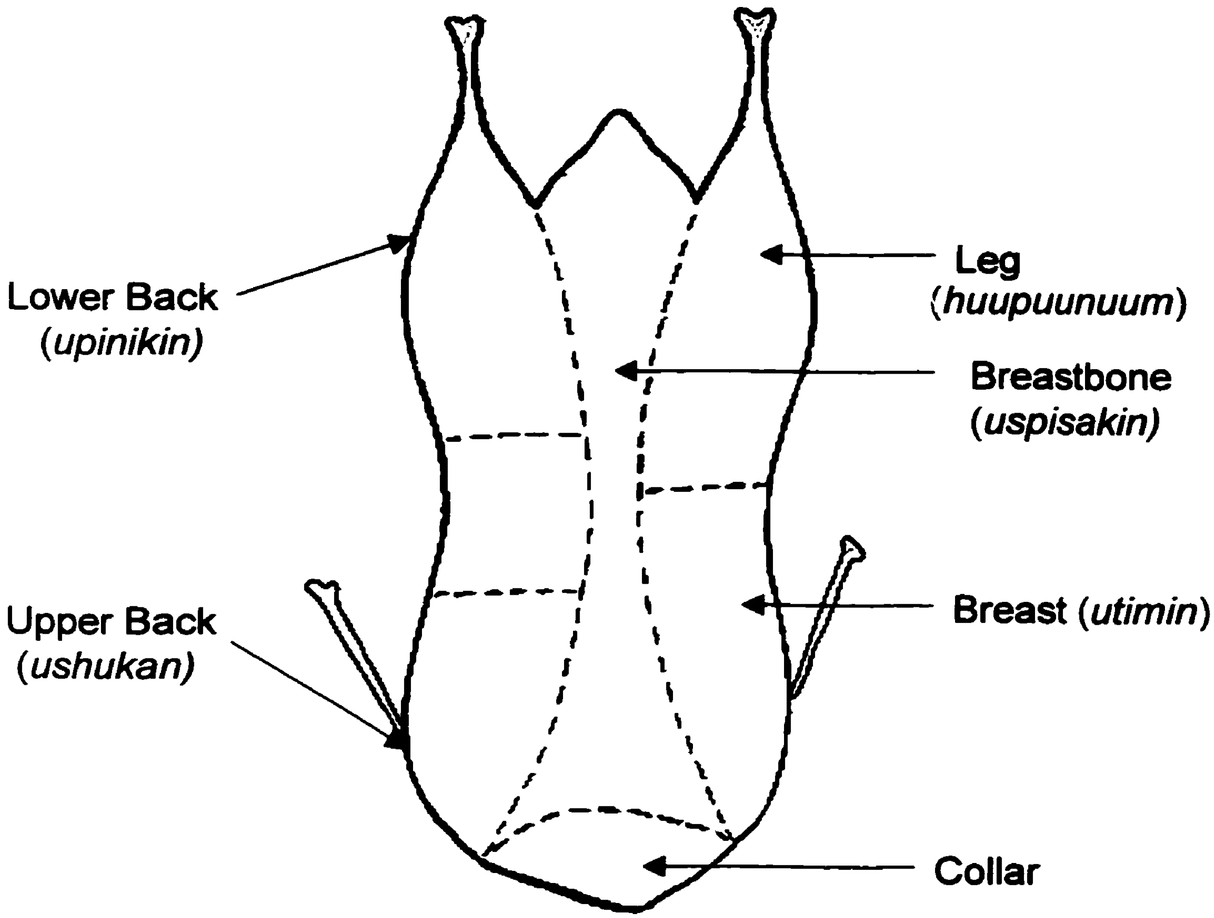


Figure 7: Consumption Portions

are considered women's food; the bottom back often goes to women and the top back to girls. Women who are cooking and serving the goose are apt to consume these portions. It was said that grandmothers (elder women) will pick at the boney parts. Hearts and intestines are regarded as most appropriate for elders. Wing bones (*utahtahkunikin*) may be given to youngsters to suck on.

Roast goose was often observed served with drippings and a fresh piece of bannock. It has a somewhat tough texture and thus is served with a knife to cut slices for consumption. Skin is never removed from the goose and is viewed as a basic and valuable consumable part of the goose. Some Cree spoke of the practice of cutting off the ends of bones and sucking out the contents. Women cook enough geese for the family and extra so that the men have portions to take hunting the following day. Pellets from gunshot are regularly found embedded within the flesh of the goose. Whole pellets are spit out but some will invariably be consumed; smaller pieces of fragmented shot are more likely to be ingested.

The taste of Canada goose is said to improve as its fat content increases. This concept is related to the general agreement that spring Canada geese, recognized as having a higher fat content, have a superior taste to fall Canada geese. Another reason mentioned was the seasonal diets of the geese. Geese which are harvested later in the fall season were noted to be fatter as compared to those harvested in early fall. One woman mentioned that the geese which congregate on the islands (perhaps resident or giant Canada geese) taste different from coastline geese. Giant Canada geese were noted to taste inferior to *Branta canadensis interior* and to have a saltier taste. The smaller *Branta canadensis hutchison*, on the other hand is said to taste analogous to *Branta canadensis interior*. Canada goose was mentioned as being the best tasting goose harvested in the James Bay region.

5.1.5 Preservation Methods

The principal method of preserving Canada goose is freezing. The geese may be frozen with or without feathers. Geese were noted to taste fresher when feathers are kept on the frozen birds, but this was said to be disadvantageous since the feathers are rendered useless. Geese to be frozen were wrapped in brown freezer paper, aluminium foil and/or freezer bags. In the goose camp, the geese were packed in boxes and placed in storage space in the ground. When it was feasible, they were brought back to the community and placed in household freezers. Boxes of wings, feet and heads were also kept in cold storage and destined for frozen storage. Formerly, geese were frozen in snow during spring, although this was not an option in fall. An island where people would bring geese to freeze was described. There was a large creviced rock where snow accumulated and remained long after snow melt. Snow was placed inside the body cavity of the goose to facilitate freezing.

The traditional method of drying goose is still practised by many community members, although less so than in past times. The decreased magnitude of drying (and salting) of geese is directly related to the availability of household freezers in the community. Elders recalled the past when all parts of the geese were dried and kept for winter months when food was less abundant. The process of drying took place inside the tepee and resulted in a product with a smoked flavour and aroma. Dried goose is always boiled or fire roasted prior to consumption.

Piyaasuumaashtaakw is the Cree name for dried, smoked goose skin. To produce this food item the entire skin of the goose's body was peeled away, along with thin pieces of attached flesh. Slices were first made around the tail region, from the belly to the end of the legs and along the breastbone. A cut was then made around the end of the leg bones to release the skin from the goose's body. Incisions were made in the flesh and the product was folded over horizontal poles (*pikutikwaawaanaahtikw*) of the tepee to dry. Down was adhered to the tips of the drying skin to prevent fat from dripping on the floor and on people's heads.

Piyaasuumaashtaakw requires approximately three weeks to dry and may be stored for up to nine months without spoiling. For consumption it is portioned into approximately eight pieces and boiled for about one hour. It is commonly eaten as a snack food, but is also consumed as side dish to a meal.

Niskimaashtaakw refers to dried, smoked goose meat. Following preparation of *piyaasuumaashtaakw* other portions (including legs, breasts, and boneless meat) of the skinned goose are separated. These pieces were dried on tepee poles and then roasted on the open fire with a bannock stick. *Niskimaashtaakw* was often consumed as the midday meal in the camp and was taken by men on hunting trips. The remaining carcass was either smoked/roasted on poles above the fire or added to a pot destined to be soup.

Heads, feet, wings and gizzards were also observed being dried at the goose camp. De-feathered heads had the upper beak and skull removed prior to being hung for drying. Feet were strung together and then hung to dry (Figure 8). Dried wings had the largest bone extracted and two metal skewers were positioned through the flesh. Gizzards were sliced thinly to create an elongated portion of meat and alternated between being hung on tepee poles and over the hearth.

Although frozen storage (in freezers) has been the most important preservation method adopted from outside influences, several other techniques have been utilized. The salting of geese is seemingly less popular than it had been in the historic past. There was a distinct difference of opinion among the Cree as to whether the taste of salted goose is agreeable or not. Among those that favored salted goose, it was explained that the practise rendered the meat more tender. Whole eviscerated geese were placed in large wooden barrels and each layer was topped with copious amounts of salt. In the past, some Cree had acquired the skill of canning goose meat, although this knowledge has apparently been lost.

Figure 8: Goose Feet Strung and Hung to Dry

5.1.6 Social Importance of Canada Goose

The harvesting of waterfowl was observed to be a cooperative and communal activity, as has been previously documented by Scott (1986). The spring hunt, in particular, provided opportunity to congregate in an environment (the goose camp) which encouraged social support and communal living, within and beyond the extended family.

Sharing (*ashihchaau*) is basic to Cree philosophy and there is a general spirit that any community member who desires geese will have access to them. Pride was expressed as people described their willingness and obligation to share harvested food with others. There is, however, current agreement that some community members are not as generous as people were in the past. It was said that some Cree nowadays expect immediate compensation, namely cash or goods such as ammunition, for geese.

Whole raw geese were said to be most often shared within the extended family and distribution occurs according to need. Households which lack hunters rely on family bonds to secure geese. People spoke most often of sharing geese with elders in their family (or in the community) who were no longer able to hunt. Other family members who do not hunt were also recipients of gifts (or exchanges) of geese. Exchange of geese outside the immediate family was also observed. While in the goose camp, news indicated that a nearby camp had been unsuccessful in the hunt. Geese were brought over to their camp and a reciprocation of market food was received. Geese were also said to be exchanged for services, such as plucking of excess geese or loan of equipment.

Food sharing of Canada goose is also realized through feasts (*makusainu*), which were said to vary in elaboration according to occasion and location (bush camp versus village). The first kill is always shared communally in the goose camp; harvested geese are divided up for people to prepare and cook. Only after this harvest feast do individuals accumulate geese for their own family A boy's first goose was said to be very important and is cooked and shared between all members of a goose camp. Everyone obtains a piece of the goose even if very small portions must be distributed. There are numerous other feasts throughout the year when geese are cooked and shared between community members.

5.1.7 Cultural Significance of Canada Goose

Canada geese are a highly valued food resource and are also greatly esteemed as living creatures. They are considered highly intelligent and are admired for their exceptional memory. The Cree, both young and old, have a special passion for goose hunting season. Great pride was expressed in both harvesting and preparation of Canada goose.

Spiritual respect for geese (observed and related) is embedded in local customs. Young hunters were observed to be less concerned with some spiritual beliefs related to goose harvesting. Songs and stories, related by the elders give thanks for current and future harvests of geese. A hunter's success was said to depend, in part, on his ability to restrain from boasting about his catch. Hunting is never practised on Sundays, even when conditions are ideal. Although it is clearly an historical adaptation to the Christian Church, Cree hunters (both young and old) expressed the importance of adherence to this custom as a symbol of respect. Trachea of harvested geese were tied together and hung from a tree. They were said to be placed in the tree so they do not lay on the ground, in reverence. Tracheas were said to represent the voice of the goose: "it is where the honking comes from". As a hunter shows respect to the animal which he hunts, so can the animal show respect to the hunter. One harvested goose contained a developed egg and it was said to be honouring the hunter. The literature cites the sacred treatment of goose bones (Preston, 1975), although they were observed being thrown out and were said to be given to dogs.

The consumption of goose was said to be substantially important for numerous ceremonial feasts and women make a concerted effort to conserve geese for these special occasions. Feasts can be divided into three main categories: life cycle rituals, hunting ceremonies and those related to calender holidays. Ceremonies related to the life cycle which goose was said to be served included birthdays, weddings, wedding anniversaries, and walking-out ceremonies (*wiiwiitihaausuunaanuu*). The latter represents a Cree child's introduction in Cree society and occurs when an infant has matured into a toddler. It was said that prior to this rite the child is not permitted to walk outside, and instead will be carried. A male and female child were said to be dressed up as adults and the boy is supplied with a wooden gun which he uses to "shoot" a goose (which is already dead). The goose (often a smaller *Branta canadensis hutchison)* is then cooked and eaten by attending kinsmen. Hunting ceremonies related to Canada goose include the season's first catch and a boy's first kill. When a boy has killed his first goose, it is always a moment for celebration, although the decoration of goose heads was said to no longer be practised. Feasts held on calender holidays include Christmas, New Years day and Mother's day (which coincides with the spring goose hunt). During observed feasts large amounts of food were prepared in the tepee and each person (or family unit) received a very large portion to be taken back to their living quarters. Feasts in the village were said to be more elaborate than those which are held in camps.

5.1.8 Seasonal Difference in the Use of Canada Goose

The arrival of geese marks the change of seasons for Cree inhabitants. In spring, with snow and ice still lining the ground, the coming of geese signals an abundance of traditional food, cultural celebration, family gatherings, and the coming of warmer weather. In fall, the sound of honking and sight of geese flying denotes the end of summer.

Spring geese are harvested more intensively, both in terms of number of community members involved in the hunt and the length of time people spend in goose camps. Goose feathers from the fall are less likely to be kept, and fall geese are apparently more difficult to pluck. Parts less likely to be consumed in fall as compared to spring include the intestine and liver. Rendered goose fat is more likely to be prepared in spring. Finally, there is a general agreement among community members that spring Canada goose taste better when compared to fall Canada goose. Nonetheless, Canada goose is a highly appreciated and valuable food resource at any time.

5.1.9 Traditional Knowledge Related to Canada Goose

Cultural adaptations have enabled the Cree to acquire precise and intimate knowledge of ecological features and environmental changes over time. This traditional knowledge is embedded in spiritual beliefs and social customs, and has been passed on from generation to generation through observation, active participation and oral interpretation. As younger generations adopt outside cultural attributes and lifestyle and experienced elders pass away, this essential information is lost.

The success of goose harvesting season was said to vary from year to year depending on various climatic and environmental conditions. A dry summer was said to result in a poor fall goose hunt because berry production is inferior and renders the region less attractive to geese. During a very cold fall, the geese may hurriedly pass through the region in order to reach wintering grounds. Cold weather in spring may extend the geese's stay in the James Bay region. Moose which forage in goose feeding grounds were said to potentially compromise the spring goose hunt. In early spring, the Cree examine the stage of development of goose eggs inside female geese. If they are small it is predicted that the geese will remain in the area for a longer period of time. Sometimes geese release fully developed eggs in flight prior to their arrival at breeding grounds; it was stressed that this behaviour originates from the spirit of the goose rather than being a careless action. It was said that since they have developed too early, these eggs are unable to produce goslings.

The different subspecies of Canada goose are well recognized and characteristic differences described include both physical and behavioural attributes. The smaller subspecies of Canada goose (*Branta canadensis hutchison*) is referred to in Cree as *Ipshdisht*. They were said to enter the region later during the spring goose hunt, at approximately the same time as Giant Canada geese (*Branta canadensis maxima*). Giant Canada geese, referred to as long necks (*kakanakwiwach*), were said to arrive in large numbers later on in the season (end of May or June). Preference for the harvesting of migratory Canada geese over giant Canada geese was expressed. *Branta canadensis interior* was said to have a higher fat content as compared to *Branta canadensis maxima*; this has been documented by Mainguy and Thomas (1985). Giant Canada geese were said to fly lower than migratory geese and proceed toward the bay's islands. As compared to migratory geese, they were said to fly in longer lines and more often when it is calm. Giant Canada geese were said not to be harvested in Wemindji in fall, perhaps because they fly too high.

Sexing of geese by cloaca inspection was unfamiliar to the Cree. Hunters habitually determined gender by sight in relation to size of necks, beaks, heads and feet, males generally being larger than their female counterparts. Older hunters were more adept at determining sex in this manner as compared to younger men. One young man recalled his grandfather teaching him how to tell a female from a male goose. In general, traditional determination of gender corresponded well to scientific sexing of the geese by cloaca inspection. In spring, women sex geese by examining the abdomen for eggs. Once a goose was opened to remove innards, women easily distinguished between the sexes by inspection of internal reproductive organs.

It was said that in the past not many nest eggs were taken for consumption, except when there was nothing else to eat. An elder explained that younger hunters no longer abide by the goose bosses authority. They may harvest geese in a manner considered poor hunting practice, such as shooting geese out of range. Customarily molting geese (or *upiskuu*) were not killed (even when there were few geese to harvest) as it was viewed as disturbing the goose population; they are also considered not as good to eat. An elder criticized the action of people who presently kill geese during molt. If geese are frightened by fox or bear, Cree hunters were said to refrain from shooting them. Items which alarm geese, such as light, blood or feathers, were concealed from view of the geese. This is particularly important for Canada geese, as their eyesight is said to be superior to that of snow geese.

Some Cree expressed disapproval of using helicopters to transport people to and from bush camps due to disturbance to goose populations. Some wildlife practices by researchers were said to be detrimental to Canada goose populations. For example, Cree hunters expressed disapproval of neck banding geese. Geese were said to have been found frozen, stuck to the ground by their neck band. It was noted that accumulated ice on neck bands make it difficult for birds to fly. The negative effects of neck banding have recently been documented by Castelli and Trost (1996). Aerial surveys were said to cause disturbance among populations of nesting geese. The handling of goose eggs by white researchers was criticized since parents may later abandon the nest. Hydro-electric dams were felt to have caused changes in Canada goose migration routes and many Cree maintained that there would be more geese if the dams had not been built.

5.2 *Nutrient Composition of Branta canadensis (Canada goose)*

5.2.1 Samples

Collected laboratory samples are shown in Appendix F and analytical samples, resulting from preparation, portioning and cooking of laboratory samples can be seen in Appendix G. Flesh parts include flesh only, leg/skin, breast/skin and collar/skin. Leg/skin, breast/skin and collar/skin are parts which were prepared to represent Cree consumption patterns. In contrast, flesh only was taken from the breastbone region of the bird following removal of other parts and is completely devoid of skin. Over 3000 analytes were prepared from anaytical samples for determination of proximate composition, trace elements, heavy metals and fatty acids. Biological measurements (shown in Table 3) indicate that collected spring Canada geese are all associated with the subspecies *Branta canadensis interior*, as determined by cut-off values established by Moser and Rolley (1990) and Merendino et al. (1994).

5.2.2 Edible Portion

The mean edible weight of whole Canada goose, including organ meat and fat, based on a sample size of 5 is 67% ± 0.03. This estimate was calculated using edible portion of both raw and cooked samples. This value is similar to that established by White (1953) of 70% described as food weight portion and greater than the value of 50% for meat and edible viscera of goose determined by Watt and Merrill (1963) (in JBNQHRC, 1982).

Percent edible portion of analytical samples is shown in Table 4. These parts were prepared to represent consumption patterns of the Cree and are disparate from typical portions observed in North America. In general, portions of *Branta canadensis* showed higher percent edible portion as compared to *Anser anser;* this may be due to a slightly higher moisture content and greater amounts of waste material associated with *Anser anser*. For domesticated goose, the percent edible portion of leg/skin was higher as compared to breast/skin. In contrast,

Table 3: Biological Measurements of Spring Canada Geese

Goose #	Sex	Weight (kg)	Head Length (mm)	Culmen Length (mm)	Tarsus Length (mm)
1	Female	3.95	110.64	48.04	80.80
2	Male	4.05	118.50	54.46	N/A
3	Male	4.50	119.70	53.48	83.90
4	Female	3.75	109.22	49.82	78.42
5	Female	3.75	111.14	49.3	76.60
6	Male	3.55	110.62	50.42	79.62
Average	Female	3.82 ± 0.12			
Average	Male	4.03 ± 0.48			

Table 4: Percent Edible Portion

Species	Part	Preparation	n	Weight (g)	% Edible Portion
Anser anser	Whole	Raw (plucked/cleaned)	2	4880 ± 1330	N/A
	Leg/skin	Raw	2	465 ± 111	79.4 ± 2.8
	Leg/skin	Oven Roast	2	248 ± 36	72.2 ± 0.2
	Breast/skin	Raw	2	270 ± 120	73.9 ± 2.0
	Breast/skin	Oven Roast	2	175 ± 36	68.2 ± 0.6
Branta canadensis	Whole	Raw	6	393 ± 0.33	67 ± 0.03 (n=5)
	Leg/skin	Raw	7	265 ± 42	84.7 ± 2.5
	Leg/skin	Oven Roast	7	204 ± 31	85.4 ± 1.6
	Leg/skin	Fire Roast	1	174	85.7
	Leg/skin	Boiled	2	161 ± 3	80.5 ± 5.0
	Breast/skin	Raw	8	270 ± 29	91.2 ± 2.2
	Breast/skin	Oven Roast	7	185 ± 25	87.3 ± 1.7
	Breast/skin	Fire Roast	1	217	91.4
	Breast/skin	Boiled	2	163 ± 2	82.9 ± 1.5
	Collar/skin	Oven Roast	6	170 ± 47	81.4 ± 5.3
	Lungs	Oven Roast	6	54 ± 11	100
	Heart	Raw	6	45 ± 15	100
	Liver	Raw	6	41 ± 10	100
	Gizzard	Raw	6	128 ± 19	100

leg/skin of *Branta canadensis* had lower percent edible portion as compared to breast/skin. During sample preparation, *Anser anser* breast/skin was observed to contain less amounts of flesh as compared to breast/skin of *Branta canadensis*.

Canada goose samples lost an estimated <1 to 4% edible portion by weight following cooking while domesticated goose lost 6 to 7% of edible portion by weight. However, caution should be taken since different portions (raw and cooked) of the same goose were used to calculate these values. In addition, the domesticated geese were larger (4.88 ± 1.33 kg; already cleaned and plucked) than the Canada geese (3.86 ± 0.35 kg; uncleaned, unplucked).

5.2.3 Proximate Composition

Proximate composition of the edible portion of fresh Canada goose is shown in Table 5. Samples where n=8 (or 7) contain both fall and spring Canada geese; all other samples were derived from the spring collection period only.

5.2.3.1 Moisture

Moisture content of Canada goose ranged from 9.74 ± 9.03 g/100g (dried skin/flesh) to 84.14 g/100g (raw intestine). Moisture varied according to fat content and preparation mode. Raw samples had higher moisture content than cooked samples. Samples with skin had less moisture than samples containing flesh only. Skin only had a very low moisture content: raw (27.95 ± 6.14 g/100g) and oven roasted (25.48 g/100g). Raw heart, liver and gizzard had similar moisture content (71.42, 70.32 and 72.94 g/100g respectively) as compared to raw flesh (70.33 ± 1.08 g/100g); oven roasted heart, liver and gizzard maintained a higher moisture content (62.48 to 64.94 g/100g) as compared to oven roasted flesh (58.87 ± 2.17 g/100g moisture). Raw intestine contained the highest level of moisture at 84.14 g/100g, while fried intestine had comparatively low moisture content (28.58 g/100g), similar to skin. The CV for analytical samples was within 5 %.

Table 6: Proximate Composition of Edible Portions of Fresh Canada Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal/100g	Energy Kjoules/100g	Moisture	Crude Fat	Protein[c]	Ash	Carbohydrate
Flesh only	Raw	8	135	565	70.33 ± 1.08	3.98 ± 0.83	23.27 ± 0.76	1.15 ± 0.04	0
Leg/Skin	Raw	8	356	1490	50.28 ± 4.27	31.78 ± 4.66	16.32 ± 1.13	0.78 ± 0.06	0
Breast/Skin	Raw	8	270	1130	57.47 ± 2.74	20.93 ± 4.65	19.11 ± 1.65	0.92 ± 0.09	0
Flesh only	Oven roasted	8	200	837	58.87 ± 2.17	7.59 ± 1.66	30.84 ± 0.81	1.12 ± 0.06	0
Leg/Skin	Oven roasted	8	345	1440	46.84 ± 3.01	26.35 ± 4.38	25.04 ± 1.65	0.84 ± 0.04	0
Breast/Skin	Oven roasted	8	292	1220	50.61 ± 2.30	18.65 ± 3.08	28.51 ± 1.25	0.89 ± 0.07	0
Collar/Skin	Oven roasted	6	259	1082	53.60 ± 2.62	14.57 ± 2.10	29.82 ± 0.82	1.01 ± 0.08	0
Skin Only	Oven Roast	6	526	2197	27.95 ± 6.14	48.16 ± 5.78	21.37 ± 2.93	0.75 ± 0.13	0
Skin Only	Raw	Composite[a]	618	2584	25.48	63.76	10.06	0.24	0
Leg/Skin	Fire Roast	1	277	1158	51.60	17.09	28.79	1.11	0
Breast/Skin	Fire Roast	1	223	933	56.09	10.09	30.97	1.20	0
Collar/Skin	Fire Roast	1	197	823	59.90	8.01	29.17	1.24	0
Flesh Only	Boiled	2	212	884	53.83 ± 0.84	6.19 ± 3.37	36.46 ± 1.63	0.77 ± 0.13	0
Leg/Skin	Boiled	2	273	1141	52.00 ± 4.36	15.56 ± 5.96	31.04 ± 1.29	0.63 ± 0.07	0
Breast/Skin	Boiled	2	251	1049	51.41 ± 2.59	11.71 ± 4.92	34.01 ± 1.69	0.70 ± 0.15	0
Skin/Flesh	Dried	2	596	2493	9.74 ± 9.03	48.91 ± 19.98	36.37 ± 12.12	1.73 ± 0.76	0
Skin/Flesh	Dried/Boiled	2	414	1732	32.96 ± 9.21	29.76 ± 12.74	34.17 ± 3.88	0.87 ± 0.13	0
Lung	Oven roasted	8	157	655	69.62 ± 2.56	6.74 ± 1.64	21.63 ± 1.81	1.11 ± 0.13	0.90
Liver	Raw	Composite[a]	144	601	70.32	4.89	20.37	1.12	3.30
Gizzard	Raw	Composite[a]	131	548	72.94	4.29	20.57	1.04	1.16
Heart	Raw	Composite[a]	145	604	71.42	5.81	19.58	0.99	2.20
Intestine	Raw	Composite[b]	80	334	84.14	2.90	11.87	0.30	0.79
Liver	Oven Roast	Composite[a]	175	730	64.24	6.11	24.39	1.26	4.00
Gizzard	Oven Roast	Composite[a]	171	714	64.94	5.59	26.87	1.12	1.48
Heart	Oven Roast	Composite[a]	194	813	62.48	8.54	25.36	1.26	2.36
Gizzard	Boiled	Composite[a]	170	712	63.34	3.55	31.40	0.59	1.12
Gizzard	Boiled	1	166	696	62.9	2.24	33.80	0.57	0.49
Heart	Boiled	1	221	924	56.08	8.13	31.30	0.84	3.65
Intestine	Boiled	Composite[b]	182	762	60.91	3.95	32.76	0.65	1.73
Intestine	Fried	Composite[b]	407	1699	28.58	22.59	44.28	1.01	3.54

a Composite of 5 samples

b Composite of 5 samples

c Protein calculated by multiplying nitrogen content by a factor of 6.25

5.2.3.2 Crude Fat

Crude fat varied greatly between samples and ranged from 2.24 g/100g (boiled gizzard) to 48.91 ± 19.98 g/100g (dried skin/flesh). Raw flesh only had a relatively low fat content (3.98 ± 0.83 g/100g), similar to raw liver, heart, and intestine (4.89, 4.29 and 2.90 g/100g fat respectively). Oven roasted and boiled flesh contained greater amounts of fat (7.59 ± 1.66 g/100g and 6.19 ± 3.37 g/100g) when compared to their raw state, similar to oven roast lung, liver and gizzard (6.74 ± 1.64, 6.11 and 5.59 g/100g fat respectively). Heart showed slightly higher amounts of fat (raw:5.81 g/100g; oven roasted: 8.54 g/100g; boiled: 8.13 g/100g) as compared to other organs and boiled gizzard and intestine showed slightly lower amounts of fat (2.24 to 3.95 g/100g).

Flesh samples with skin (leg/skin, breast/skin, collar/skin) had higher levels of fat as compared to flesh only. Oven roasted leg/skin contained more fat (26.35 ± 4.38 g/100g) as compared to breast/skin (18.85 ± 3.08 g/100g), and collar/skin contained less fat (14.57 ± 2.10 g/100g) than either leg/skin or breast/skin. Boiled leg/skin and breast/skin had somewhat lower amounts of fat at 15.56 ± 5.96 g/100g and 11.71 ± 4.92 g/100g respectively, as did fire roasted leg/skin and breast/skin (17.09 and 10.09 g/100g fat). These latter portions may be more relevant for the Cree since these cooking methods (fire roasting and boiling) may be used more frequently than oven roasting. High fat samples included dried skin/flesh (48.91 ± 19.98 g/100g) and fried intestine (22.59 g/100g); however, since dried skin is always consumed boiled by the Cree, its fat content is more realistically considered at 29.76 ± 12.74 g/100g. The CV for project samples was within 5%.

5.2.3.3 Protein

Protein content of Canada goose samples ranged from 10.06 g/100g (raw skin) to 44.28 g/100g (fried intestine). Protein content was consistently greater in oven roasted parts as compared to raw parts. Oven roasted leg/skin (25.04 ± 1.65 g/100g) and breast/skin (28.51 ± 1.25 g/100g) contained lower amounts of protein as compared to oven roasted flesh only (30.84 ± 0.81 g/100g). The protein content of oven roasted collar/skin (29.82 ± 0.82 g/100g) resembled that of oven roasted flesh only. Boiled and fire roasted parts contained higher amounts of protein and corresponding lower amounts of fat as compared to analogous oven roasted parts. High fat samples which also contained high amounts of protein included dried skin/flesh (36.37 ± 12.12 g/100g), boiled dried skin/flesh (34.17 ± 3.88 g/100g) and fried intestine (44.28 g/100g); these samples had corresponding low levels of moisture. Raw organ meat (liver, gizzard and heart) contained approximately 20 g/100g protein, which was correspondingly higher in analogous oven roasted (24.39 to 26.87 g/100g protein) and boiled samples (31.30 to 33.80 g/100g protein; gizzard and heart only). Oven roasted lung contained 21.37 ± 2.93 g/100g protein. The CV for analytical samples was within 1.5%.

5.2.3.4 Total Ash

Values for total ash ranged from 0.24 g/100g (raw skin) to 1.73 g/100g (dried skin/flesh). Parts with skin (leg/skin, breast/skin, collar/skin) had lower amounts of ash as compared to flesh only. Boiled parts generally had lower amounts of ash as compared to oven or fire roasted portions. The CV for analytical samples was within 9%.

5.2.3.5 Carbohydrate

Carbohydrate content of flesh samples was assumed to be zero. Carbohydrate content of organs ranged from 0.49 g/100g (boiled gizzard) to 4.00 g/100g (oven roasted liver). Carbohydrate levels in organ meats increased following cooking, but remained relatively low. Liver showed the highest level of carbohydrate (raw: 3.30 g/100g; oven roasted: 4.00 g/100g). Carbohydrate content in heart was somewhat lower, at 2.20 g/100g for raw heart, 2.36 g/100g for oven roasted heart and 3.65 g/100g for boiled heart.

5.2.3.6 Energy

Energy content ranged from 321 kilojoules (kj)/100g (raw intestines) to 2493 kj/100g (dried skin/flesh). As expected, energy levels of samples corresponded to fat content and thus parts containing skin/fat had higher energy levels as compared to those without (flesh only and organs). Oven roasted flesh portions (flesh only, leg/skin, breast/skin, collar/skin) ranged from 200 to approximately 350 kj/100g. Organ meats, including oven roasted lung, heart, liver and gizzard ranged from 153 to 194 kj/100g.

5.2.3.7 Effects of Season and Sex

There were no differences in proximate composition between fall and spring Canada goose, as can be seen in Tables 6 and 7. Proximate nutrients of male and female Canada geese are shown in Table 8 and 9; there were no statistical differences between the 2 groups. Female Canada goose samples tended to have higher levels of fat and lower levels of moisture.

5.2.3.8 Comparison to Domesticated Goose (*Anser anser*)

Table 10 shows the proximate composition of analysed domesticated goose. No statistical differences in proximate composition were found between the two species (*Branta canadensis* and *Anser anser*). Fire roasted and boiled Canada goose parts had lower amounts of fat as compared to analogous oven roasted domesticated goose parts.

5.2.3.9 Comparison to Literature Values

Data from United States Department of Agriculture (USDA) Handbook No. 8 (1979) for raw domesticated goose flesh plus skin had lower levels of moisture (49.66 g/100g), higher levels of fat (33.62 g/100g), and lower or similar levels of protein (15.96 g/100g) as compared to analysed samples of Canada and domesticated goose raw flesh parts with skin. Methods of portioning, however, were

Table 6: Proximate Composition of Edible Portions of Fresh Fall Canada Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal/100g	Energy Kjoules/100g	Moisture	Crude Fat	Protein[c]	Ash
Flesh only	Raw	2	127	531	71.40 ± 1.44	3.08 ± 0.16	23.22 ± 1.49	1.20 ± 0.03
Leg/Skin	Raw	2	354	1479	51.28 ± 1.86	32.03 ± 0.63	15.20 ± 1.30	0.72 ± 0.05
Breast/Skin	Raw	2	293	1223	56.66 ± 0.65	24.14 ± 0.24	17.51 ± 0.99	0.64 ± 0.02
Flesh only	Oven Roast	2	182	762	61.48 ± 2.17	6.09 ± 0.93	29.82 ± 0.74	1.15 ± 0.11
Leg/Skin	Oven Roast	2	361	1507	45.86 ± 4.50	28.78 ± 6.05	23.66 ± 1.09	0.87 ± 0.03
Breast/Skin	Oven Roast	2	287	1198	51.27 ± 2.44	18.20 ± 3.90	28.70 ± 1.86	0.99 ± 0.03
Collar/Skin	Oven Roast	1	225	942	57.85	10.71	30.17	0.99
Lung	Oven Roast	2	151	630	71.08 ± 1.46	7.20 ± 0.99	20.11 ± 1.61	0.97 ± 0.25

c Protein calculated by multiplying nitrogen content by a factor of 6.25

Table 7: Proximate Composition of Edible Portions of Fresh Spring Canada Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal/100g	Energy Kjoules/100g	Moisture	Crude Fat	Protein[c]	Ash
Flesh Only	Raw	6	138	577	69.97 ± 0.77	4.28 ± 0.73	23.29 ± 0.60	1.14 ± 0.03
Leg/Skin	Raw	6	357	1493	49.94 ± 4.93	31.70 ± 5.50	16.71 ± 0.87	0.82 ± 0.04
Breast/Skin	Raw	6	263	1099	57.74 ± 3.18	19.86 ± 4.98	19.64 ± 1.50	0.95 ± 0.09
Flesh Only	Oven Roast	6	206	861	58.00 ± 1.42	8.09 ± 1.57	31.17 ± 0.50	1.10 ± 0.04
Leg/Skin	Oven Roast	6	339	1418	47.17 ± 2.85	25.53 ± 4.04	25.51 ± 1.60	0.83 ± 0.04
Breast/Skin	Oven Roast	6	293	1227	50.40 ± 2.45	19.07 ± 3.16	28.45 ± 1.21	0.86 ± 0.03
Collar/Skin	Oven Roast	5	265	1109	52.75 ± 1.77	15.34 ± 1.04	29.75 ± 0.90	1.04 ± 0.11
Lung	Oven Roast	6	154	644	69.14 ± 3.07	6.59 ± 1.86	22.14 ± 1.69	1.15 ± 0.03

c Protein calculated by multiplying nitrogen content by a factor of 6.25

Table 8: Proximate Composition of Edible Portions of Fresh Male Spring Canada Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal/100g	Kjoules/100g	Moisture	Crude Fat	Protein[c]	Ash
Flesh Only	Raw	3	133	557	70.47 ± 0.53	3.74 ±0.52	23.32 ±0.68	1.15 ± 0.03
Leg/Skin	Raw	3	323	1349	53.52 ±3.78	27.59 ± 3.49	17.30 ± 0.42	0.85 ± 0.04
Breast/Skin	Raw	3	234	980	60.18 ± 1.90	16.13 ± 3.65	20.82 ±1.06	1.01 ± 0.09
Flesh Only	Oven Roast	3	197	822	59.17 ± 0.83	7.04 ±1.19	31.17 ± 0.59	1.11 ± 0.03
Leg/Skin	Oven Roast	3	317	1325	49.24 ± 1.89	22.61 ± 1.63	26.45 ±0.82	0.85 ± 0.04
Breast/Skin	Oven Roast	3	272	1137	52.56 ± 0.47	16.33 ±1.43	29.21 ±1.31	0.87 ± 0.04
Collar/Skin	Oven Roast	2	260	1086	57.13 ± 1.46	14.88 ± 0.93	29.44 ±0.92	1.02 ± 0.15
Lung	Oven Roast	3	138	575	71.50 ±1.49	5.32 ± 1.88	20.97 ± 1.53	1.14 ± 0.03
Skin Only	Oven Roast	3	519	2169	28.18 ±6.05	46.54 ± 5.65	23.19 ± 2.97	0.85 ± 0.08

c Protein calculated by multiplying nitrogen content by a factor of 6.25

Table 9: Proximate Composition of Edible Portions of Fresh Female Spring Canada Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal/100g	Kjoules/100g	Moisture	Crude Fat	Protein[c]	Ash
Flesh Only	Raw	3	143	597	69.47 ± 0.69	4.83 ± 0.39	23.26 ±0.65	1.12 ± 0.02
Leg/Skin	Raw	3	392	1638	46.37 ± 2.87	35.81 ±3.55	16.11 ±0.81	0.79 ± 0.01
Breast/Skin	Raw	3	292	1219	55.30 ± 1.94	23.60 ± 2.62	18.46 ± 0.55	0.89 ± 0.04
Flesh Only	Oven Roast	3	215	901	56.83 ±0.50	9.13 ± 1.21	31.18 ± 0.54	1.10 ± 0.05
Leg/Skin	Oven Roast	3	362	1511	45.10 ± 1.98	28.45 ± 3.54	24.57 ± 1.76	0.81 ± 0.04
Breast/Skin	Oven Roast	3	315	1317	48.23 ±0.85	21.82 ± 0.50	27.70 ± 0.51	0.85 ± 0.02
Collar/Skin	Oven Roast	3	273	1139	51.21 ± 0.59	16.03 ± 1.02	29.96 ± 1.01	1.00 ± 0.07
Lung	Oven Roast	3	170	712	66.78 ± 0.44	7.86 ± 0.60	23.30 ±0.84	1.17 ± 0.03
Skin Only	Oven Roast	3	532	2226	27.73 ± 7.57	49.78 ± 6.61	19.55 ± 1.66	0.65 ± 0.04

c Protein calculated by multiplying nitrogen content by a factor of 6.25

Table 10: Proximate Composition of Edible Portions of Fresh Domesticated Goose (mean ± SD g/100g)

Part	Preparation	n	Energy Kcal	Energy Kjoules	Moisture	Crude Fat	Protein[c]	Ash
Flesh only	Raw	2	128	535	71.78 ± 0.83	3.72 ± 1.59	22.10 ± 1.09	1.12 ± 0.03
Leg/Skin	Raw	2	305	1273	55.83 ± 3.13	26.81 ± 3.10	14.71 ± 0.63	0.71 ± 0.02
Breast/Skin	Raw	2	262	1097	60.05 ± 5.61	20.35 ● 7.22	18.45 ± 1.01	0.70 ± 0.07
Flesh only	Oven Roast	2	207	865	59.51 ± 0.30	8.56 ± 0.63	30.38 ± 1.00	0.99 ± 0.02
Leg/Skin	Oven Roast	2	286	1194	52.67 ± 2.48	18.70 ± 3.86	27.41 ± 1.91	0.90 ± 0.06
Breast/Skin	Oven Roast	2	256	1072	57.37 ± 4.62	16.45 ± 5.79	25.32 ± 0.94	0.85 ± 0.03

c Protein calculated by multiplying nitrogen content by a factor of 6.25

likely to differ from those used by the contemporary Cree. Nutrient values for wild goose published in Native Foods and Nutrition by Health Canada (1994) are based on these USDA nutrient values.

USDA data for roast domesticated goose flesh plus skin show similar levels of protein (25.16 g/100g) and moisture (51.95 g/100g), and higher levels of fat (21.92 g/100g) when compared to analyzed parts of Canada and domesticated geese, with the exception of oven roasted Canada goose leg/skin. As compared to boiled or fire roasted Canada goose, the USDA data had higher amounts of fat and lower quantities of protein.

Raw and roasted domesticated goose flesh alone had higher levels of fat (7.13 and 12.67 g/100g respectively) from the USDA data as compared to analogous Canada and domesticated geese presented here. Levels of moisture were correspondingly lower in the USDA data. Protein content was similar to analyzed domesticated goose but lower than Canada goose analogous parts. Boiled Canada goose flesh only contained lower levels of fat and moisture and higher levels of protein as compared to the USDA roast domesticated goose flesh.

USDA data for raw domesticated goose liver had similar moisture (71.78 g/100g) and fat content (4.28g/100g), lower protein (16.37 g/100g) and higher carbohydrate content (6.32 g/100g) as compared to raw Canada goose liver. Nutrient values for raw goose gizzard published in Pennington and Church (1985) were lower for moisture (69.13 g/100g), similar for protein (20.81 g/100g) and higher for fat (7.05 g/100g) as compared to raw Canada goose gizzard.

Souci, Fachmann, and Kraut's (1994) data for *Anser anser* had lower protein levels (15.70 g/100g) and higher fat levels (31.00 g/100g) as compared to analyzed Canada and domesticated goose. Paul and Southgate's (1978) data for roast goose had similar protein levels (29.3 g/100g) and higher fat levels (22.4 g/100g) as compared to analyzed oven roasted Canada and domesticated goose parts with skin, except for oven roast Canada goose leg/skin. Values for dried Canada goose skin/flesh are similar to those reported in Kuhnlein et al. (1994).

5.2.4 Trace Elements

Trace elements of the edible portion of Canada goose samples are shown in Table 11. In general, the concentration of minerals was greater in cooked samples, due to moisture loss following cooking.

5.2.4.1 Iron

Iron content of Canada goose samples ranged from 2.96 mg/100g (raw skin) to 49.18 mg/100g (roast liver). Iron content of parts without skin was higher than those with skin (leg/skin, breast/skin and collar/skin). Skin alone contained the lowest concentration of iron, 2.96 mg/100g and 3.89 ± 0.83 mg/100g for raw and oven roasted skin, respectively. Oven roasted flesh parts with skin (leg/skin, breast/skin, collar/skin) ranged from 5.70 ± 1.39 mg/100g to 7.47 ± 1.09 mg/100g to iron. The range for fire roasted and boiled flesh parts with skin was somewhat higher (5.58 to 8.98 mg/100g iron) when compared to oven roasted samples. The iron content of raw flesh only (8.26 ± 1.45 mg/100g) was very similar to the value of 8.41 ± 1.62 mg/100g for post-molting Canada geese published in Rosser and George (1985). Oven roasted and boiled flesh had comparatively higher iron levels at 9.81 ± 1.57 mg/100g and 11.68 ± 0.27 mg/100g respectively. Iron levels of dried skin/flesh (8.88 ± 3.89 mg/100g) and boiled dried skin/flesh (9.51 ± 0.96 mg/100g) were relatively high despite notable levels of skin/fat, probably due to extremely low moisture content.

Oven roasted liver had the highest amount of iron (49.18 mg/100g), followed by oven roasted lung (46.30 ± 5.95 mg/100g) and raw liver (41.60 mg/100g). Raw, oven roasted and boiled heart also had relatively high iron levels (18.05, 21.56 and 15.06 mg/100g respectively). Iron content of raw and cooked gizzard (4.85 mg/100g and 6.52 to 6.94 mg/100g respectively) had values similar to flesh portions with skin. The iron content of intestine when boiled (14.15 mg/100g) or fried (21.97 mg/100g) was considerably higher as compared to its raw state (5.76 mg/100g); this may be due to loss of a relatively large amount of moisture following cooking. The CV for

Table 11: Trace Elements in Edible Portions of Fresh Canada Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh only	Raw	8	8.26 ± 1.45	2.16 ± 0.22	5.44 ± 1.51	0.51 ± 0.06
Leg/Skin	Raw	8	4.90 ± 1.65	2.58 ± 0.25	8.05 ± 3.44	0.17 ± 0.04
Breast/Skin	Raw	8	6.19 ± 1.77	1.87 ± 0.08	8.94 ± 8.06	0.31 ± 0.06
Flesh only	Oven Roast	8	9.81 ± 1.57	3.15 ± 0.31	6.91 ± 2.36	0.64 ± 0.07
Leg/Skin	Oven Roast	8	5.70 ± 1.39	4.12 ± 0.37	9.62 ± 3.02	0.22 ± 0.03
Breast/Skin	Oven Roast	8	6.78 ± 0.82	3.05 ± 0.31	7.44 ± 3.36	0.40 ± 0.06
Collar/Skin	Oven Roast	6	7.47 ± 1.09	3.47 ± 0.26	11.01 ± 4.24	0.41 ± 0.06
Skin Only	Oven Roast	6	3.89 ± 0.83	2.77 ± 0.49	19.79 ± 4.89	0.08 ± 0.02
Skin Only	Raw	Composite[a]	2.96	1.45	11.96	0.05
Leg/Skin	Fire Roast	1	5.58	4.10	8.59	0.26
Breast/Skin	Fire Roast	1	7.81	2.90	6.53	0.45
Collar/Skin	Fire Roast	1	8.20	3.96	27.59	0.34
Flesh Only	Boiled	2	11.68 ± 0.27	3.69 ± 0.74	4.91 ± 0.90	0.75 ± 0.04
Leg/Skin	Boiled	2	6.40 ± 0.44	4.81 ± 0.46	7.54 ± 0.53	0.27 ± 0.001
Breast/Skin	Boiled	2	8.98 ± 0.23	3.25 ± 0.73	5.83 ± 0.02	0.50 ± 0.01
Skin/Flesh	Dried	2	8.88 ± 3.89	3.27 ± 0.91	11.35 ± 2.57	0.52 ± 0.01
Skin/Flesh	Dried/Boiled	2	9.51 ± 0.96	3.11 ± 0.49	11.40 ± 4.12	0.48 ± 0.12
Lung	Oven Roast	8	46.30 ± 5.95	1.39 ± 0.22	8.86 ± 1.58	0.10 ± 0.03
Liver	Raw	Composite[a]	41.6	5.14	6.37	2.16
Gizzard	Raw	Composite[a]	4.85	3.09	5.48	0.11
Heart	Raw	Composite[a]	18.05	2.41	5.82	0.40
Intestine	Raw	Composite[b]	5.76	1.93	7.34	0.09
Liver	Oven Roast	Composite[a]	49.18	6.12	7.22	2.53
Gizzard	Oven Roast	Composite[a]	6.94	4.30	6.74	0.14
Heart	Oven Roast	Composite[a]	21.56	3.31	5.84	0.64
Gizzard	Boiled	Composite[a]	6.59	4.85	8.88	0.08
Gizzard	Boiled	1	6.52	4.37	6.43	0.18
Heart	Boiled	1	15.06	4.96	8.53	0.94
Intestine	Boiled	Composite[b]	14.15	6.43	15.09	0.16
Intestine	Fried	Composite[b]	21.97	7.24	23.26	0.29

a Composite of 6 samples

b Composite of 5 samples

analytical samples fell within 10%, with the exception of oven roasted skin which had a CV of 21%; these samples were re-analyzed on three separate occasions.

5.2.4.2 Zinc

Zinc content ranged from 1.39 ± 0.22 mg/100g in oven roasted lung to 7.24 mg/100g in fried intestine. Oven roasted, fire roasted and boiled flesh samples had zinc values ranging from 2.90 to 4.81 ± 0.46 mg/100g. Leg/skin (raw, oven roasted, fire roasted and boiled) tended to have higher amounts of zinc as compared to other flesh parts. Heart and gizzard had similar or slightly higher levels of zinc as compared to flesh parts. Highest quantities of zinc were found in oven roasted liver (6.12 mg/100g), boiled intestine (6.43 mg/100g) and fried intestine (7.24 mg/100g). Raw intestine had a much lower zinc content (1.93 mg/100g) as compared to fried intestine. In contrast, liver contained the highest level of zinc of all raw samples at 5.14 mg/100g. The CV for analytical samples was within 10%.

5.2.4.3 Calcium

Calcium values for Canada goose ranged from 4.91 ± 0.90 mg/100g in boiled flesh only to 27.59 mg/100g in fire roasted collar/skin. Flesh only (raw, oven roasted and boiled) had lower levels of calcium (5.44 ± 1.51 mg/100g, 6.91 ± 2.36 mg/100g and 4.91 ± 0.90 mg/100g calcium respectively) as compared to parts containing skin. Fire roasted, oven roasted and boiled flesh samples with skin (leg/skin, breast/skin, collar/skin) ranged from 5.83 ± 0.02 mg/100g to 11.01 ± 4.24 mg/100g of calcium, with the exception of a higher value for fire roasted collar (27.59 mg/100g calcium). Skin alone (raw, oven roasted, dried and dried/boiled) had relatively higher levels of calcium (11.96 mg/100g, 19.79 ± 4.89 mg/100g, 11.35 ± 2.57 mg/100g and 11.40 ± 4.12 mg/100g respectively) as compared to flesh samples; this may be due to feather residue contamination. Raw organ meat (liver, gizzard, heart and intestine) ranged from 5.48 mg/100g to 7.34 mg/100g calcium. Once cooked, calcium values in organ meat increased, with the highest increase for boiled and fried intestine (15.09 and 23.26 mg/100g respectively) probably due to concentration of nutrients following loss of moisture. Oven roasted lung had similar calcium levels (8.86 ± 1.58 mg/100g) as compared to boiled gizzard and heart.

Calcium content of replicate samples varied to a greater degree than for other minerals analyzed. This may be a function of residue fragments of bone and/or feathers in samples. Nonetheless, this may be representative of consumption levels, since bone and feather fragments are likely to be ingested along with portions of meat. The CV for analytical samples fell below 10% with the exception of 9 samples. These samples were re-analyzed but did not fall below the required level of 10% CV.

5.2.4.4 Copper

Copper values ranged from 0.05 mg/100g (raw skin) to 2.53 mg/100g (oven roasted liver). Copper content was higher in cooked samples and correspondingly lower in parts containing skin. Flesh samples (with and without skin) ranged from 0.17 ± 0.04 mg/100g to 0.75 ± 0.04 mg/100g of copper. Liver contained the highest amount of copper in both its raw (2.15 mg/100g) and oven roasted state (2.53 mg/100g). Copper values for heart were 0.40 mg/100g for raw, 0.54 mg/100g for oven roasted and 0.94 mg/100g for boiled samples. Oven roasted lung (0.10 ± 0.03 mg/100g), gizzard (0.11 mg/100g: raw; 0.14 mg/100g: oven roasted and 0.18 mg/100g: boiled) and raw intestine (0.09 mg/100g) showed relatively lower levels of copper. The lowest level of copper was found in raw and oven roasted skin only (0.05 mg/100g and 0.08 ± 0.02 mg/100g respectively). The CV for analytical samples was less than 9%, with the exception of 4 samples containing extremely low levels of copper.

5.2.4.5 Effects of Season and Sex

Tables 12 and 13 show the trace elements for the edible portion of fall and spring Canada goose. There was a statistically significant difference found in the

Table 12: Trace Elements in Edible Portions of Fresh Fall Canada Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh only	Raw	2	7.76 ± 1.94	2.16 ± 0.49	4.61 ± 0.93	0.55 ± 0.08
Leg/Skin	Raw	2	3.49 ± 1.49	2.91 ± 0.001	11.03 ± 4.01	0.20 ± 0.04
Breast/Skin	Raw	2	4.48 ± 1.48	1.92 ± 0.01	8.62 ± 3.85	0.28 ± 0.04
Flesh only	Oven Roast	2	8.95 ± 1.80	2.90 ± 0.48	9.68 ± 3.76	0.62 ± 0.02
Leg/Skin	Oven Roast	2	5.25 ± 1.65	4.06 ± 0.21	14.01 ± 0.77	0.26 ± 0.03
Breast/Skin	Oven Roast	2	6.66 ± 0.65	3.42 ± 0.37	12.69 ± 1.63	0.36 ± 0.09
Collar/Skin	Oven Roast	1	7.93	3.22	12.71	0.32
Lung	Oven Roast	2	44.24 ± 10.37	1.64 ± 0.27	8.66 ± 0.55	0.10 ± 0.05

Table 13: Trace Elements in Edible Portions of Fresh Spring Canada Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh Only	Raw	6	8.42 ± 1.43	2.16 ± 0.13	5.72 ± 1.64	0.49 ± 0.05
Leg/Skin	Raw	6	5.37 ± 1.52	2.47 ± 0.18	7.05 ± 2.93	0.16 ± 0.04
Breast/Skin	Raw	6	6.76 ± 1.55	1.85 ± 0.08	9.05 ± 9.38	0.31 ± 0.07
Flesh Only	Oven Roast	6	10.10 ± 1.55	3.23 ± 0.23	5.98 ± 0.92	0.65 ± 0.08
Leg/Skin	Oven Roast	6	5.85 ± 1.43	4.15 ± 0.42	8.16 ± 1.54	0.21 ± 0.03
Breast/Skin	Oven Roast	6	6.81 ± 0.92	2.93 ± 0.19	5.69 ± 0.78	0.41 ± 0.06
Collar/Skin	Oven Roast	5	7.38 ± 1.20	3.52 ± 0.26	10.67 ± 4.64	0.43 ± 0.03
Lung	Oven Roast	6	46.98 ± 5.08	1.31 ± 0.15	8.92 ± 1.85	0.10 ± 0.03

calcium content of between fall and spring Canada goose oven roasted breast/skin; it is unlikely that this difference is a true effect of season since other parts do not show this effect and contamination by feather and/or bone residue of samples is possible. Spring Canada goose tended to have higher amounts of iron as compared to analogous parts of fall Canada goose, although this was not statistically significant.

Trace elements for male and female Canada goose are shown in Tables 14 and 15. There were no statistical differences in trace element content between the sexes. Nonetheless, female Canada goose parts consistently had higher amounts of iron and calcium, with the exception of a lower iron content in female oven roasted Canada goose skin.

5.2.4.6 Comparison to Domesticated Goose (*Anser anser*)

Trace element content of the edible portion for domesticated goose is shown in Table 16. No statistically significant differences were found between domesticated goose and Canada goose. Nonetheless, Canada goose consistently showed higher levels of iron and copper, as compared to analogous parts of domesticated goose. The difference in iron content between species was less distinct in leg/skin and more prominent in breast/skin and flesh only.

5.2.4.7 Comparison to Literature Values

Appavoo et al. (1991) reported higher levels of trace elements for dried Canada goose than reported here: 23 ± 0.4 mg/100g calcium, 12 ± 3.9 mg/100g iron, 5 ± 1.8 mg/100g and 0.7 ± 0.35 mg/100g copper. The iron value of 5.6 mg/100g published by Heller and Scott (1969) for *Branta canadensis* was comparable to fire and oven roasted Canada goose leg/skin but lower than other parts analyzed here. As compared to analyzed parts of domesticated goose it is higher, with the exception of oven roast flesh only.

Trace element data for raw and roast domesticated goose flesh published in

Table 14: Trace Elements in Edible Portions of Fresh Male Spring Canada Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh Only	Raw	3	7.83 ± 0.85	2.19 ± 0.13	5.71 ± 2.48	0.46 ± 0.03
Leg/Skin	Raw	3	4.38 ± 0.80	2.43 ± 0.09	4.65 ± 1.77	0.17 ± 0.02
Breast/Skin	Raw	3	5.95 ± 0.59	1.89 ± 0.11	3.50 ± 0.71	0.34 ± 0.02
Flesh Only	Oven Roast	3	9.78 ± 1.45	3.18 ± 0.22	5.71 ± 1.17	0.61 ± 0.11
Leg/Skin	Oven Roast	3	4.87 ± 1.05	4.38 ± 0.27	7.94 ± 2.32	0.19 ± 0.03
Breast/Skin	Oven Roast	3	6.50 ± 0.54	2.97 ± 0.24	5.22 ± 0.72	0.41 ± 0.07
Collar/Skin	Oven Roast	2	7.11 ± 0.21	3.46 ± 0.01	9.60 ± 5.85	0.42 ± 0.02
Lung	Oven Roast	3	44.38 ± 5.59	1.20 ± 0.13	7.74 ± 0.75	0.09 ± 0.03
Skin Only	Oven Roast	3	4.33 ± 0.94	2.62 ± 0.65	15.22 ± 5.76	0.09 ± 0.02

Table 15: Trace Elements in Edible Portions of Fresh Female Spring Canada Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh Only	Raw	3	9.01 ± 1.84	2.13 ± 0.16	5.74 ± 0.72	0.53 ± 0.06
Leg/Skin	Raw	3	6.37 ± 1.47	2.52 ± 0.25	9.45 ± 1.02	0.14 ± 0.05
Breast/Skin	Raw	3	7.58 ± 1.91	1.81 ± 0.01	14.60 ± 11.26	0.29 ± 0.10
Flesh Only	Oven Roast	3	10.43 ± 1.89	3.28 ± 0.27	6.25 ± 0.72	0.69 ± 0.04
Leg/Skin	Oven Roast	3	6.83 ± 1.04	3.91 ± 0.45	8.37 ± 0.61	0.23 ± 0.03
Breast/Skin	Oven Roast	3	7.13 ± 1.24	2.88 ± 0.15	6.16 ± 0.58	0.42 ± 0.06
Collar/Skin	Oven Roast	3	7.56 ± 1.65	3.56 ± 0.36	11.38 ± 4.91	0.44 ± 0.04
Lung	Oven Roast	3	49.58 ± 3.60	1.43 ± 0.03	10.10 ± 1.94	0.11 ± 0.04
Skin Only	Oven Roast	3	3.45 ± 0.51	2.92 ± 0.33	19.40 ± 0.99	0.07 ± 0.02

Table 16: Trace Elements in Edible Portions of Fresh Domesticated Goose (mean ± SD mg/100g)

Part	Preparation	n	Iron	Zinc	Calcium	Copper
Flesh only	Raw	2	5.13 ± 0.26	1.67 ± 0.05	6.44 ± 0.82	0.44 ± 0.13
Leg/Skin	Raw	2	2.01 ± 0.19	2.92 ± 0.01	8.45 ± 0.72	0.10 ± 0.02
Breast/Skin	Raw	2	2.14 ± 0.23	2.51 ± 0.14	13.42 ± 5.32	0.15 ± 0.04
Flesh only	Oven Roast	2	6.00 ± 0.34	2.20 ± 0.13	6.18 ± 0.70	0.42 ± 0.10
Leg/Skin	Oven Roast	2	3.26 ± 0.28	5.15 ± 0.15	12.82 ± 2.94	0.15 ± 0.002
Breast/Skin	Oven Roast	2	2.71 ± 0.30	3.13 ± 0.09	13.68 ± 3.62	0.17 ± 0.04

USDA (1979) have lower values for iron (2.57 and 2.87 mg/100g iron respectively) and copper (0.306 and 0.276 mg/100g respectively), and higher values for calcium (13 and 14 mg/100g respectively) as compared to raw and roast domesticated and Canada goose flesh reported here. Zinc was not included in the USDA data. USDA data for raw and roast flesh with skin had higher calcium (12 and 13 mg/100g respectively), lower iron (2.5 and 2.83 mg/100g) and lower copper (0.31 and 0.28 mg/100g respectively) as compared to Canada goose flesh with skin (leg/skin, breast/skin, collar/skin); these data were similar to analyzed raw and oven roasted domesticated goose leg/skin and breast/skin in terms of calcium and iron, but higher in copper.

Trace element data for *Anser anser* (part and preparation style not indicated) published by Souci, Fachmann and Kraut (1994) had lesser amounts of iron (1.90 mg/100g) and zinc (1.30 mg/100g), similar amounts of copper (0.33 mg/100g) and higher or similar levels of calcium (12 mg/100g) for Canada and domesticated goose reported here. Paul and Southgate's (1978) data for roast goose provide an iron value of 4.6 mg/100g, which fell in the range of analyzed domesticated goose but is lower than analyzed Canada goose. Calcium (10 mg/100g) and copper (0.49 mg/100g) values were within the range of both species analyzed here. A value for zinc was not included in Paul and Southgate (1978).

USDA (1979) data for calcium and copper content of raw goose liver (43 mg/100g and 7.52 mg/100g respectively) were greater than raw Canada goose liver reported here. Iron and zinc values were not included in the USDA data.

5.2.6 Fatty Acid Analysis

Fatty acids of fresh Canada goose samples are shown in Tables 17 through 20. SFAs are reported in Table 17, and show that the predominant SFA was palmitate (C16:0), followed by stearate (C18:0), except in the case of fall raw flesh only where palmitate (C18:0) was slightly higher than stearate (C16:0). Generally, the third most important SFA was myristate (C14:0), although this was not the case

Table 17: Saturated Fatty Acid Composition of Fresh Canada Goose (mean ± SD g/100g)

Season	Part	Preparation	n	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C20:0	C22:0	C24:0
Spring	Fat	Raw	6	nd	0.01 ± 0.01	0.02 ± 0.002	0.35 ± 0.05	20.90 ± 2.39	6.88 ± 0.53	0.08 ± 0.02	0.01 ± 0.01	nd
Fall	Fat	Raw	2	nd	0.01 ± 0.003	0.02 ± 0.001	0.36 ± 0.10	20.20 ± 1.90	6.61 ± 1.77	0.08 ± 0.04	nd	0.04 ± 0.06
Spring	Fat	Oven Roasted	6	0.01 ± 0.003	0.01 ± 0.003	0.03 ± 0.01	0.41 ± 0.08	21.04 ± 1.85	6.25 ± 0.54	0.10 ± 0.02	0.02 ± 0.01	0.03 ± 0.02
Fall	Fat	Oven Roasted	2	0.02 ± 0.02	0.01 ± 0.0001	0.03 ± 0.01	0.41 ± 0.03	21.12 ± 0.17	5.72 ± 0.33	0.09 ± 0.03	nd	0.07 ± 0.11
Spring	Fat	Rendered	2	0.01 ± 0.01	0.01 ± 0.001	0.02 ± 0.004	0.40 ± 0.01	22.28 ± 1.06	7.72 ± 0.23	0.10 ± 0.003	0.005 ± 0.01	nd
Fall	Fat	Rendered	2	0.01 ± 0.01	0.01 ± 0.001	0.03 ± 0.02	0.40 ± 0.40	22.37 ± 0.80	8.03 ± 0.10	0.08 ± 0.06	0.04 ± 0.01	tr
Fall	Flesh	Raw	2	nd	nd	tr	0.01 ± 0.001	0.24 ± 0.02	0.29 ± 0.01	tr	nd	0.02 ± 0.01
Fall	Flesh	Oven Roasted	2	tr	nd	tr	0.02 ± 0.004	1.14 ± .0.15	0.62 ± 0.07	0.01 ± 0.001	tr	0.03 ± 0.02
Fall	Leg/Skin	Raw	2	tr	tr	0.01 ± 0.001	0.14 ± 0.02	6.45 ± 0.66	1.95 ± 0.23	0.04 ± 0.01	0.01 ± 0.002	0.04 ± 0.05
Fall	Leg/Skin	Oven Roasted	2	tr	tr	0.01 ± 0.002	0.12 ± 0.04	6.03 ± 1.89	1.80 ± 0.82	0.03 ± 0.01	tr	0.03 ± 0.04
Fall	Breast/Skin	Raw	2	tr	tr	0.01 ± 0.002	0.10 ± 0.01	5.00 ± 0.29	1.50 ± 0.27	0.02 ± 0.01	tr	0.02 ± 0.03
Fall	Breast/Skin	Oven Roasted	2	tr	tr	0.01 ± 0.004	0.07 ± 0.03	3.73 ± 1.18	1.17 ± 0.38	0.02 ± 0.01	tr	tr
Fall	Collar/Skin	Oven Roasted	1	tr	tr	tr	0.04	2.03	0.61	0.01	tr	0.04
Spring	Lung	Oven Roasted	2	nd	nd	tr	0.03 ± 0.001	1.50 ± 0.25	0.51 ± 0.12	0.01 ± 0.001	tr	nd
Fall	Lung	Oven Roasted	2	tr	nd	tr	0.03 ± 0.003	1.77 ± 0.27	0.55 ± 0.03	0.01 ± 0.001	tr	nd
Spring	Liver	Raw	Composite	nd	nd	nd	0.01	1.07	0.59	tr	tr	0.01
Spring	Liver	Oven Roasted	Composite	nd	nd	nd	0.01	0.79	0.50	tr	nd	0.02

nd: not detected

tr: trace

Table 18: Monounsaturated Fatty Acid Composition of Fresh Canada Goose (mean ± SD g/100g)

Season	Part	Preparation	n	C12:1	C14:1	C16:1	C18:1	C20:1 (5)	C20:1 (11)	C22:1	C24:1
Spring	Fat	Raw	6	nd	0.02 ± 0.01	2.86 ± 0.55	44.10 ± 2.50	0.19 ± 0.03	0.23 ± 0.06	nd	nd
Fall	Fat	Raw	2	nd	0.03 ± 0.01	2.52 ± 0.10	43.41 ± 0.21	0.28 ± 0.18	0.23 ± 0.004	0.06 ± 0.09	nd
Spring	Fat	Oven Roasted	6	nd	0.04 ± 0.02	3.71 ± 0.87	47.30 ± 1.70	0.24 ± 0.02	0.29 ± 0.04	tr	nd
Fall	Fat	Oven Roasted	2	nd	0.04 ± 0.01	3.96 ± 0.25	50.36 ± 3.00	0.31 ± 0.16	0.29 ± 0.001	0.03 ± 0.05	nd
Spring	Fat	Rendered	2	nd	0.03 ± 0.002	2.86 ± 0.09	47.08 ± 0.38	0.21 ± 0.03	0.24 ± 0.01	nd	nd
Fall	Fat	Rendered	2	nd	0.03 ±0.002	2.81 ± 0.06	46.07 ± 1.44	0.27 ± 0.01	0.26 ± 0.01	nd	nd
Fall	Flesh	Raw	2	nd	tr	0.10 ± 0.02	1.09 ± 0.09	tr	0.01 ± 0.001	nd	nd
Fall	Flesh	Oven Roasted	2	nd	tr	0.21 ± 0.01	2.29 ± 0.25	0.01 ± 0.001	0.01 ± 0.003	nd	nd
Fall	Leg/Skin	Raw	2	nd	0.02 ± 0.01	1.23 ± 0.02	16.77 ± 0.58	0.10 ± 0.03	0.11 ± 0.01	0.01 ± 0.01	nd
Fall	Leg/Skin	Oven Roasted	2	nd	0.01 ± 0.01	1.03 ± 0.28	13.85 ± 3.25	0.08 ± 0.05	0.08 ± 0.02	nd	nd
Fall	Breast/Skin	Raw	2	nd	0.01 ± 0.003	0.85 ± 0.10	11.55 ± 0.09	0.07 ± 0.03	0.07 ± 0.002	nd	nd
Fall	Breast/Skin	Oven Roasted	2	nd	0.01 ± 0.01	0.69 ± 0.21	8.52 ± 2.21	0.05 ± 0.03	0.05 ± 0.01	nd	nd
Fall	Collar/Skin	Oven Roasted	2	nd	tr	0.39	4.75	0.02	0.03	nd	nd
Spring	Lung	Oven Roasted	2	nd	tr	0.21 ± 0.01	3.29 ± 0.69	0.02 ± 0.002	0.02 ± 0.01	nd	nd
Spring	Lung	Oven Roasted	2	nd	tr	0.25 ± 0.03	3.42 ± 0.38	0.03 ± 0.001	0.02 ± 0.01	nd	nd
Spring	Liver	Raw	Composite	nd	nd	0.09	1.73	tr	0.01	nd	nd
Spring	Liver	Oven Roasted	Composite	nd	nd	0.06	1.43	tr	nd	nd	nd

nd: not detected

tr: trace

Table 19: Omega-3 Fatty Acid Composition of Fresh Canada Goose (mean ± SD g/100g)

Season	Part	Preparation	n	C18:3	C20:3	C20:5	C22:3	C22:6
Spring	Fat	Raw	6	0.05 ± 0.01	0.03 ± 0.02	nd	nd	nd
Fall	Fat	Raw	2	0.04 ± 0.002	0.04 ± 0.03	0.05 ± 0.07	nd	nd
Spring	Fat	Oven roasted	6	0.06 ± 0.01	0.05 ± 0.01	0.01 ± 0.01	tr	nd
Fall	Fat	Oven roasted	2	0.05 ± 0.01	0.07 ± 0.04	0.06 ± 0.09	nd	nd
Spring	Fat	Rendered	2	0.06 ± 0.01	0.03 ± 0.01	0.01 ± 0.01	nd	nd
Fall	Fat	Rendered	2	0.05 ± 0.05	0.04 ± 0.02	0.04 ± 0.05	tr	0.01 ± 0.02
Fall	Flesh	Raw	2	tr	0.01 ± 0.003	0.02 ± 0.02	0.01 ± 0.01	0.02 ± 0.01
Fall	Flesh	Oven roasted	2	0.01 ± 0.002	0.02 ± 0.01	0.04 ± 0.04	0.02 ± 0.01	0.04 ± 0.02
Fall	Leg/Skin	Raw	2	0.01 ± 0.003	0.03 ± 0.01	0.03 ± 0.04	0.01 ± 0.004	0.02 ± 0.03
Fall	Leg/Skin	Oven roasted	2	0.02 ± 0.004	0.02 ± 0.01	0.02 ± 0.03	0.01 ± 0.01	0.02 ± 0.03
Fall	Breast/Skin	Raw	2	0.01 ± 0.001	0.02 ± 0.004	0.02 ± 0.03	0.01 ± 0.01	0.01 ± 0.01
Fall	Breast/Skin	Oven roasted	2	0.01 ± 0.003	0.02 ± 0.01	0.03 ± 0.04	0.02 ± 0.001	0.02 ± 0.03
Fall	Collar/Skin	Oven roasted	2	0.01	0.02	0.04	0.01	0.03
Spring	Lung	Oven roasted	2	tr	tr	nd	0.01 ± 0.001	nd
Fall	Lung	Oven roasted	2	tr	tr	0.01 ± 0.01	tr	nd
Spring	Liver	Raw	Composit	0.01	0.01	0.01	0.01	0.07
Spring	Liver	Oven roasted	Composit	0.01	0.01	0.01	0.01	nd

nd: not detected

tr: trace

Table 20: Omega-6 Fatty Acid Composition of Fresh Canada Goose (mean ± SD g/100g)

Season	Part	Preparation	n	C18:2	C18:3	C20:2	C20:3	C20:4	C22:2	C22:4
Spring	Fat	Raw	6	9.53 ± 2.11	2.22 ± 1.55	0.04 ± 0.01	0.01 ± 0.01	0.04 ± 0.02	tr	nd
Fall	Fat	Raw	2	6.45 ± 0.46	4.64 ± 5.36	0.06 ± 0.05	0.07 ± 0.10	0.05 ± 0.07	nd	nd
Spring	Fat	Oven Roasted	6	10.65 ± 2.45	2.75 ± 1.57	0.05 ± 0.01	0.02 ± 0.01	0.07 ± 0.02	tr	nd
Fall	Fat	Oven Roasted	2	8.77 ± 0.39	0.69 ± 0.93	0.10 ± 0.03	0.09 ± 0.13	0.10 ± 0.06	nd	nd
Spring	Fat	Rendered	2	10.61 ± 0.99	2.44 ± 0.96	0.04 ± 0.01	0.01 ± 0.01	0.07 ± 0.03	nd	nd
Fall	Fat	Rendered	2	7.92 ± 2.36	4.99 ± 3.82	0.04 ± 0.03	0.04 ± 0.06	0.09 ± 0.05	0.01 ± 0.004	nd
Fall	Flesh	Raw	2	0.47 ± 0.08	0.16 ± 0.11	tr	tr	0.15 ± 0.06	nd	nd
Fall	Flesh	Oven Roasted	2	0.81 ± 0.02	0.35 ± 0.33	0.01 ± 0.01	0.01 ± 0.01	0.21 ± 0.05	nd	nd
Fall	Leg/Skin	Raw	2	2.91 ± 0.01	0.23 ± 0.30	0.03 ± 0.02	0.04 ± 0.05	0.09 ± 0.04	0.01 ± 0.01	nd
Fall	Leg/Skin	Oven Roasted	2	2.45 ± 0.90	1.38 ± 1.31	0.02 ± 0.01	0.02 ± 0.03	0.15 ± 0.01	nd	nd
Fall	Breast/Skin	Raw	2	2.07 ± 0.38	1.33 ± 1.40	0.02 ± 0.01	0.02 ± 0.03	0.12 ± 0.08	nd	nd
Fall	Breast/Skin	Oven Roasted	2	1.71 ± 0.54	0.89 ± 0.83	0.02 ± 0.01	0.01 ± 0.02	0.15 ± 0.01	nd	nd
Fall	Collar/Skin	Oven Roasted	1	0.93	1.03	0.01	0.02	0.1	tr	nd
Spring	Lung	Oven Roasted	2	0.63 ± 0.20	0.10 ± 0.06	tr	tr	0.06 ± 0.02	nd	nd
Fall	Lung	Oven Roasted	2	0.44 ± 0.04	0.22 ± 0.23	tr	tr	0.04 ± 0.004	nd	nd
Spring	Liver	Raw	Composite	0.50	0.10	tr	nd	0.33	nd	0.01
Spring	Liver	Oven Roasted	Composite	0.38	0.09	tr	tr	0.30	nd	0.01

nd: not detected

tr: trace

for raw and oven roasted fall leg/skin and raw and oven roasted liver. Oleate (C18:1) was the major MUFA in all samples, followed by palmitoleate (C16:1), as reported in Table 18. Omega-3 fatty acids in Canada goose were comparatively lower than SFA and MUFA, and more variable in terms of precedence, as can be seen in Table 19. With the exception of raw liver collected in spring, only fall samples contained quantities of docosahexaenoate (C22:6). Table 20 shows ω-6 fatty acids of Canada goose samples. Linoleate (C18:2) was the predominant ω-6 fatty acid, followed by gamma linolenate (C18:3) in almost all samples. In the case of liver, arachidonate (C20:4) was the second most important ω-6 fatty acid rather than gamma linolenate (C18:3). For fall collar/skin gamma linolenate (C18:3) was slightly higher than linoleate(C18:2). Generally, these results corroborate with previously reported fatty acid data for *Branta canadensis* by Appavoo et al. (1991) and Austin (1993).

A summary of fatty acid composition of fresh Canada goose is shown in Table 21. Canada goose samples had highest amounts of MFA, followed by SFA and lowest quantities of PUFA. Omega-3:ω-6 ratios ranged from 0.007 in raw spring fat to 0.12 in raw spring liver. Fat samples from fall had higher ω-3:ω-6 ratios as compared to spring fat samples. The ratio between MUFA and SFA ranged from 1.09:1 in raw liver to 2.21:1 in oven roasted lung. The ratio between PUFA and SFA ranged from 0.36:1 in oven roasted fall fat to 1.5:1 in raw fall flesh only. Raw fat (from the abdominal region) had comparatively lesser amounts of MUFA and PUFA as compared to values published by Austin (1993) in terms of proportions of PUFA:SFA:MUFA.

Table 22 shows the fatty acid profile for analyzed domesticated goose (*Anser anser*). As compared to Canada goose fat, samples of domesticated goose fat had lower amounts of SFAs, slightly higher amounts of MUFAs, and lower amounts of ω-3 and ω-6 PUFAs. Parts of domesticated goose flesh samples also showed lower amounts of SFAs as compared to analogous parts of Canada goose. Quantities of MUFA of domesticated goose were higher in flesh only and lower in

Table 21: Summary of Fatty Acid Composition of Fresh Canada Goose (g/100g)

Season	Part	Preparation	n	Total SFA	Total MUFA	Total ω-3 PUFA	Total ω-6 PUFA	Total PUFA	ω-3:ω-6 Ratio	P:S:M Ratio
Spring	Fat	Raw	6	28.25	47.40	0.08	11.84	11.92	0.007	0.42 : 1 : 1.68
Fall	Fat	Raw	2	27.32	46.53	0.13	11.27	11.40	0.012	0.42 : 1 : 1.70
Spring	Fat	Oven Roasted	6	27.90	51.58	0.12	13.54	13.66	0.009	0.49 : 1 : 1.85
Fall	Fat	Oven Roasted	2	27.47	54.99	0.18	9.75	9.93	0.018	0.36 : 1 : 2.00
Spring	Fat	Rendered	2	30.55	50.42	0.10	13.17	13.27	0.008	0.43 : 1 : 1.65
Fall	Fat	Rendered	2	30.97	49.44	0.14	13.09	13.23	0.011	0.43 : 1 : 1.60
Fall	Flesh	Raw	2	0.56	1.20	0.06	0.78	0.84	0.077	1.50 : 1 : 2.14
Fall	Flesh	Oven Roasted	2	1.72	2.52	0.13	1.39	1.52	0.094	0.88 : 1 : 1.47
Fall	Leg/Skin	Raw	2	8.64	18.24	0.10	3.31	3.41	0.030	0.39 : 1 : 2.11
Fall	Leg/Skin	Oven Roasted	2	8.02	14.97	0.09	4.02	4.11	0.022	0.51 : 1 : 1.87
Fall	Breast/Skin	Raw	2	6.65	12.55	0.07	3.56	3.63	0.020	0.55 : 1 : 1.89
Fall	Breast/Skin	Oven Roasted	2	5.00	9.32	0.10	2.78	2.88	0.036	0.58 : 1 : 1.86
Fall	Collar/Skin	Oven Roasted	1	2.73	5.19	0.11	2.09	2.20	0.053	0.81 : 1 : 1.90
Spring	Lung	Oven Roasted	2	2.05	3.54	0.01	0.79	0.80	0.013	0.39 : 1 : 1.73
Fall	Lung	Oven Roasted	2	1.68	3.72	0.01	0.70	0.71	0.014	0.42 : 1 : 2.21
Spring	Liver	Raw	Composite	1.68	1.83	0.11	0.94	1.05	0.117	0.63 : 1 : 1.09
Spring	Liver	Roast	Composite	1.32	1.49	0.04	0.78	0.82	0.051	0.62 : 1 : 1.13

Table 22: Fatty Acid Composition of Fresh Domesticated Goose (mean ± SD g/100g)

Part		Fat	Fat	Flesh	Flesh	Leg	Leg	Breast/Skin	Breast/Skin
Preparation		Raw	Oven Roasted	Raw	Oven Roasted	Raw	Oven Roasted	Raw	Oven Roasted
n		2	2	2	2	2	2	2	2
SFA	C8:0	tr	tr	tr	nd	tr	nd	tr	nd
	C10:0	tr	tr	nd	tr	tr	tr	tr	tr
	C12:0	0.01± 0.003	0.02 ± 0.003	tr	0.02 ± 0.03	0.01 ± 0.001	0.01 ± 0.002	0.01 ± 0.002	tr
	C14:0	0.36 ± 0.03	0.41 ± 0.05	0.01 ± 0.01	0.04 ± 0.01	0.11 ± 0.02	0.08 ± 0.02	0.09 ± 0.03	0.07 ± 0.02
	C16:0	19.68 ± 0.53	21.09 ± 2.49	0.84 ± 0.50	1.84 ± 0.51	5.53 ± 1.08	3.92 ± 0.93	4.36 ± 1.79	3.53 ± 1.46
	C18:0	5.19 ± 0.38	5.02 ± 0.76	0.30 ± 0.13	0.63 ± 0.14	1.37 ± 0.24	1.10 ± 0.38	1.09 ± 0.54	0.94 ± 0.47
	C20:0	0.02 ± 0.004	0.02 ± 0.01	tr	tr	0.01 ± 0.002	0.01 ± 0.002	0.01 ± 0.003	0.01 ± 0.002
	C22:0	nd	nd	nd	tr	nd	nd	nd	nd
	C24:0	nd	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.02	0.01 ± 0.02	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
Total SFA		**25.26**	**26.57**	**1.16**	**2.84**	**7.04**	**5.13**	**5.57**	**4.56**
MUFA	C12:1	nd	nd	nd	nd	nd	nd	nd	nd
	C14:1	0.02 ± 0.004	0.03 ± 0.01	tr	tr	0.01 ± 0.002	0.01 ± 0.002	0.01 ± 0.004	0.01 ± 0.002
	C16:1	2.45 ± 0.24	3.01 ± 0.10	0.09 ± 0.05	0.23 ± 0.04	0.87 ± 0.19	0.58 ± 0.12	0.66 ± 0.25	0.49 ± 0.13
	C18:1	48.03 ± 2.18	50.52 ± 5.06	1.61 ± 0.91	3.78 ± 0.72	13.57 ± 3.28	9.37 ± 2.88	10.25 ± 4.80	8.29 ± 4.08
	C20:1 (5)	0.14 ± 0.02	0.13 ± 0.01	tr	tr	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.02	0.02 ± 0.01
	C20:1 (11)	0.24 ± 0.03	0.27 ± 0.04	0.01 ± 0.01	0.01 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.06 ± 0.02	0.05 ± 0.01
	C22:1	nd	nd	nd	tr	tr	nd	nd	nd
	C24:1	nd	nd	nd	nd	nd	nd	nd	nd
Total MUFA		**50.88**	**53.96**	**1.71**	**4.02**	**14.57**	**10.05**	**11.01**	**8.86**
ω-3 PUFA	C18:3	0.02 ± 0.002	0.04 ± 0.01	tr	tr	0.01 ± 0.0003	0.01 ± 0.001	0.01 ± 0.002	0.01 ± 0.001
	C20:3	0.02 ± 0.003	0.01 ± 0.01	tr	0.01 ± 0.01	0.01 ± 0.001	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.002
	C20:5	nd	nd	tr	tr	tr	nd	nd	nd
	C22:3	nd	0.01 ± 0.01	0.02 ± 0.004	0.02 ± 0.03	0.03 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.03 ± 0.0002
	C22:6	nd	nd	0.01 ± 0.01	0.02 ± 0.03	0.01 ± 0.02	0.01 ± 0.02	tr	0.01 ± 0.01
Total ω-3 PUFA		**0.04**	**0.06**	**0.03**	**0.05**	**0.06**	**0.08**	**0.05**	**0.06**
ω-6 PUFA	C18:2	6.73 ± 1.42	7.42 ± 0.76	0.31 ± 0.07	0.72 ± 0.06	1.96 ± 0.05	1.39 ± 0.14	1.48 ± 0.40	1.16 ± 0.22
	C18:3	0.98 ± 0.32	1.04 ± 0.25	0.03 ± 0.01	0.07 ± 0.01	0.27 ± 0.02	0.18 ± 0.01	0.21 ± 0.03	0.15 ± 0.01
	C20:2	0.03 ± 0.01	0.04 ± 0.01	tr	tr	0.02 ± 0.0004	0.01 ± 0.005	0.01 ± 0.01	0.01 ± 0.001
	C20:3	nd	nd	nd	tr	nd	nd	nd	nd
	C20:4	0.06 ± 0.001	0.06 ± 0.01	0.12 ± 0.00002	0.22 ± 0.04	0.13 ± 0.04	0.20 ± 0.10	0.11 ± 0.45	0.12 ± 0.01
	C22:2	nd	0.01 ± 0.01	nd	tr	tr	nd	nd	nd
	C22:4	nd	nd	nd	nd	nd	nd	nd	nd
Total ω-6 PUFA		**7.80**	**8.53**	**0.46**	**1.01**	**2.38**	**1.78**	**1.81**	**1.44**
ω-3:ω-6		**0.01**	**0.01**	**0.07**	**0.05**	**0.03**	**0.04**	**0.03**	**0.04**
P:S:M		**0.31 : 1 : 2.01**	**0.32 : 1: 2.03**	**0.42 : 1: 1.47**	**0.42 :1 : 1.58**	**0.35 : 1 : 2.07**	**0.36 : 1 : 1.96**	**0.33 : 1 : 1.98**	**0.33 : 1 : 1.94**

nd: not detected
tr: trace

leg/skin and breast/skin as compared to analogous Canada goose parts. Amounts of ω-3 and ω-6 fatty acids were higher in Canada goose as compared to analogous domesticated goose flesh parts (flesh only, leg/skin, breast/skin).

Fatty acid composition of market fat, including lard (Tenderflake), shortening (Crisco) and margarine (Bonnie Bell) are shown in Table 23. Compared to lard, Canada goose rendered fat had lower quantities of SFA, higher amounts of MUFA, lower amounts of ω-3 PUFA and higher amounts of ω-6 PUFA. The difference in SFA and MUFA between lard and rendered Canada goose fat was found to be statistically significant, although not so for PUFA. The ω-3:ω-6 ratio was higher in lard samples, in comparison to Canada goose rendered fat. As expected, rendered Canada goose fat had higher amounts of SFAs and lower amounts of MUFAs and PUFAs as compared to margarine or shortening.

USDA data for domesticated goose fat show similar amounts of SFA (27.7 g/100g), with similar amounts for individual SFA; palmitate (C16:0) at 20.7 g/100g and stearate (C18:0) at 6.1 g/100g as compared to Canada goose fat; in comparison to data on domesticated goose fat presented here, the USDA data have somewhat higher values for SFA, resulting from higher amounts of stearate. For MUFA, USDA data has a higher value (56.7 g/100g) than either Canada or domesticated goose fat of the present study, due to higher levels of oleate (53.5 g/100g). As compared to domesticated goose presented here, the USDA data for goose fat has a higher PUFA value (11.0 g/100g), due to higher value for linoleate (C18:2) of 9.8 g/100g; as compared to Canada goose fat, the USDA PUFA value is lower, with the exception of fall oven roasted Canada goose fat, due primarily to higher gamma linolenate (C18:3) levels associated with the Canada goose fat samples.

USDA data for lard show very similar values as compared to data for lard presented here: SFA (39.2 g/100g); MUFA (45.1 g/100g); PUFA (11.2 g/100g). USDA values for shortening are similar for SFA (25.0 g/100g), lower for MUFA (44.5 g/100g) and higher in PUFA (26.1 g/100g), as compared to shortening analysed in the present study. USDA data for regular soft margarine had a higher SFA value

Table 23: Fatty Acid Composition of Market Fat (mean ± SD g/100g)

Market Fat		Lard	Shortening	Margarine
n		2	2	1
SFA	C8:0	0.01 ± 0.0001	0.01 ± 0.001	0.01
	C10:0	0.10 ± 0.003	0.01 ± 0.01	nd
	C12:0	0.10 ± 0.01	0.07 ± 0.01	0.12
	C14:0	1.46 ± 0.05	0.28 ± 0.01	0.10
	C16:0	24.33 ± 0.27	13.34 ± 0.13	5.79
	C18:0	14.40 ± 0.08	9.91 ± 0.16	4.99
	C20:0	0.24 ± 0.01	0.75 ± 0.02	0.53
	C22:0	0.03 ± 0.01	0.38 ± 0.01	0.35
	C24:0	0.02 ± 0.02	0.20 ± 0.01	0.09
Total SFA		40.69	24.95	11.98
MUFA	C12:1	nd	nd	nd
	C14:1	0.03 ± 0.01	nd	nd
	C16:1	2.29 ± 0.01	0.22 ± 0.02	0.12
	C18:1	39.17 ± 0.95	61.90 ± 0.25	51.25
	C20:1 (5)	0.08 ± 0.01	0.10 ± 0.01	nd
	C20:1 (11)	0.83 ± 0.06	1.11 ± 0.06	0.80
	C22:1	0.03 ± 0.01	0.17 ± 0.02	0.24
	C24:1	nd	0.12 ± 0.04	nd
Total MUFA		42.43	63.62	52.41
ω-3 PUFA	C18:3	0.06 ± 0.001	0.23 ± 0.02	0.17
	C20:3	0.08 ± 0.01	nd	nd
	C20:5	nd	nd	nd
	C22:3	0.05 ± 0.03	nd	nd
	C22:6	nd	nd	nd
Total ω-3 PUFA		0.19	0.23	0.17
ω-6 PUFA	C18:2	10.78 ± 0.48	5.77 ± 0.27	12.09
	C18:3w6	0.51 ± 0.09	0.58 ± 0.09	4.83
	C20:2	0.46 ± 0.03	nd	nd
	C20:3	0.08 ± 0.02	nd	nd
	C20:4	0.16 ± 0.01	nd	nd
	C22:2	0.02 ± 0.02	nd	nd
	C22:4	nd	nd	nd
Total ω-6 PUFA		12.01	6.35	16.92
ω-3:ω-6		0.02	0.04	0.01
P:S:M		0.30 : 1 : 1.04	0.26 : 1 : 2.55	1.43 : 1 : 4.37

nd not detected
t trace

(13.8 g/100g), a lower MUFA (28.5 g/100g) and a higher PUFA value (34.6 g/100g) as compared to fatty acid data presented here for margarine.

Table 24 shows the percent of total fatty acids for Canada goose samples. When shown in this manner, oleate (C18:1) accounted for approximately 50% (ranging from 47 to 55%) of the total fatty acids except in the case of liver and flesh parts where it is approximately 40% of total fatty acids. Palmitate (C16:0) was the second highest, ranging from 19 to 24% of total fatty acids. Linoleate (C18:2) was the third proportionally highest fatty acid for most samples, ranging from approximately 9 to 16 % of total fatty acids. However, for liver, fall lung, fall rendered fat and fall raw fat, stearate (C18:0) was the third proportionally highest fatty acid. For most samples stearate (C18:0) follows behind linoleate (C18:0) , although for the aforementioned parts the opposite was true. In general, gamma linolenate (C18:3) was next in importance, with the exception of spring raw, oven roasted and raw fat, fall oven roasted fat and fall raw leg/skin where palmitoleate (C16:1) took precedence over gamma linolenate (C18:3). Fall fresh samples, lungs and liver had a relatively higher proportion of arachidonic acid (C24:0). Raw liver and fall flesh parts had the highest proportion of docosahexaenoate (C22:6).

The percent of total fatty acids of domesticated goose is shown in Table 25. In comparison to analogous Canada goose parts, domesticated goose had a slightly higher proportion of SFAs, except in the case of raw fat (with a lower value) and oven roasted fat (with a similar value). MUFAs were proportionally higher in domesticated goose parts and ω-3 and ω-6 PUFAs were in Canada goose. The order of importance of fatty acids was very similar to those found in Canada goose.

Table 26 shows the percent of total fatty acids for market fat. Although the predominate fatty acid was still oleate (C18:1), its importance was less for lard (41%) and higher for shortening (65%) and margarine (63%) as compared to Canada goose fat. Palmitate (C16:0) remained the second highest fatty acid for lard with a value similar to Canada goose fat (25.5%) and for shortening at a lower value of 14%. For margarine, the second most important fatty acid was linoleate (C18:2) at

Table 24: Percent of Total Fatty Acids of Canada Goose

Season	Spring	Fall	Spring	Fall	Spring	Fall	Fall	Fall	Fall	Fall	Fall	Fall	Fall	Spring	Fall	Spring	Spring
Part	Fat	Fat	Fat	Fat	Fat	Fat	Flesh	Flesh	Leg/Skin	Leg/Skin	Breast/Skin	Breast/Skin	Collar/Skin	Lung	Lung	Liver	Liver
Preparation	Raw	Raw	Oven Roast	Oven Roast	Rendered	Rendered	Raw	Oven Roast	Raw	Oven Roast	Raw	Oven Roast	Oven Roast	Oven Roast	Oven Roast	Raw	Oven Roast
n	6	2	6	2	2	2	2	2	2	2	2	2	1	2	2	Composit	Composit
C8:0	nd	nd	0.02 ± 0.003	0.03 ± 0.02	0.01 ± 0.01	0.01 ± 0.01	nd	0.01 ± 0.01	tr	0.01 ± 0.01	0.01 ± 0.003	0.02 ± 0.01	0.01	nd	0.04 ± 0.03	nd	nd
C10:0	0.01 ± 0.01	0.01 ± 0.004	0.01 ± 0.004	0.01 ± 0.0001	0.01 ± 0.002	0.01 ± 0.001	nd	nd	0.01 ± 0.001	0.01 ± 0.001	0.01 ± 0.0002	0.02 ± 0.01	0.01	nd	nd	nd	nd
C12:0	0.02 ± 0.003	0.02 ± 0.001	0.03 ± 0.01	0.03 ± 0.01	0.02 ± 0.004	0.03 ± 0.02	0.03 ± 0.003	0.04 ± 0.01	0.03 ± 0.004	0.03 ± 0.004	0.03 ± 0.01	0.04 ± 0.02	0.03	0.01 ± 0.01	0.02 ± 0.01	nd	nd
C14:0	0.40 ± 0.08	0.43 ± 0.06	0.44 ± 0.09	0.45 ± 0.04	0.42 ± 0.02	0.43 ± 0.03	0.29 ± 0.01	0.40 ± 0.01	0.46 ± 0.05	0.43 ± 0.07	0.43 ± 0.07	0.42 ± 0.09	0.39	0.39 ± 0.07	0.45 ± 0.02	0.25	0.21
C16:0	23.85 ± 2.47	23.72 ± 2.66	22.59 ± 2.00	22.85 ± 0.17	23.64 ± 1.18	23.89 ± 0.65	18.50 ± 0.13	19.89 ± 0.52	21.28 ± 2.47	21.93 ± 2.33	21.93 ± 1.50	21.43 ± 2.27	20.02	23.67 ± 1.09	25.98 ± 0.33	23.69	21.70
C18:0	7.86 ± 0.67	7.77 ± 2.22	6.70 ± 0.57	6.19 ± 0.45	6.19 ± 0.26	6.58 ± 0.22	10.02 ± 0.13	9.12 ± 0.24	6.45 ± 0.62	6.50 ± 1.27	6.57 ± 1.25	6.72 ± 0.76	6.06	7.98 ± 0.17	8.14 ± 0.66	12.96	13.72
C20:0	0.09 ± 0.02	0.09 ± 0.05	0.11 ± 0.02	0.10 ± 0.03	0.10 ± 0.003	0.08 ± 0.06	0.05 ± 0.07	0.11 ± 0.01	0.11 ± 0.03	0.12 ± 0.02	0.10 ± 0.03	0.11 ± 0.01	0.08	0.09 ± 0.01	0.12 ± 0.001	0.02	0.07
C22:0	0.01 ± 0.01	nd	0.02 ± 0.01	nd	0.01 ± 0.01	0.04 ± 0.01	nd	0.04 ± 0.01	0.03 ± 0.01	0.02 ± 0.02	0.01 ± 0.02	0.02 ± 0.03	0.02	0.02 ± 0.01	0.03 ± 0.05	nd	0.05
C24:0	nd	0.05 ± 0.07	0.03 ± 0.02	0.08 ± 0.11	nd	tr	0.64 ± 0.40	0.53 ± 0.29	0.12 ± 0.16	0.13 ± 0.16	0.08 ± 0.11	0.02 ± 0.02	0.38	nd	nd	0.16	0.41
Total SFA	32.24	32.04	29.95	29.74	32.40	33.07	29.53	29.74	28.49	29.16	29.17	28.80	27.00	32.16	34.76	37.16	36.16
C12:1																	
C14:1	0.03 ± 0.02	0.03 ± 0.01	0.05 ± 0.02	0.05 ± 0.02	0.03 ± 0.002	0.03 ± 0.003	0.04 ± 0.03	0.07 ± 0.004	0.05 ± 0.02	0.05 ± 0.02	0.04 ± 0.02	0.06 ± 0.02	0.04	0.03 ± 0.02	0.04 ± 0.01	nd	nd
C16:1	3.25 ± 0.73	2.95 ± 0.06	3.99 ± 0.94	4.29 ± 0.34	3.04 ± 0.10	3.01 ± 0.02	3.36 ± 0.50	3.65 ± 0.42	4.07 ± 0.16	3.76 ± 0.22	3.71 ± 0.47	3.98 ± 0.38	3.66	3.32 ± 0.79	3.68 ± 0.01	1.92	1.66
C18:1	50.36 ± 2.46	50.94 ± 0.67	50.79 ± 1.93	54.47 ± 2.40	49.96 ± 0.51	49.21 ± 2.17	37.39 ± 1.18	39.63 ± 1.64	55.43 ± 3.03	50.79 ± 1.29	50.65 ± 0.69	49.30 ± 2.29	46.92	51.50 ± 0.03	50.32 ± 1.34	38.18	39.46
C20:1 (8)	0.22 ± 0.04	0.33 ± 0.22	0.25 ± 0.02	0.34 ± 0.16	0.22 ± 0.03	0.29 ± 0.02	0.08 ± 0.11	0.16 ± 0.05	0.31 ± 09	0.28 ± 0.12	0.29 ± 0.15	0.27 ± 0.13	0.18	0.25 ± 0.03	0.41 ± 0.04	0.08	0.10
C20:1 (11)	0.26 ± 0.06	0.27 ± 0.01	0.31 ± 0.05	0.32 ± 0.004	0.26 ± 0.01	0.27 ± 0.01	0.20 ± 0.04	0.23 ± 0.02	0.35 ± 0.04	0.29 ± 0.02	0.29 ± 0.01	0.28 ± 0.01	0.28	0.27 ± 0.02	0.29 ± 0.04	0.17	nd
C22:1	nd	0.07 ± 0.10	tr	0.04 ± 0.05	nd	nd	nd	nd	0.03 ± 0.04	nd	nd	nd	nd	nd	nd	nd	nd
C24:1																	
Total MUFA	54.12	54.59	55.64	59.51	53.51	52.81	41.07	43.94	60.24	55.19	54.98	53.89	51.28	55.37	54.74	40.35	41.24
C18:3	0.06 ± 0.01	0.05 ± 0.001	0.06 ± 0.01	0.06 ± 0.004	0.07 ± 0.01	0.05 ± 0.06	0.10 ± 0.01	0.09 ± 0.03	0.07 ± 0.01	0.06 ± 0.001	0.06 ± 0.004	0.06 ± 0.004	0.06	0.07 ± 0.02	0.06 ± 0.02	0.13	0.14
C20:3	0.03 ± 02	0.05 ± 0.04	0.05 ± 0.01	0.07 ± 0.04	0.04 ± 0.01	0.05 ± 0.02	0.36 ± 0.12	0.28 ± 0.13	0.09 ± 0.05	0.08 ± 0.04	0.08 ± 0.02	0.11 ± 0.06	0.17	0.05 ± 0.01	0.04 ± 0.06	0.19	0.26
C20:5	nd	0.05 ± 0.08	0.01 ± 0.01	0.07 ± 0.09	0.01 ± 0.02	0.04 ± 0.06	0.77 ± 0.79	0.61 ± 0.63	0.10 ± 0.14	0.10 ± 0.14	0.08 ± 0.11	0.18 ± 0.26	0.38	nd	0.09 ± 0.12	0.22	0.22
C22:3	nd	nd	tr	nd	nd	tr	0.44 ± 0.27	0.34 ± 0.16	0.04 ± 0.01	0.03 ± 0.04	0.06 ± 0.04	0.09 ± 0.01	0.09	0.10 ± 0.01	0.03 ± 0.04	0.22	0.26
C22:6	nd	nd	nd	nd	nd	0.01 ± 0.02	0.77 ± 0.39	0.63 ± 0.27	0.06 ± 0.09	0.09 ± 0.13	0.04 ± 0.06	0.14 ± 0.20	0.32	nd	nd	1.50	nd
Total ω-3 PUFA	0.09	0.15	0.12	0.20	0.12	0.15	2.44	1.95	0.36	0.36	0.32	0.59	1.02	0.22	0.22	2.26	0.88
C18:2	10.91 ± 2.29	7.57 ± 0.68	11.44 ± 2.62	9.50 ± 0.56	11.26 ± 1.02	8.47 ± 2.63	15.93 ± 2.04	14.17 ± 1.74	9.61 ± 0.15	8.86 ± 1.44	9.07 ± 1.77	9.64 ± 1.00	9.22	9.73 ± 1.11	6.64 ± 1.56	10.37	10.59
C18:3	2.64 ± 1.69	5.39 ± 6.19	2.94 ± 1.67	0.76 ± 1.02	2.59 ± 1.01	5.31 ± 4.01	5.71 ± 4.09	5.79 ± 4.83	0.73 ± 0.10	5.69 ± 6.01	5.78 ± 6.09	5.85 ± 6.10	10.16	1.56 ± 0.56	3.00 ± 2.90	2.32	2.49
C20:2	0.04 ± 0.01	0.07 ± 0.06	0.06 ± 0.01	0.10 ± 0.03	0.04 ± 0.01	0.04 ± 0.03	0.13 ± 0.01	0.13 ± 0.06	0.11 ± 0.07	0.09 ± 0.04	0.09 ± 0.04	0.11 ± 0.06	0.13	0.06 ± 0.01	0.04 ± 0.06	0.06	0.12
C20:4	0.04 ± 0.02	0.06 ± 0.09	0.08 ± 0.02	0.10 ± 0.06	0.07 ± 0.04	0.09 ± 0.06	5.11 ± 1.90	3.80 ± 1.42	0.31 ± 0.13	0.54 ± 0.08	0.52 ± 0.35	0.86 ± 0.13	1.00	0.69 ± 0.10	0.54 ± 0.02	7.38	8.23
C20:3	0.01 ± 0.01	0.08 ± 0.11	0.02 ± 0.01	0.10 ± 0.14	0.01 ± 0.01	0.04 ± 0.06	0.08 ± 0.12	0.09 ± 0.13	0.12 ± 0.16	0.09 ± 0.13	0.09 ± 0.12	0.09 ± 0.13	0.18	nd	0.05 ± 0.07	nd	0.04
C22:2	tr	nd	tr	nd	nd	0.01 ± 0.004	nd	nd	0.02 ± 0.03	nd	nd	nd	0.02	nd	nd	nd	nd
C22:4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.14	0.24
Total ω-6 PUFA	13.64	13.17	14.64	10.56	13.97	13.96	32.20	23.98	10.90	15.27	15.65	16.75	20.73	12.24	10.27	20.29	21.71

nd: not detected
tr: trace

Table 25: Percent of Total Fatty acids of Domesticated Goose

Part	Fat	Fat	Raw	Flesh	Leg/Skin	Leg/Skin	Breast/Skin	Breast/Skin
Preparation	Raw	Oven Roasted	Flesh	Oven Roasted	Raw	Oven Roasted	Raw	Oven Roasted
n	2	2	2	2	2	2	2	2
C8:0	tr	tr	0.02 ± 0.02	nd	tr	nd	tr	nd
C10:0	tr	tr	nd	tr	tr	tr	tr	tr
C12:0	0.02 ± 0.004	0.02 ± 0.01	0.04 ± 0.01	0.25 ± 0.32	0.03 ± 0.0003	0.03 ± 0.002	0.03 ± 0.003	0.03 ± 0.01
C14:0	0.43 ± 0.04	0.46 ± 0.02	0.43 ± 0.06	0.46 ± 0.07	0.46 ± 0.02	0.45 ± 0.02	0.50 ± 0.03	0.48 ± 0.06
C16:0	23.43 ± 0.63	23.61 ± 0.84	24.20 ± 2.46	23.84 ± 2.92	22.99 ± 0.05	23.10 ± 0.68	23.80 ± 0.56	23.76 ± 0.42
C18:0	6.18 ± 0.45	5.62 ± 0.39	9.09 ± 0.57	8.20 ± 0.61	5.70 ± 0.12	6.40 ± 0.54	5.80 ± 0.41	6.20 ± 0.49
C20:0	0.03 ± 0.004	0.03 ± 0.01	0.04 ± 0.06	0.05 ± 0.07	0.03 ± 0.02	0.05 ± 0.003	0.04 ± 0.001	0.04 ± 0.01
C22:0	nd	nd	nd	0.02 ± 0.03	nd	nd	nd	nd
C24:0	nd	0.01 ± 0.02	0.24 ± 0.34	0.20 ± 0.29	0.05 ± 0.08	0.06 ± 0.09	0.05 ± 0.07	0.07± 0.10
Total SFA	**30.09**	**29.75**	**34.04**	**33.02**	**29.26**	**30.09**	**30.22**	**30.58**
C12:1	nd	nd	nd	nd	nd	nd	nd	nd
C14:1	0.03 ± 0.01	0.03 ± 0.003	0.06 ± 0.01	0.02 ± 0.03	0.04 ± 0.001	0.04 ± 0.0003	0.05 ± 0.002	0.04 ± 0.01
C16:1	2.92 ± 0.29	3.39 ± 0.16	2.75 ± 0.05	2.98 ± 0.02	3.59 ± 0.08	3.45 ± 0.23	3.61 ± 0.17	3.39 ± 0.55
C18:1	57.17 ± 2.60	56.60 ± 1.01	46.65 ± 3.73	49.27 ± 1.74	56.19 ± 2.50	54.71 ± 2.29	55.11 ± 2.26	54.80 ± 3.88
C20:1 (5)	0.16 ± 0.03	0.15 ± 0.001	0.08 ± 0.12	0.07 ± 0.10	0.17 ± 0.02	0.17 ± 0.03	0.17 ± 0.03	0.16 ± 0.02
C20:1(11)	0.29 ± 0.04	0.30 ± 0.07+	0.30 ± 0.10	0.19 ± 0.27	0.33 ± 0.04	0.34 ± 0.02	0.35 ± 0.02	0.32 ± 0.05
C22:1	nd	nd	nd	0.02 ± 0.02	0.01 ± 0.01	nd	nd	nd
C24:1	nd	nd	nd	nd	nd	nd	nd	nd
Total MUFA	**60.57**	**60.47**	**49.84**	**52.55**	**60.33**	**58.71**	**59.29**	**58.71**
C18:3	0.04 ± 0.002	0.04 ± 0.005	0.03 ± 0.04	0.03 ± 0.05	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.003	0.04 ± 0.01
C20:3	0.02 ± 0.004	0.01 ± 0.02	0.14 ± 0.01	0.09 ± 0.13	0.04 ± 0.01	0.07 ± 0.02	0.05 ± 0.01	0.05 ± 0.01
C20:5	nd	nd	0.07 ± 0.10	0.05 ± 0.08	0.01 ± 0.01	nd	nd	nd
C22:3	nd	0.01 ± 0.02	0.66 ± 0.21	0.32 ± 0.45	0.14 ± 0.06	0.29 ± 0.03	0.16 ± 0.01	0.20 ± 0.09
C22:6	nd	nd	0.30 ± 0.42	0.26 ± 0.37	0.07 ± 0.09	0.08 ± 0.11	0.04 ± 0.05	0.09 ± 0.12
Total ω-3 PUFA	**0.06**	**0.06**	**1.20**	**0.75**	**0.30**	**0.48**	**0.29**	**0.38**
C18:2	8.02 ± 1.69	8.38 ± 1.54	9.84 ± 2.76	9.63 ± 2.34	8.30 ± 1.43	8.36 ± 1.39	8.31 ± 1.42	8.26 ± 2.06
C18:3	1.16 ± 0.38	1.19 ± 0.38	1.02 ± 0.19	0.97 ± 0.35	1.14 ± 0.32	1.12 ± 0.36	1.22 ± 0.37	1.13 ± 0.42
C20:2	0.04 ± 0.01	0.05 ± 0.001	0.10 ± 0.01	0.07 ± 0.10	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	0.06 ± 0.02
C20:3	nd	nd	nd	0.01 ± 0.01	nd	nd	nd	nd
C20:4	0.07 ± 0.001	0.07 ± 0.01	3.94 ± 1.97	2.99 ± 0.98	0.58 ± 0.30	1.16 ± 0.002	0.61 ± 0.02	0.88 ± 0.45
C22:2	nd	0.01 ± 0.02	nd	0.01 ± 0.02	0.01 ± 0.02	nd	0.01 ± 0.01	nd
C22:4	nd	nd	nd	nd	nd	nd	nd	nd
Total ω-6 PUFA	**9.29**	**9.70**	**14.90**	**13.68**	**10.10**	**10.71**	**10.22**	**10.33**

nd: not detected

tr: trace

Table 26: Percent of Total Fatty Acids of Market Fat

Market Fat	Lard	Shortening	Margarine
n	2	2	1
C8:0	0.02 ± 0.0002	0.01 ± 0.001	0.01
C10:0	0.11 ± 0.003	0.01 ± 0.01	nd
C12:0	0.11 ± 0.01	0.07 ± 0.01	0.14
C14:0	0.54 ± 0.05	0.30 ± 0.01	0.13
C16:0	25.52 ± 0.31	14.02 ± 0.14	7.10
C18:0	15.10 ± 0.07	10.42 ± 0.17	6.13
C20:0	0.26 ± 0.01	0.79 ± 0.02	0.65
C22:0	0.03 ± 0.01	0.40 ± 0.01	0.43
C24:0	0.02 ± 0.02	0.21 ± 0.01	0.11
Total SFA	**41.71**	**26.23**	**14.70**
C12:1	nd	nd	nd
C14:1	0.03 ± 0.01	nd	nd
C16:1	2.40 ± 0.01	0.23 ± 0.02	0.15
C18:1	41.08 ± 0.94	65.05 ± 0.29	62.90
C20:1 (5)	0.08 ± 0.01	0.10 ± 0.01	nd
C20:1 (11)	0.87 ± 0.06	1.17 ± 0.07	0.98
C22:1	0.03 ± 0.01	0.18 ± 0.02	0.30
C24:1	nd	0.12 ± 0.04	nd
Total MFA	**44.49**	**66.85**	**64.33**
C18:3	0.07 ± 0.001	0.24 ± 0.02	0.21
C20:3	0.09 ± 0.01	nd	nd
C20:5	nd	nd	nd
C22:3	0.06 ± 0.03	nd	nd
C22:6	nd	nd	nd
Total ω-3 PUF	**0.22**	**0.24**	**0.21**
C18:2	11.31 ± 0.52	6.07 ± 0.28	14.84
C18:3	0.54 ± 0.10	0.61 ± 0.10	5.93
C20:2	0.48 ± 0.03	nd	nd
C20:3	0.09 ± 0.02	nd	nd
C20:4	0.17 ± 0.01	nd	nd
C22:2	0.02 ± 0.02	nd	nd
C22:4	nd	nd	nd
Total ω-6 PUF	**12.61**	**6.68**	**20.77**

nd: not detected

tr: trace

15%, followed by palmitate (C16:0) at 7%. When compared to rendered goose fat, lard shows proportionally larger amounts of SFA, and lower amounts of MUFA and PUFA. As expected, margarine and shortening contained proportionally smaller quantities of SFA and higher quantities of MUFA and PUFA as compared to fat originating from either species of goose.

The order of importance of fatty acids of Canada goose raw fat corroborates with values found in premigrant and postmigrant Canada geese presented by Thomas and George (1975). However, the present data more closely resemble the postmigrant stage reported by Thomas and George (1975) due to more similar values for C18:2 and C18:0. Data for gamma linolenate (C18:3) and stearate (C18:0) were somewhat higher in the present study and values for linoleate (C18:2) somewhat lower.

5.2.7 Relevance of Ethnographic Data For Nutrient Data

The ethnography of Canada goose was essential in the generation of culturally relevant food samples and nutrient composition data. It allowed the determination of the parts of the goose which were regularly consumed and the manner which these parts were prepared (cooking and preservation methods). The documentation of portioning techniques was crucial for the creation of appropriate analytical samples.

5.3 *Heavy Metal Content*

There were no detectable levels of any heavy metals found in domesticated goose or fall Canada goose samples. Therefore, the following results are related only to spring Canada goose samples.

5.3.1 Mercury and Cadmium

Canada goose parts which had samples containing detectable levels of either mercury and/or cadmium are shown in Table 27; parts not included in this table were found to be below the detection limit. None of the samples had levels of mercury or cadmium which surpassed the Agricultural Canada action levels of 2 μg/g and 0.5 μg/g respectively (Salisbury et al., 1991). Nonetheless, liver contained the highest level for both metals. Liver was the only part which had detectable levels of mercury at 0.02 ± 0.004 μg/g for raw liver and 0.02 ± 0.002 μg/g for oven roasted liver. Liver also yielded the highest cadmium content at 0.37 μg/g (raw) and 0.44 μg/g (oven roasted). Other organ meat (heart, gizzard, intestine and lung) contained lesser amounts ranging from <0.001 to 0.04 μg/g of cadmium. Organs, in general, had relatively higher quantities of cadmium as compared to flesh parts ranging from 0.02 μg/g to below the detection limit.

Mercury values for Canada goose by Somer (1993 and 1994) had higher levels than presented here for liver (0.12 and 0.16 mg/kg) and muscle (0.06 mg/kg and 0.094 mg/kg). Samples of Canada goose flesh analyzed by the Canadian Wildlife Service were found to be below the detection limit (Rodrigue, 1995).

The Canadian Wildlife Service found detectable levels of cadmium in 2 of 7 Canada goose flesh samples analyzed providing a mean of 0.035 mg/kg (Rodrigue, 1995). Somer (1994) found cadmium levels to be below detection limits for Canada goose muscle.

The CV for samples with detectable levels of mercury was above 10%, which is not surprising given the extremely low values detected. The CV for samples with detectable levels of cadmium was within 9%.

Table 27: Mercury and Cadmium Content of Edible Portions of Fresh Canada Goose (mean ± SD $\mu g/g$)

Part	Preparation	n	Mercury	Cadmium
Flesh Only	Raw	2	BDL	0.005 ± 0.003
Flesh Only	Oven Roast	2	BDL	0.006 ± 0.003
Collar/Skin	Oven Roast	2	BDL	0.007 ± 0.004
Lung	Oven Roast	2	BDL	0.01 ± 0.01
Flesh Only	Boiled	1	BDL	0.008
Leg/Skin	Boiled	1	BDL	0.02
Heart	Boiled	1	BDL	0.02
Gizzard	Boiled	1	BDL	0.04
Gizzard	Raw	Composite[a]	BDL	0.02
Gizzard	Oven Roast	Composite[a]	BDL	0.02
Gizzard	Boiled	Composite[a]	BDL	0.02
Intestine	Raw	Composite[b]	BDL	<0.001
Intestine	Boiled	Composite[b]	BDL	0.02
Intestine	Fried	Composite[b]	BDL	0.03
Liver	Raw	Composite[a]	0.02 ± 0.004	0.37
Liver	Oven Roast	Composite[a]	0.02 ± 0.002	0.44

BDL: Below Detection Limit

a Composite of 6 samples

b Composite of 5 samples

5.3.2 Lead and Arsenic

Table 28 shows mean values of lead and arsenic for Canada goose samples. Mean lead levels ranged from below the detection limit to 849.25 μg/g in raw liver. The highest level of lead was found in raw liver (849.25 μg/g), followed by raw gizzard (221.85 μg/g) and dried skin/flesh (121 ± 168.75 μg/g). Appendix H shows lead and arsenic values of replicates along with mean values of each individual sample. Of the 79 samples analyzed, 15 or 19% had levels of lead above the action level of 2 μg/g set by the Agri-food Safety division of Agriculture Canada (Salisbury et al., 1991).

Lead levels of Canada goose muscle (n=4) from the James Bay area were below detectable limit in a study by Somer (1994). Canada geese from the St. Laurence region showed detectable levels of lead in 8 of the 11 samples with a mean of 0.08 mg/kg (Rodrigue, 1997). Of 227 waterfowl breast samples 15% contained lead exceeding a level of 0.5 mg/kg set for fish and ranged as high as 759 mg/kg (Scheuhammer and Norris, 1995). Unpublished data by the USFWS showed liver lead values in dead Canada geese with lead pellets in their gizzards ranging from 48 to 109 μg/g of dry weight (in Scheuhammer and Norris, 1995).

Although none of the samples showed levels of arsenic which exceeded Agricultural Canada's action level of 2 μg/g, there was a general trend for samples which contained high levels of lead to also contain detectable levels of arsenic. This phenomenon seemed to be proportionally related as the highest levels of arsenic were found in samples containing the highest levels of lead (Figure 9). This relationship (r=0.92) was found to be statistically significant, although the strength of the correlation may lie in the few very high values and many samples which approached zero. All samples containing over 50 μg/g of lead contained detectable levels of arsenic and all samples containing less than 20 μg/g had no detectable levels of arsenic. When looking at replicate samples individually (see Appendix H) raw liver exceeded the action level for arsenic set by Agricultural Canada.

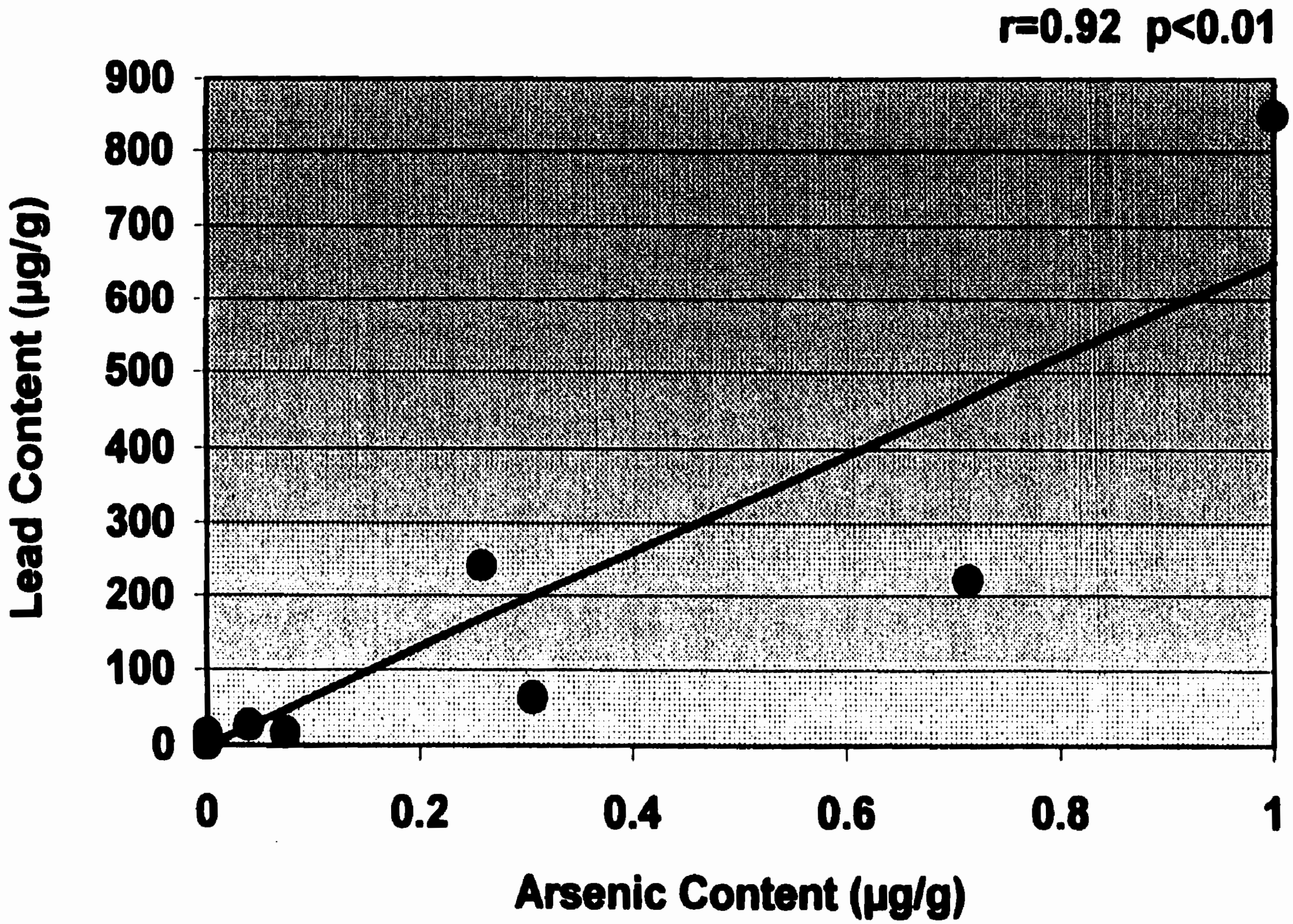
Somer (1994) found no detectable levels of arsenic in two Canada goose

Table 28: Lead and Arsenic Content of Edible Portions of Fresh Canada Goose (mean ± SD μg/g)

Part	Preparation	n	Lead	Arsenic
Flesh Only	Raw	6	10.66 ± 26.00	0.08 ± 0.11
Leg/Skin	Raw	6	3.10 ± 6.25	BDL
Breast/Skin	Raw	6	1.48 ± 2.63	BDL
Flesh Only	Oven Roast	6	0.09 ± 0.06	BDL
Leg/Skin	Oven Roast	6	0.06 ± 0.01	BDL
Breast/Skin	Oven Roast	6	1.92 ± 4.58	BDL
Collar/Skin	Oven Roast	5	5.56 ± 12.31	0.036 ± 0.002
Lung	Oven Roast	6	1.84 ± 2.78	BDL
Skin Only	Oven Roast	6	0.18 ± 0.20	BDL
Skin Only	Raw	Composite	0.47	BDL
Leg/Skin	Fire Roast	1	BDL	BDL
Breast/Skin	Fire Roast	1	0.15	BDL
Collar/Skin	Fire Roast	1	5.63	BDL
Flesh Only	Boiled	2	BDL[a]	BDL
Leg/Skin	Boiled	2	BDL	BDL
Breast/Skin	Boiled	2	BDL	BDL
Skin/Flesh	Dried	2	9.18 ± 11.75	0.05 ± 0.03
Skin/Flesh	Dried/Boiled	2	121 ± 168.75	0.15 ± 0.16
Liver	Raw	Composite	849.25	1.00
Liver	Oven Roast	Composite	BDL	BDL
Gizzard	Raw	Composite	221.85	0.71
Gizzard	Oven Roast	Composite	0.19	BDL
Gizzard	Boiled	Composite	BDL	BDL
Gizzard	Boiled	1	BDL	BDL
Heart	Raw	Composite	BDL	BDL
Heart	Oven Roast	Composite	BDL	BDL
Heart	Boiled	1	BDL	BDL
Intestine	Raw	Composite	BDL	BDL
Intestine	Boiled	Composite	BDL	BDL
Intestine	Fried	Composite	BDL	BDL

a. BDL = Below Detection Limit

Figure 9: Lead and Arsenic Content of Canada Goose Samples (n=79)



muscle samples from the James Bay region. Other samples from the St. Laurence and Kativik regions had detectable amounts of arsenic (0.002 and 0.0058 mg/kg respectively) (Rodrigue, 1997).

Analysis showed both lead and arsenic to be distributed heterogeneously within the sample tissue resulting in standard deviations which were quite high. The CV for replicates were often quite disparate; samples containing detectable levels of lead and arsenic ranged from 1.3% to 139% for lead and from 16% to 122% for arsenic.

6. DISCUSSION

6.1 Sociocultural Importance of Canada Goose

Canada goose is a highly important traditional food resource for the Eastern James Bay Cree of Wemindji. This was illustrated during collection of laboratory samples, particularly during the fall research period when people were very reluctant to forfeit harvested geese for research purposes; the poor fall goose hunting season rendered it essential to consume geese which people had been able to procure. One woman indicated that she would not give up any geese, even if offered $100 each.

The cultural significance of Canada goose was demonstrated by community-wide participation in harvesting activities. Goose harvesting season confers a cultural experience not attainable to all within daily life in the community of Wemindji. For children, who spend their days at school, goose break allows essential knowledge about living on the land to be acquired in an environment (the goose camp) which fosters active participation. Pride in successful hunting, as well as skillful preparation of Canada goose, promotes a healthy view of what it means to be Cree. Sharing of Canada goose (as well as other traditional food) may facilitate community participation in a mixed economy of subsistence harvesting and wage employment. Food exchange within the extended family is fundamental to bush food access for those unable to hunt. Exchange systems outside the family allow distribution of geese to flow through the community. Food sharing may also help to enhance and maintain social bonds. The ceremonial importance of consuming Canada goose during specific occasions, such as birthdays, walking out ceremonies, weddings and calender holidays demonstrates the enormous value of this resource to Cree culture.

6.2 Nutritional Significance

Canada goose contributes nutritional benefits to consumers by providing high quality protein, as well as essential minerals. The Canadian RNI for a 100g of oven roasted Canada goose flesh for adult men and women is shown in Figure 10. As shown, this serving contributes substantially to daily requirements of protein, iron and zinc. Although RNI's for copper have not been set, the recommendation of approximately 2 mg/day for adults (HWC, 1990) would classify this serving as an excellent source of copper, as it provides 32% of this recommended value.

Canadian RNIs for 100 g of Canada goose for various age/gender categories are illustrated in Table 29. According to standards of Consumer and Corporate Affairs Canada (1991), Canada goose can be classified as an excellent source of protein, with one serving providing at least 25% of the daily recommended intake. 100g of Canada goose is shown to provide between 31 and 72% of the Canadian RNI for protein depending on the part and age/gender of the consumer.

Canada goose is also an excellent source of iron with 100g of flesh or gizzard providing between 25 and 126% of the daily RNI. Heart provides between 94 and 270% RNI depending on part and consumer age and gender. Lung and liver are extremely high in iron with 100 g providing from 204% (for females in the third trimester of pregnancy) to 615% of the RNI for females over 50 years of age.

Figure 11 shows the iron content of oven roasted Canada goose parts. Error bars represent standard deviations; Canada goose parts lacking error bars include composited samples. With the exception of gizzard, the iron content of organ meats was found to be higher as compared to flesh parts. Lung and liver, in particular, had very large amounts of iron, providing close to 50 mg/100g. As such, they may be suitable food supplements for iron deficiency anemia and during pregnancy when extra iron is needed. Unpublished preliminary data by Willows, Morel and Gray-Donald (1997) indicate that the prevalence of anemia (defined by a hemoglobin level of < 110 g/L) in Cree infants is 31% as compared to 8% in Urban Canadian infants. Lung, in particular, may be an ideal dietary source of iron for children, given its soft texture and extremely low heavy metal content.

As compared to domesticated goose, overall contribution of iron would be greater in Canada goose; for example, the iron content of the edible portion of two

Figure 10: Percent Canadian Recommended Nutrient Intake of 100g of Oven Roasted Canada Goose Flesh

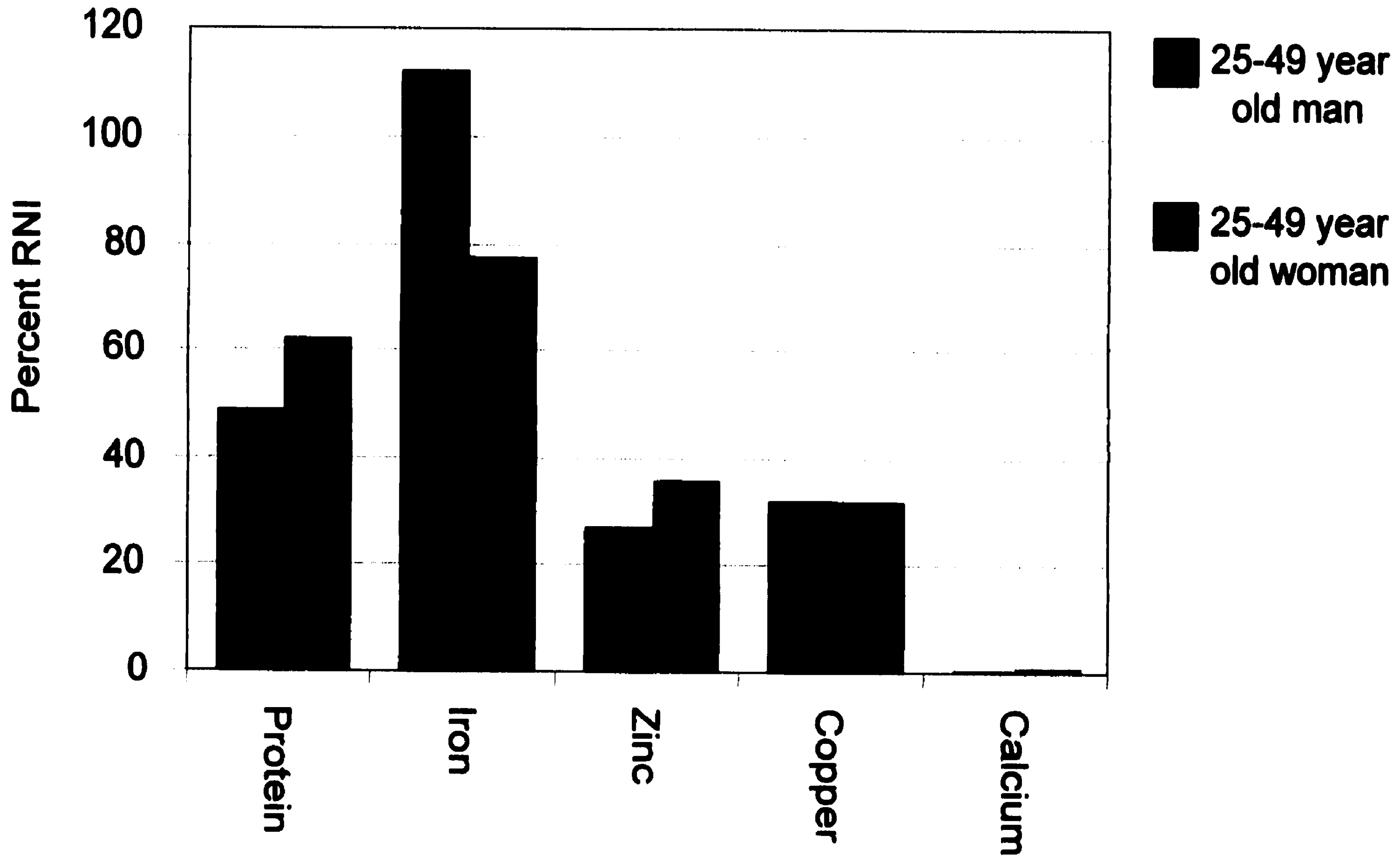
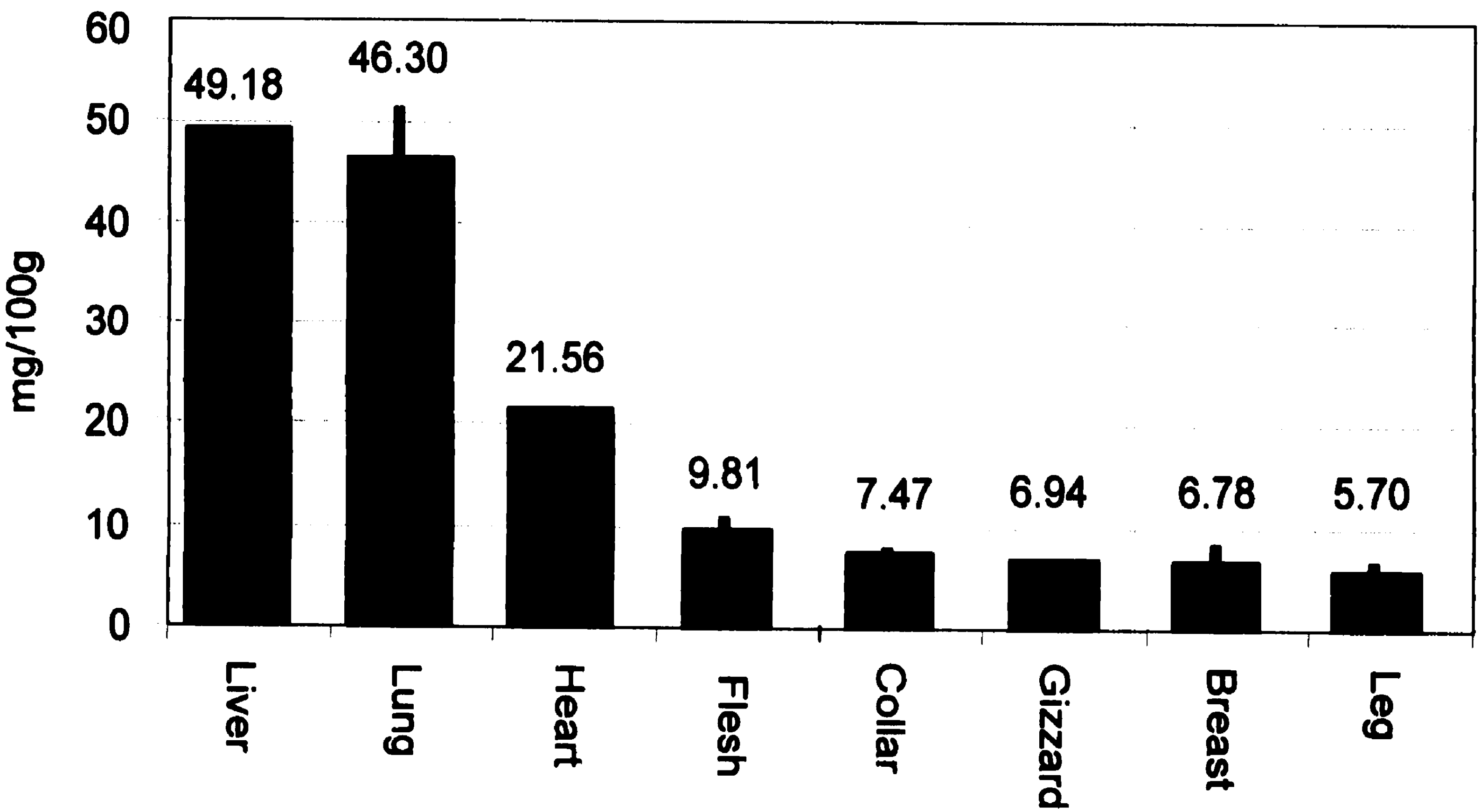


Table 29: Percent of Recommended Nutrient Intakes (RNI) for 100g Portions of Canada Goose

		Oven Roasted Flesh				Oven Roasted Leg/Skin				Fire Roasted Collar/Skin				Boiled Breast/Skin				Boiled Dried Skin/Flesh			
		Protein	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*
13-15	**Male**	31	101	27	1	52	59	35	1	69	82	33	3	60	90	27	1	70	95	26	1
	Female	64	78	36	1	55	45	46	1	74	63	44	3	63	69	36	1	74	73	35	1
16-18	**Male**	68	101	27	1	44	59	35	1	69	82	33	3	50	90	27	1	59	95	26	1
	Female	54	84	36	1	54	49	46	1	72	68	44	4	62	75	36	1	73	79	35	2
19-24	**Male**	66	112	27	1	42	65	35	1	56	91	33	3	48	100	27	1	58	106	26	1
	Female	61	78	36	1	51	45	46	1	68	63	44	4	58	69	38	1	68	73	35	2
25-49	**Male**	62	112	27	1	40	65	35	1	53	91	33	3	46	100	27	1	63	106	26	1
	Female	49	78	36	1	50	45	46	1	67	63	44	4	57	69	38	1	67	73	35	2
50-74	**Male**	61	112	27	1	40	65	35	1	54	91	33	3	46	100	27	1	64	106	26	1
	Female	49	126	36	1	47	73	46	1	63	103	44	3	54	112	38	1	63	119	35	1
75+	**Male**	58	112	27	1	43	65	35	1	58	91	33	3	49	100	27	1	58	106	26	1
	Female	53	126	36	1	46	73	46	1	62	103	44	3	53	112	38	1	62	119	35	1
3rd trimester		57	44	22	0	34	25	28	1	45	36	26	2	39	39	22	0	46	41	21	1

		Oven Roasted Liver				Oven Roasted Gizzard				Oven Roasted Heart				Boiled Intestine				Oven Roasted Lung			
		Protein	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*
13-15	**Male**	60	492	51	1	55	69	36	1	52	216	28	1	67	142	54	1	45	470	11	1
	Female	53	378	68	1	58	53	48	1	56	166	37	1	71	109	71	2	48	361	16	1
16-18	**Male**	42	492	51	1	46	69	36	1	44	216	28	1	56	142	54	2	38	470	11	1
	Female	52	410	68	1	57	58	48	1	54	180	37	1	70	118	71	2	47	392	16	1
19-24	**Male**	40	546	51	1	44	77	36	1	42	240	28	1	54	157	54	2	36	522	11	1
	Female	49	378	68	1	54	53	48	1	51	166	37	1	66	109	71	2	44	361	16	1
25-49	**Male**	38	546	51	1	42	77	36	1	40	240	28	1	51	157	54	2	35	522	11	1
	Female	48	378	68	1	53	53	48	1	50	166	37	1	64	109	71	2	43	361	16	1
50-74	**Male**	39	546	51	1	43	77	36	1	40	240	28	1	52	157	54	2	35	522	11	1
	Female	45	616	68	1	50	87	48	1	47	270	37	1	61	177	71	2	41	587	16	1
75+	**Male**	41	546	51	1	46	77	36	1	43	240	28	1	56	157	54	2	38	522	11	1
	Female	44	616	68	1	49	87	48	1	46	270	37	1	60	177	71	2	40	587	16	1
3rd trimester		33	214	41	1	36	30	29	1	34	94	22	0	44	62	43	1	30	204	9	1

Figure 11: Iron Content of Oven Roast Canada Goose Parts



200 g legs and two 175 g breast portions would provide 12.88 mg of iron from domesticated goose and 40.13 mg of iron from Canada goose. The higher iron content of Canada goose as compared to domesticated goose may be a function of their greater use of muscles. The fact this was more distinct in breast/skin and flesh only may be due to greater use of breast muscles by migrating Canada geese.

In general, Canada goose is an excellent source of zinc with 100 g providing between 21 and 71% of the RNI, again depending on the part and the age/gender of the consumer. Lung, can be classified as a good source of zinc, with 100 g providing 11% of the daily RNI for men and 15% of the RNI for females.

Canada goose, as analysed here, cannot be considered as a source of calcium, since it provides less than 5% of daily RNI. However, traditions such as the sucking of bones or boiling of bones to prepare soup may provide sources of calcium which are not calculable from the nutrient data composition provided here.

Since portion sizes of organs are generally smaller as compared to flesh parts, Table 30 provides values for the percent RNI for 50 g servings. Lung remains an excellent source of iron, a good source of protein and a source of zinc. Liver and intestine remain excellent sources of protein, iron and zinc. Gizzard and heart are excellent sources of iron, excellent or good sources of protein and good sources of zinc.

As previously mentioned, RNIs for copper have not been set. Nonetheless, Canada goose can be considered an excellent source of copper, as 100 g of oven roasted flesh provides 32% of this recommended amount. A 100g of oven roasted liver would provide over 100% of this recommendation. Leg/skin can be classified as a source of copper providing between 11% and 14% of the recommendation depending on preparation mode (oven roasted, fire roasted or boiled). Canada goose breast/skin and collar/skin can be considered a good or an excellent source of copper, providing between 17% and 25% of the daily recommendation.

Some parts of Canada goose are relatively high in fat, and cultural traditions such as consuming skin and serving with fat drippings make Canada goose a source

Table 30: Percent of Recommended Nutrient Intakes (RNI) for 50g Portions of Canada Goose Organs

		Oven Roasted Lung				Oven Roasted Liver				Oven Roasted Gizzard				Oven Roasted Heart				Boiled Intestine			
		Protein	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*	*Protein*	*Iron*	*Zinc*	*Calcium*
13-15	**Male**	23	235	5	0.4	25	246	26	0.3	27	35	18	0.3	26	108	14	0.3	33	71	27	0.7
	Female	24	181	7	0.4	27	189	34	0.4	29	27	24	0.3	28	83	18	0.3	36	54	36	0.8
16-18	**Male**	19	235	5	0.5	21	246	26	0.4	23	35	18	0.4	22	108	14	0.3	28	71	27	0.8
	Female	24	196	7	0.6	28	205	34	0.5	29	29	24	0.5	27	90	18	0.4	35	59	36	1.1
19-24	**Male**	18	261	5	0.6	20	273	26	0.5	22	39	18	0.4	21	120	14	0.4	27	79	27	0.9
	Female	22	181	7	0.6	24	189	34	0.5	27	27	24	0.5	25	83	18	0.4	33	54	36	1.1
25-49	**Male**	17	261	5	0.6	19	273	26	0.5	21	39	18	0.4	20	120	14	0.4	26	79	27	0.9
	Female	22	181	7	0.6	24	189	34	0.5	26	27	24	0.5	25	83	18	0.4	32	54	36	1.1
50-74	**Male**	18	261	5	0.6	19	273	26	0.5	21	39	18	0.4	20	120	14	0.4	26	79	27	0.9
	Female	21	294	7	0.6	23	307	34	0.5	25	43	24	0.4	23	135	18	0.4	30	88	36	0.9
75+	**Male**	19	261	5	0.6	21	273	26	0.5	23	39	18	0.4	21	120	14	0.4	28	79	27	0.9
	Female	20	294	7	0.6	22	307	34	0.5	24	43	24	0.4	23	135	18	0.4	30	88	36	0.9
3rd trimester		15	102	4	0.4	16	107	20	0.3	18	15	14	0.3	17	47	11	0.2	22	31	21	0.6

of fat and corresponding energy. The link between positive taste attributes and fat content remain valid among the Cree. The Cree attribute the superior taste of female and spring Canada geese to their higher fat content. For Cree community members who are overweight, this taste preference may be of concern. Flesh alone and organ meat such as heart, liver, gizzard and lung have lesser amounts of fat with comparable or higher amounts of protein, iron and zinc. The fatty acid profile of Canada goose may, however, possess advantages over market fat, in particular the most popular fat used by the Cree, lard. As seen in Figure 12, the level of SFAs are significantly lower and the levels of MUFA are significantly greater in rendered Canada goose fat as compared to lard; the level of PUFAs is also greater in Canada goose fat, although this was not found to be statistically significant. Shortening and margarine are known to contain quantities of TFA ranging from 5 to over 30% of the total fatty acids (Enig et al., 1983). The TFA content of Canada goose fat is presumably low; this will be determined in Dr. Kubow's laboratory of the School of Dietetics and Nutrition of McGill University. Canada goose fat may also possess other nutritional benefits, such as fat-soluble vitamins. The cultural importance of continued use of traditional fats must also be considered.

From 24 hour recalls administered to Cree women in summer, Delormier (1995) documented that Cree women consumed 70 grams of Canada goose flesh per day. Based on nutrient values of Canada goose fire roasted breast/skin, on a daily basis this would provide 457 kjoules (156 Kcalories) of energy, 7.06 g of fat, 21.68 g of protein, 5.47 mg of iron, 2.03 mg of zinc, 4.57 mg of calcium and 0.32 mg of copper. Figure 13 shows the % RNI provided by 70g serving of Canada goose fire roasted breast/skin for women, aged 25 to 49. As shown, it would provide 43% of the daily RNI for protein, 42% for iron, 23% for zinc, 16% for copper (not true RNI), and 1% for calcium. Based on an RNI 1900 kcal, it would provide 8% of daily energy and 11% of daily energy allowance from fat (30% of total energy). During spring and fall goose harvesting seasons it is reasonable to assume larger contributions to daily RNIs from Canada goose.

Figure 12: Fatty Acid Profile of Canada Goose Fat and Lard

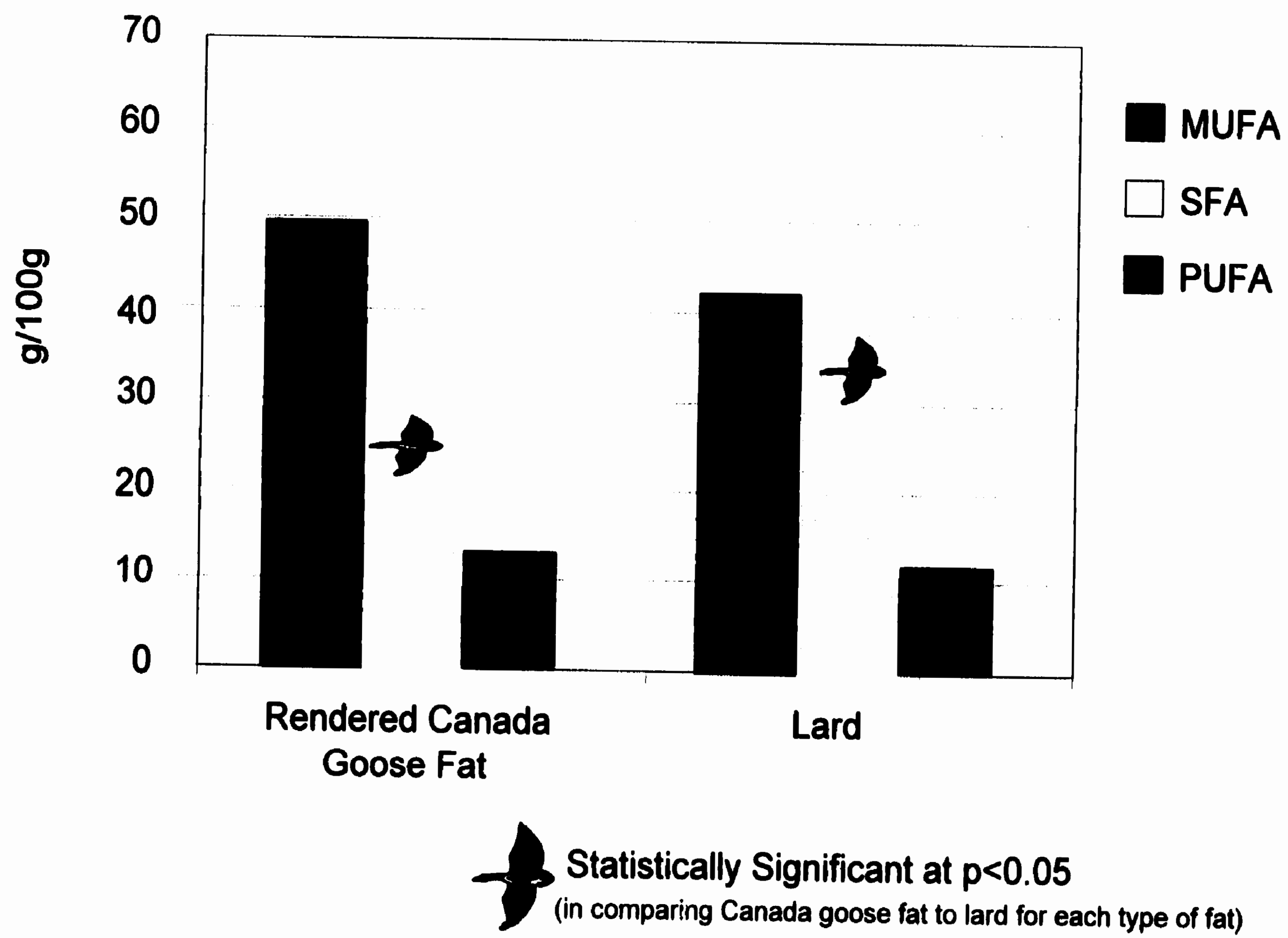
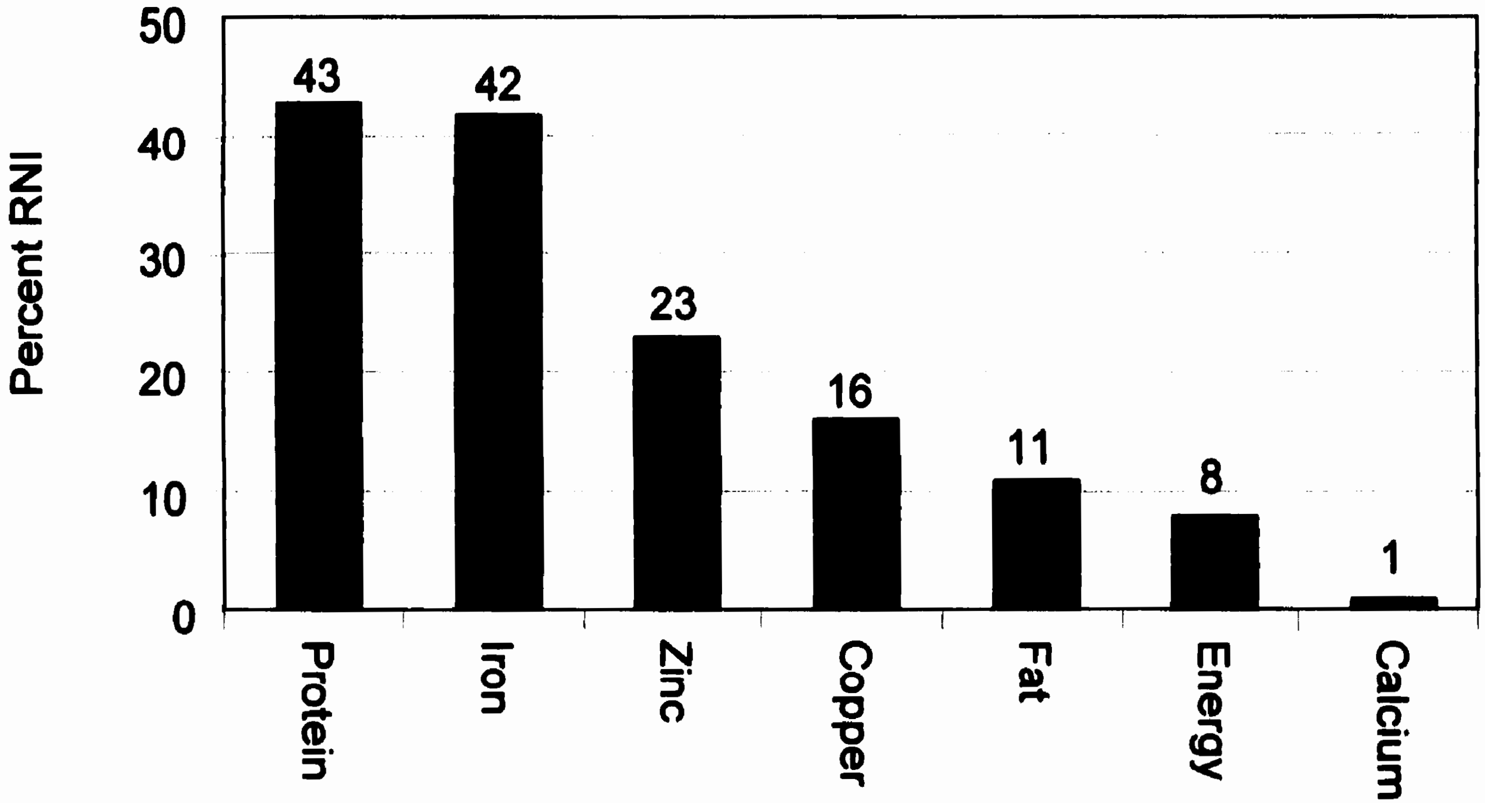


Figure 13: Percent RNI for 25 - 49 year old Woman for 70 g of Fire Roasted Canada goose Breast/skin



The contribution of nutrients may vary according to gender and age of community members due to cultural consumption patterns. In the past this may have been more strongly adhered to, and some traditions may have been ecologically adaptive. For example, men are traditionally served legs; from nutrient data, this part is shown to be higher in fat (and corresponding energy) which may have been advantageous to men who were taking long and arduous daily hunting trips. The contribution to the daily RNI of adult men from an average fire roasted Canada goose leg of 174 g is shown in Figure 14. This serving would contribute a substantial amount of the daily RNI for protein (78%), iron (75%) and zinc (79%). In addition, approximately one fourth of the daily copper recommendation would be met.

Traditional cooking methods of fire roasting and boiling provide nutrient values lower in fat and energy as compared to analogous parts of oven roasted Canada goose. However, fire roasted parts may be served with fat drippings increasing the fat content of the meal. Fire roasted and boiled parts show corresponding higher levels of protein and minerals as compared to analogous oven roasted Canada goose.

Canada goose may be considered nutritionally superior as compared to market food commonly consumed by the Cree. Comparison of nutrient values of fire roasted Canada goose leg to a hot dog and a battered fried chicken leg are shown in Figures 15 and 16. As shown, Canada goose fire roasted leg has higher amounts of protein, and lower or similar quantities of fat (Figure 15) and higher amounts of iron, zinc and copper (Figure 16) as compared to these popular market items.

For the number of animals used in this study there were no statistical differences found in the nutrient composition between male and female Canada goose and between the species, Canada goose and domesticated goose. For the effect of season, only the difference in calcium content of oven roasted breast/skin was found to be statistically significant. However, traditional food composition data cannot practically adhere to ideal sample size. As calculated from the present

Figure 14: Percent RNI for 174g Fire Roasted Canada Goose Leg/skin

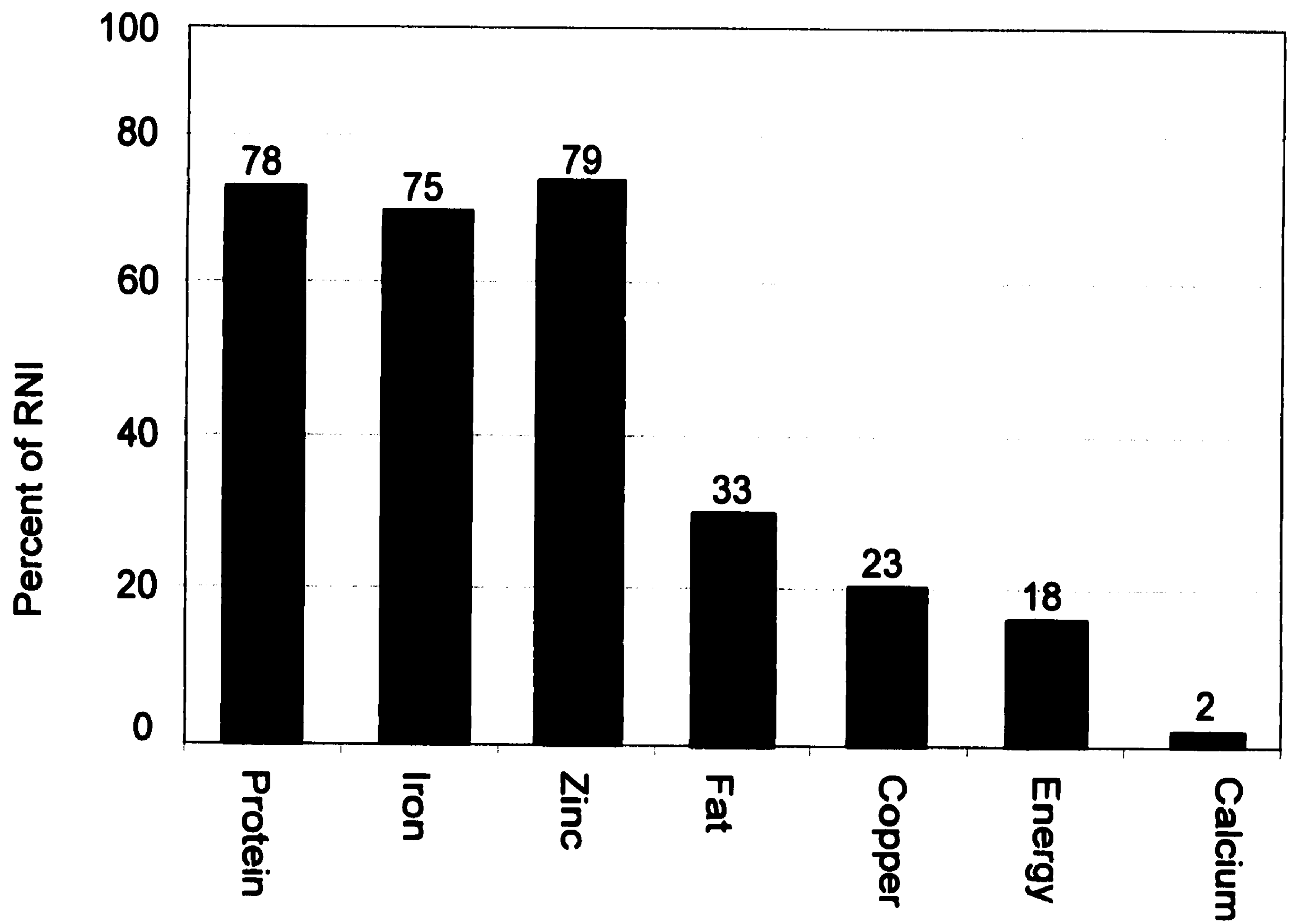
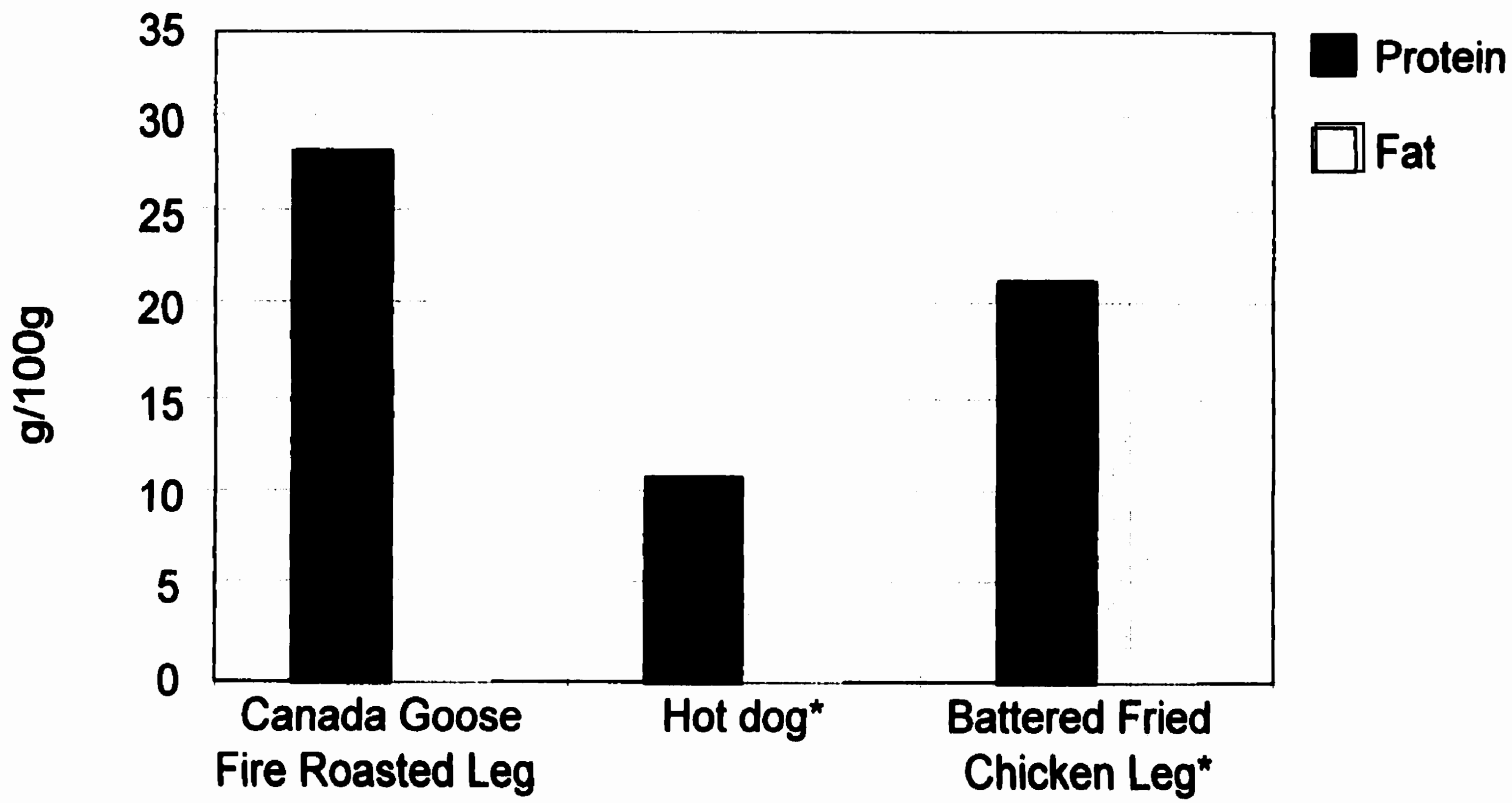
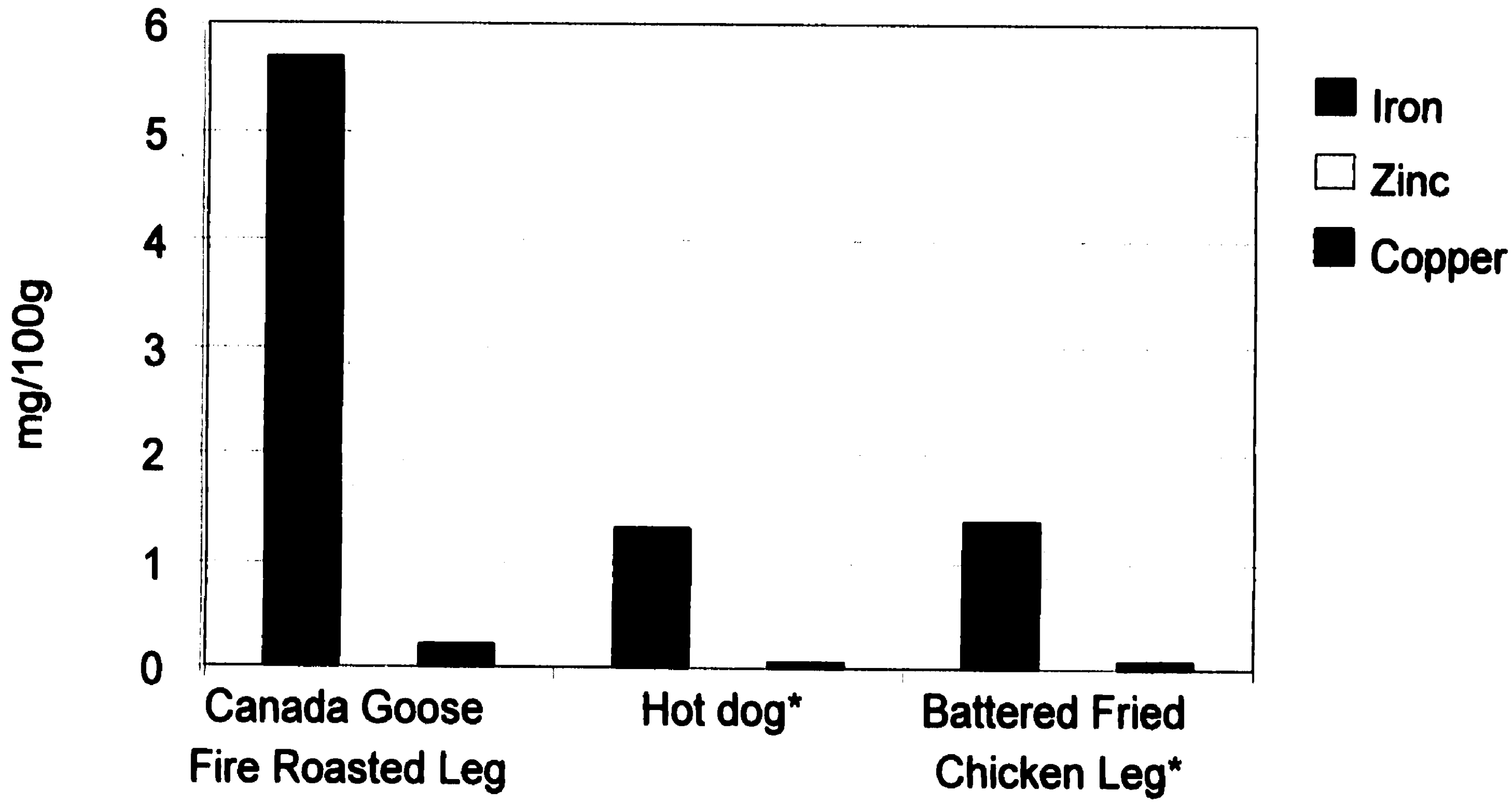


Figure 15: Comparison of Protein and Fat Content of Canada Goose to Commonly Consumed Market Food



*Brault Dubuc & Caron Lahaie, 1987

Figure 16: Comparison of Trace Elements of Canada Goose to Commonly Consumed Market Food



*Brault Dubuc & Caron Lahaie, 1987

nutrient data, in order to have detected a difference, for example, in fat content in oven roasted flesh only between fall and spring Canada geese, a sample size of 10 geese collected for each season would have been required. In order to have detected a difference in iron content of leg/skin between Canada and domesticated goose, a sample size of 5 for each species would have been required.

6.3 Heavy Metal Content

In contrast to analyzed fish samples from the James Bay region (Belinsky et al.1996), Canada goose, in general, had levels of mercury which were below detection limits; Canada goose liver had very low levels of mercury, which are not of concern to human health. Cadmium and arsenic content of Canada goose are also below levels of concern for human health. However, arsenic levels were found to increase in samples of goose containing high levels of lead.

The danger of lead poisoning in waterfowl has been well documented and an estimated 240,000 to 360,000 birds in Canada die annually from the consumption of lead shot (Scheuhammer and Norris, 1995). Szymczak and Adrian (1978) and Hochbaum (1993) have reported high mortality rates from lead poisoning for Canada geese (in Scheuhammer and Norris, 1995). This has prompted regulations (1997) against the use of lead shot in Canada for harvesting of migratory birds. Nonetheless, the risk to human health from occasional consumption of lead shot birds is assumed to be minimal (NWHC, 1997); however, for the Cree the risk may be increased due to high consumption of waterfowl.

High lead values in samples reported here were most likely a result of both minute particles of lead pellet remaining in the food samples, and bioaccumulation from the ingestion of lead pellets by birds. During portioning, both shattered pieces and whole lead pellets were found. Since bioaccumulation may also contribute to high lead values, replacement of steel shot for lead shot may not fully eliminate the problem, particularly in liver and bones. Lead levels in food items such as goose soup are largely unknown.

To estimate risk associated with consumption of Canada goose according to WHO (1993) lead consumption guidelines of 25 μg/ kg of body weight /week, an average calculated value of 18.78 μg lead for all analyzed samples would provide a hypothetical woman consuming 70g of Canada goose (Delormier, 1995) with 1314.6 μg of lead per week or 23.9 μg of lead/ kg of body weight/ week; this value approached the limit for tolerable level of lead ingestion. Since the value of 70 g of Canada goose was obtained from summer 24 hour recalls, amount of lead ingested during goose harvesting season may be increased and perhaps exceed WHO guidelines. Nonetheless, for a thorough evaluation of risk, further analyses of food samples and seasonal dietary information is recommended, particularly for children who are assumed to be at greatest risk for lead toxicity.

Given the importance of Canada goose to the Cree diet, further monitoring of this element in geese may be warranted. The use of non-toxic shot as a replacement for lead shot should be encouraged for hunting to reduce exposure to lead. Since lead poisoned birds have visible signs such as green staining of the cloaca and feces by bile, perhaps education to women, involved in the preparation of Canada goose, may allow avoidance of high risk items such as liver. Future risk/benefit assessment related to lead toxicity should consider social, cultural and nutritional benefits of continued use of Canada goose among the Cree. Negative impacts on the social, cultural and nutritional well-being of native peoples resulting from discontinued use of traditional food has been recognized (Dumont and Kosatsky, 1990) and should not be underestimated.

SUMMARY AND CONCLUSION

Harvesting, preparation, cooking and consumption patterns were shown to follow Cree customs and provide opportunity for values and traditions to be passed to the next generation. Sharing of Canada goose is extensive and functions to maintain family and social ties. Preference for spring Canada goose over fall Canada goose was documented and parts such as intestine, liver and goose fat were found more likely consumed in spring.

Canada goose is a highly nutritious source of fresh meat which can be preserved for use throughout the year. It is an excellent source of protein, iron, zinc and copper, and particular parts such as liver and lung may provide amounts of iron which could be used as food supplements of iron in cases of iron deficiency anemia and life cycle stages when higher nutrient requirements of iron are warranted. Canada goose is a source of fat and corresponding energy which may be of concern for some Cree with weight problems. This consideration may be one factor decreasing the number of women preparing the traditional goose fat. The continued use of goose fat may be beneficial since it has lower amounts of SFA and higher amounts of MUFA and PUFA as compared to lard. In addition, selected market food may be higher in total fat and lack other nutritional benefits of Canada goose. Traditional methods of cooking (boiling and fire roasting) generate portions with lower amounts of fat as compared to oven roasting. Organ meats had relatively low levels of fat as compared to flesh portions with skin and, in general, had comparable or high levels of protein, iron, zinc and copper.

Canada goose is generally low in heavy metal content, although high levels of lead found in some samples may warrant further monitoring of this metal.

No statistical differences were found in proximate composition or trace elements between spring and fall Canada geese, between male and female geese or between Canada goose and domesticated goose, with the exception of a statistically significant difference between calcium content of oven roasted breast of spring Canada goose as compared to fall Canada goose. However, Canada goose was found to provide higher levels of iron and copper as compared to domesticated goose, and this was most pronounced in breast portions.

Canada goose is an important seasonally abundant cultural food among the Eastern James Bay Cree. Cultural, social, personal and environmental factors influence the selection of Canada goose as a food resource by the Cree. This resource is familiar to all Cree, is considered a healthy food and is associated with favorable taste. Canada goose is a highly prestigious food item, in the sense that it is reserved for special occasions. Continued use of Canada goose as a food resource among the Cree benefits social and cultural integrity and contributes important nutrients to the diet.

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APPENDICES

McGill

Appendix A

Faculty of Agricultural and Environmental Sciences

Faculté des sciences de l'agriculture et de l'environnement

McGill University
Macdonald Campus

Université McGill
Campus Macdonald

School of Dietetics and Human Nutrition

École de diététique et nutrition humaine

21,111, Lakeshore
Ste-Anne-de-Bellevue
Quebec, Canada H9X 3V9

Tel.: (514) 398-7842
Fax: (514) 398-7739

CERTIFICATION OF ETHICAL ACCEPTABILITY FOR RESEARCH INVOLVING HUMAN SUBJECTS

A review committee consisting of:

Position	Field of Research
L. Prichard	Lay Member
D. Buszard	Plant Science
C. Chadee	Parasitology
K. Gray-Donald	Human Nutrition

has examined the application for funds in support of a project entitled:

Nutritional and socio-cultural significance of *Branta canadensis* (Canada Goose) for the Eastern Bay Cree.

As proposed by H.V. Kuhnlein, D. Belinsky (Applicant) to DINA - NSTG (Granting agency, if any)

and consider the experimental procedures, as outlined by the applicant, to be acceptable on ethical grounds for research involving human subjects.

Comments:

June 12. 1995
Date

K. Marie Gray-Donald
Chairperson of Ethics Committee

[signature]
Dean's Representative

b:\ethics_f6

Appendix B

COUNCIL RESOLUTION

Chronological No. - Numero consécutif
95 - 016

Subject - Sujet

RESEARCH AGREEMENT WITH THE CENTRE FOR NUTRITION AND THE ENVIRONMENT OF INDIGENOUS PEOPLES

CREE NATION OF WEMINDJI

16 Beaver Road, P.O. Box 60
WEMINDJI
James Bay, Quebec J0M 1L0

PROPOSED BY:

Chief Walter Hughboy

SECONDED BY:

Dennis Georgekish

ACTION:

Carried

Certified copy of a Resolution adopted on February 21, 1995.

Helen Hawkins,
Corporate Secretary

WHEREAS the draft of a Research Agreement with the Centre for Nutrition and the Environment of Indigenous Peoples was submitted for approval; and

WHEREAS the main objective of the Research Project will be to determine the nutrient composition of Canada Geese, which constitutes an important part of the traditional food system of the Eastern James Bay Crees.

RESOLVED:

THAT Deputy Chief Billy Atsynia be and he is hereby authorized to sign the Research Agreement, for and on behalf of the Cree Nation of Wemindji, in order to allow the researchers, Dr. Harriet V. Kuhnlein, Ph.D. and Devorah Belinsky, to complete their study; and

THAT the Treasurer be and he is hereby instructed to provide the above-mentioned Centre with the compensation rates for the Community member(s) employed as interviewer(s) and translator(s).

Environnement Canada - Environment Canada

Service canadien de la faune   Canadian Wildlife Service

P.O. Box 10100, Ste-Foy, Quebec G1V 4H5

Appendix C

Scientific purposes	Quebec
nature du permis — type of permit	dans la(les) province(s) — in the province(s)
no du permis, coût, nom, adresse — permit no., fee, name, address	24
SC-1457 96 a 001 06 -	délivré en vertu de l'article — issued under section
Belinsky, Devorah	Migratory Birds Convention Act / Regulation
McGill University 21,111 Lakeshore Ste-Anne-de-Bellevue, Qc H9X 3V9	de — of 1995-05-09
	date d'émission — date of issue 1996-06-09
	date d'expiration — date of expiry
signature du détenteur — signature of holder	pour le ministre — for the minister (418) 648-7225

conditions spéciales — special conditions

1- This permit authorizes you to the species listed below.
2- The holder must have the permit in his possession when working in the field, and present it to any game officer (CWS, RCMP, MLCP) who so requests.
3- Provide a report within 30 days of the day this permit expires, showing the number and species of birds taken, banded or killed.

-To possess, collect 20 Canada Geese or their parts for scientific project.

VOTRE REGISTRE OFFICIEL — YOUR OFFICIAL RECORD

Instructions

Énumérez, au fur et à mesure, toutes les activités se rattachant à votre genre de permis en indiquant les renseignements suivants au verso:

1. DATE — quelle est la date de l'activité?
2. ACTIVITÉ — énumérer toutes vos activités en utilisant une ligne pour chacune d'elles (tuer, acheter, vendre, naturaliser, etc.).
3. ESPÈCE/PRODUIT — préciser l'espèce d'oiseau ou la nature du produit (Bernache du Canada, Canard Malard, Grande Oie blanche, etc./partie d'oiseau, carcasse, oeuf, nid, édredon, etc.).
4. QUANTITÉ — indiquer le nombre d'oiseaux ou la quantité de produit.
5. NOM, ADRESSE DU CLIENT — écrire le nom, l'adresse et le numéro de permis (s'il y a lieu) de la personne avec qui vous avez fait affaire. Détenteurs de permis d'aéroport et de permis scientifique, utiliser cet espace pour indiquer de quelle façon vous vous êtes défait des oiseaux ou du matériel.

Please list, as they occur, all activities relating to your type of permit by providing the following information on the reverse side:

1. DATE — on which date was the activity held?
2. ACTIVITY — list all activities held, using a separate line for each one (kill, buy, sell, mount, etc.).
3. SPECIES/PRODUCT — specify the bird species or nature of product (Canada Goose, Mallard Duck, Greater Snow Goose, etc./part of bird, skin, egg, nest eiderdown, etc.).
4. QUANTITY — Indicate the number of birds or quantity of product.
5. CLIENT'S NAME, ADDRESS/DISPOSITION OF MATERIAL — write the name, address and permit number (if applicable) of the person with whom you had dealings. Airport and scientific permit holders, use this space to indicate the disposition of birds or material.

Eastern James Bay Cree Canada Goose Sampling Data Sheet

Date:____________________
day-month-year

Harvest Location:______________________
Harvest Date:_____________

Person Harvesting:_____________________
Person Packaging:_______________

Weight Of Whole Goose:__________________

General Health/Condition of goose:__________________________
Approximate age:____________________________
Sex:__________________________

Sample Collected (whole or part):___________________________

Preparation Style (raw, roasted):____________________________

Sample notes (especially any occurence of thaw-refreeze):
____
____
____

Time Placed in freezer (Date and time):_________________________
Time from killing to freezing of sample:__________________________

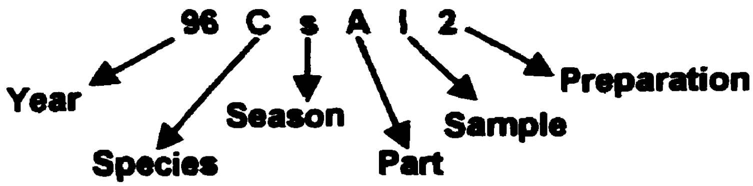
Transportation Notes:
Date of departure:____________ Time:___________
Date of arrival:______________ Time:___________
Condition on arrival:___________________________________

Label on packaged frozen sample must include:

Canada Goose #	Harvest Season, date
Portion sample	Person packaging sample
Preparation (ie.raw, cooked)	Date

Cree Goose Project
Belinsky 1996

Guidelines for Coding Analytical Samples



Species	Season	Part	Preparation	Sample No.
C - Canada goose	s - spring	A - Flesh Only	I - Raw	1
D - Domesticated goose	f - fall	B - Leg/Skin	II - Fire Roasted	2
	u -unknown	C - Breast/Skin	III - Oven Roasted	3
		D - Fat	IV - Dried	4, etc.
		E - Collar/Skin	V - Fried	c - composit
		F - Liver	VI - Boiled	
		G - Gizzard		
		H - Heart		
		I - Intestine		
		J - Skin Only		
		K - Skin/Flesh		
		L - Lung		

Appendix F: Canada Goose Samples from Eastern James Bay

Season	n	Type
Fall	2	Whole Raw
Fall	2	Rendered Fat - Composite
Spring	3	Whole Raw, Female
Spring	3	Whole Raw, Male
Spring	2	Whole Raw
Spring	2	Dried Skin/Flesh
Spring	2	Rendered Fat - Composite
Spring	1	Fire Roasted Leg/Skin
Spring	1	Fire Roasted Breast/Skin
Spring	1	Fire Roasted Collar/Skin

Appendix G: Analytical Samples

Lab Code	Sample Code	Type of Goose	Season	Part	Preparation
G1	96 Du A I 1	*Anser anser*	N/A	Flesh Only	Raw
G2	96 Du B I 1	*Anser anser*	N/A	Leg/Skin	Raw
G3	96 Du C I 1	*Anser anser*	N/A	Breast/Skin	Raw
G4	96 Du A III 1	*Anser anser*	N/A	Flesh roast	Oven Roasted
G5	96 Du B III 1	*Anser anser*	N/A	Leg/skin	Oven Roasted
G6	96 Du C III 1	*Anser anser*	N/A	Breast/Skin	Oven Roasted
G7	96 Du A I 2	*Anser anser*	N/A	Flesh Only	Raw
G8	96 Du B I 2	*Anser anser*	N/A	Leg/Skin	Raw
G9	96 Du C I 2	*Anser anser*	N/A	Breast/Skin	Raw
G10	96 Du A III 2	*Anser anser*	N/A	Flesh Only	Oven Roasted
G11	96 Du B III 2	*Anser anser*	N/A	Leg/Skin	Oven Roasted
G12	96 Du C III 2	*Anser anser*	N/A	Breast/Skin	Oven Roasted
G13	96 Cf A I 1	*Branta canadensis*	Fall	Flesh Only	Raw
G14	96 Cf B I 1	*Branta canadensis*	Fall	Leg/Skin	Raw
G15	96 Cf C I 1	*Branta canadensis*	Fall	Breast/Skin	Raw
G16	96 Cf A III 1	*Branta canadensis*	Fall	Flesh Only	Oven Roasted
G17	96 Cf B III 1	*Branta canadensis*	Fall	Leg/skin	Oven Roasted
G18	96 Cf C III 1	*Branta canadensis*	Fall	Breast/Skin	Oven Roasted
G19	96 Cf L I 1	*Branta canadensis*	Fall	Lung	Oven Roasted
G20	96 Cf A I 2	*Branta canadensis*	Fall	Flesh Only	Raw
G21	96 Cf B I 2	*Branta canadensis*	Fall	Leg/Skin	Raw
G22	96 Cf C I 2	*Branta canadensis*	Fall	Breast/Skin	Raw
G23	96 Cf A III 2	*Branta canadensis*	Fall	Flesh Only	Oven Roasted
G24	96 Cf B III 2	*Branta canadensis*	Fall	Leg/Skin	Oven Roasted
G25	96 Cf C III 2	*Branta canadensis*	Fall	Breast/Skin	Oven Roasted
G26	96 Cf E III 2	*Branta canadensis*	Fall	Collar/Skin	Oven Roasted
G27	96 Cf L III 2	*Branta canadensis*	Fall	Lung	Oven Roasted
Cs 1	96 Cs A I 1	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 2	96 Cs A I 2	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 3	96 Cs A I 3	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 4	96 Cs A I 4	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 5	96 Cs A I 5	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 6	96 Cs A I 6	*Branta canadensis*	Spring	Flesh Only	Raw
Cs 7	96 Cs B I 1	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 8	96 Cs B I 2	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 9	96 Cs B I 3	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 10	96 Cs B I 4	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 11	96 Cs B I 5	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 12	96 Cs B I 6	*Branta canadensis*	Spring	Leg/Skin	Raw
Cs 13	96 Cs C I 1	*Branta canadensis*	Spring	Breast/Skin	Raw
Cs 14	96 Cs C I 2	*Branta canadensis*	Spring	Breast/Skin	Raw
Cs 15	96 Cs C I 3	*Branta canadensis*	Spring	Breast/Skin	Raw

Lab Code	Sample Code	Type of Goose	Season	Part	Preparation
Cs 16	96 Cs C I 4	*Branta canadensis*	Spring	Breast/Skin	Raw
Cs 17	96 Cs C I 5	*Branta canadensis*	Spring	Breast/Skin	Raw
Cs 18	96 Cs C I 6	*Branta canadensis*	Spring	Breast/Skin	Raw
Cs 19	96 Cs A III 1	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 20	96 Cs A III 2	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 21	96 Cs A III 3	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 22	96 Cs A III 4	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 23	96 Cs A III 5	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 24	96 Cs A III 6	*Branta canadensis*	Spring	Flesh Only	Oven Roasted
Cs 25	96 Cs B III 1	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 26	96 Cs B III 2	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 27	96 Cs B III 3	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 28	96 Cs B III 4	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 29	96 Cs B III 5	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 30	96 Cs B III 6	*Branta canadensis*	Spring	Leg/Skin	Oven Roasted
Cs 31	96 Cs C III 1	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 32	96 Cs C III 2	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 33	96 Cs C III 3	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 34	96 Cs C III 4	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 35	96 Cs C III 5	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 36	96 Cs C III 6	*Branta canadensis*	Spring	Breast/Skin	Oven Roasted
Cs 37	96 Cs E III 1	*Branta canadensis*	Spring	Collar/Skin	Oven Roasted
Cs 38	96 Cs E III 3	*Branta canadensis*	Spring	Collar/Skin	Oven Roasted
Cs 39	96 Cs E III 4	*Branta canadensis*	Spring	Collar/Skin	Oven Roasted
Cs 40	96 Cs E III 5	*Branta canadensis*	Spring	Collar/Skin	Oven Roasted
Cs 41	96 Cs E III 6	*Branta canadensis*	Spring	Collar/Skin	Oven Roasted
Cs 42	96 Cs L III 1	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 43	96 Cs L III 2	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 44	96 Cs L III 3	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 45	96 Cs L III 4	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 46	96 Cs L III 5	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 47	96 Cs L III 6	*Branta canadensis*	Spring	Lung	Oven Roasted
Cs 48	96 Cs J III 2	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 49	96 Cs J III 1	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 50	96 Cs J III 3	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 51	96 Cs J III 4	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 52	96 Cs J III 5	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 53	96 Cs J III 6	*Branta canadensis*	Spring	Skin Only	Oven Roasted
Cs 54	96 Cs A VI 7	*Branta canadensis*	Spring	Flesh Only	Boiled
Cs 55	96 Cs B VI 7	*Branta canadensis*	Spring	Leg/Skin	Boiled
Cs 56	96 Cs C VI 7	*Branta canadensis*	Spring	Breast/Skin	Boiled
Cs 57	96 Cs H VI 7	*Branta canadensis*	Spring	Heart	Boiled
Cs 58	96 Cs G VI 7	*Branta canadensis*	Spring	Gizzard	Boiled

Lab Code	Sample Code	Type of Goose	Season	Part	Preparation
Cs 59	96 Cs B II 8	*Branta canadensis*	Spring	Leg/Skin	Fire Roasted
Cs 60	96 Cs C II 8	*Branta canadensis*	Spring	Breast/Skin	Fire Roasted
Cs 61	96 Cs E II 8	*Branta canadensis*	Spring	Collar/Skin	Fire Roasted
Cs 62	96 Cs F I c	*Branta canadensis*	Spring	Liver	Raw
Cs 63	96 Cs F III c	*Branta canadensis*	Spring	Liver	Oven Roasted
Cs 64	96 Cs G I c	*Branta canadensis*	Spring	Gizzard	Raw
Cs 65	96 Cs G III c	*Branta canadensis*	Spring	Gizzard	Oven Roasted
Cs 66	96 Cs G VI c	*Branta canadensis*	Spring	Gizzard	Boiled
Cs 67	96 Cs H I c	*Branta canadensis*	Spring	Heart	Raw
Cs 68	96 Cs H III c	*Branta canadensis*	Spring	Heart	Oven Roasted
Cs 69	96 Cs K IV 9	*Branta canadensis*	Spring	Skin/Flesh	Dried
Cs 70	96 Cs K IV 10	*Branta canadensis*	Spring	Skin/Flesh	Dried
Cs 71	96 Cs K IV-VI 9	*Branta canadensis*	Spring	Skin/Flesh	Dried - Boiled
Cs 72	96 Cs K IV-VI 10	*Branta canadensis*	Spring	Skin/Flesh	Dried - Boiled
Cs 73	96 Cs I I c	*Branta canadensis*	Spring	Intestine	Raw
Cs 74	96 Cs I VI c	*Branta canadensis*	Spring	Intestine	Boiled
Cs 75	96 Cs I V c	*Branta canadensis*	Spring	Intestine	Fried
Cs 76	96 Cs A VI 11	*Branta canadensis*	Spring	Flesh Only	Boiled
Cs 77	96 Cs B VI 11	*Branta canadensis*	Spring	Leg/Skin	Boiled
Cs 78	96 Cs C VI 11	*Branta canadensis*	Spring	Breast/Skin	Boiled
Cs 79	96 Cs J I c	*Branta canadensis*	Spring	Skin Only	Raw

Appendix H: Lead and Arsenic Content of Fresh Spring Canada Goose (mean ± SD µg/g)

Part	Preparation	Lab Code	Lead	Mean ± SD	Arsenic	Mean ± SD
Flesh	Raw	Cs 1a	BDL		BDL	
		Cs 1b	BDL		BDL	
		Cs 2a	BDL		BDL	
		Cs 2b	BDL		BDL	
		Cs 3a	BDL		BDL	
		Cs 3b	BDL		BDL	
		Cs 4a	BDL		BDL	
		Cs 4b	BDL		BDL	
		Cs 5a	0.12	0.10 ± 0.03	BDL	
		Cs 5b	0.09		BDL	
		Cs 6a	16.63	63.73 ± 66.61	0.07	0.31 ± 0.33
		Cs 6b	110.83		0.54	
Leg/Skin	Raw	Cs 7a	0.14	0.13 ± 0.01	BDL	
		Cs 7b	0.12		BDL	
		Cs 8a	BDL		BDL	
		Cs 8b	BDL		BDL	
		Cs 9a	BDL		BDL	
		Cs 9b	BDL		BDL	
		Cs 10a	10.98	15.71 ± 6.68	BDL	
		Cs 10b	20.44		BDL	
		Cs 11a	1.44	2.55 ± 1.56	BDL	
		Cs 11b	3.65		BDL	
		Cs 12a	0.20	0.12 ± 0.11	BDL	
		Cs 12b	BDL		BDL	
Breast/Skin	Raw	Cs 13a	5.20	6.57 ± 1.93	BDL	
		Cs 13b	7.94		BDL	
		Cs 14a	BDL		BDL	
		Cs 14b	BDL		BDL	
		Cs 15a	BDL		BDL	
		Cs 15b	BDL		BDL	
		Cs 16a	BDL		BDL	
		Cs 16b	BDL		BDL	
		Cs 17a	2.63	2.15 ± 0.67	BDL	
		Cs 17b	1.68		BDL	
		Cs 18a	BDL		BDL	
		Cs 18b	BDL		BDL	
Flesh	Oven Roasted	Cs 19a	BDL		BDL	
		Cs 19b	BDL		BDL	
		Cs 20a	BDL		BDL	
		Cs 20b	BDL		BDL	
		Cs 21a	0.10	0.07 ± 0.04	BDL	
		Cs 21b	BDL		BDL	
		Cs 22a	BDL		BDL	
		Cs 22b	BDL		BDL	
		Cs 23a	BDL	0.13 ± 0.12	BDL	
		Cs 23b	0.22		BDL	
		Cs 24a	0.25	0.19 ± 0.07	BDL	
		Cs 24b	0.14		BDL	
Leg/Skin	Oven Roasted	Cs 25a	BDL		BDL	
		Cs 25b	BDL		BDL	
		Cs 26a	BDL		BDL	
		Cs 26b	BDL		BDL	
		Cs 27a	BDL		BDL	
		Cs 27b	BDL		BDL	
		Cs 28a	0.12	0.09 ± 0.05	BDL	
		Cs 28b	BDL		BDL	
		Cs 29a	BDL		BDL	
		Cs 29b	BDL		BDL	
		Cs 30a	BDL		BDL	
		Cs 30b	BDL		BDL	

Part	Preparation	Lab Code	Lead	Mean ± SD	Arsenic	Mean ± SD
Breast/Skin	Oven Roasted	Cs 31a	BDL		BDL	
		Cs 31b	BDL		BDL	
		Cs 32a	BDL		BDL	
		Cs 32b	BDL		BDL	
		Cs 33a	BDL		BDL	
		Cs 33b	BDL		BDL	
		Cs 34a	BDL		BDL	
		Cs 34b	BDL		BDL	
		Cs 35a	1.33	11.27 ± 14.05	BDL	
		Cs 35b	21.21		BDL	
		Cs 36a	BDL		BDL	
		Cs 36b	BDL		BDL	
Collar/Skin	Oven Roasted	Cs 37a	BDL		BDL	
		Cs 37b	BDL		BDL	
		Cs 38a	BDL		BDL	
		Cs 38b	BDL		BDL	
		Cs 39a	BDL		BDL	
		Cs 39b	BDL		BDL	
		Cs 40a	0.51	27.58 ± 38.28	BDL	0.04 ± 0.01
		Cs 40b	54.65		0.04	
		Cs 41a	BDL		BDL	
		Cs 41b	BDL		BDL	
Lung	Oven Roasted	Cs 42a	11.88	6.28 ± 7.91	BDL	
		Cs 42b	0.69		BDL	
		Cs 43a	BDL		BDL	
		Cs 43b	BDL		BDL	
		Cs 44a	0.06	0.10 ± 0.06	BDL	
		Cs 44b	0.14		BDL	
		Cs 45a	0.11	0.10 ± 0.01	BDL	
		Cs 45b	0.09		BDL	
		Cs 46a	5.48	4.42 ± 1.50	BDL	
		Cs 46b	3.36		BDL	
		Cs 47a	0.12	0.11 ± 0.01	BDL	
		Cs 47b	0.10		BDL	
Skin	Oven Roasted	Cs 48a	BDL		BDL	
		Cs 48b	BDL		BDL	
		Cs 49a	BDL		BDL	
		Cs 49b	BDL		BDL	
		Cs 50a	BDL		BDL	
		Cs 50b	BDL		BDL	
		Cs 51a	0.59	0.58 ± 0.01	BDL	
		Cs 51b	0.57		BDL	
		Cs 52a	BDL	0.18 ± 0.13	BDL	
		Cs 52b	0.27		BDL	
		Cs 53a	BDL		BDL	
		Cs 53b	BDL		BDL	
Flesh	Boiled	Cs 54a	BDL		BDL	
		Cs 54b	BDL		BDL	
Leg/Skin	Boiled	Cs 55a	BDL		BDL	
		Cs 55b	BDL		BDL	
Breast/Skin	Boiled	Cs 56a	BDL		BDL	
		Cs 56b	BDL		BDL	
Heart	Boiled	Cs 57a	BDL		BDL	
		Cs 57b	BDL		BDL	
Gizzard	Boiled	Cs 58a	BDL		BDL	
		Cs 58b	BDL		BDL	
Leg/Skin	Fire Roasted	Cs 59a	BDL		BDL	
		Cs 59b	BDL		BDL	
Breast/Skin	Fire Roasted	Cs 60a	BDL	0.15 ± 0.15	BDL	
		Cs 60b	0.26		BDL	
Collar/Skin	Fire Roasted	Cs 61a	6.96	5.63 ± 1.87	BDL	

Part	Preparation	Lab Code	Lead	Mean ± SD	Arsenic	Mean ± SD
		Cs 61b	4.31		BDL	
Liver	Raw	Cs 62a	1641.32	8.49 ± 1120.16	1.75	1.00 ± 1.07
		Cs 62b	57.18		0.25	
Liver	Oven Roasted	Cs 63a	BDL		BDL	
		Cs 63b	BDL		BDL	
Gizzard	Raw	Cs 64a	279.40	221.85 ± 81.39	0.93	0.71 ± 0.30
		Cs 64b	164.30		0.50	
Gizzard	Oven Roasted	Cs 65a	0.25	0.25 ± 0.09	BDL	
		Cs 65b	0.12		BDL	
Gizzard	Boiled	Cs 66a	BDL		BDL	
		Cs 66b	BDL		BDL	
Heart	Raw	Cs 67a	BDL		BDL	
		Cs 67b	BDL		BDL	
Heart	Oven Roasted	Cs 68a	BDL		BDL	
		Cs 68b	BDL		BDL	
Skin/Flesh	Dried	Cs 69a	27.33	17.49 ± 13.92	0.11	0.07 ± 0.05
		Cs 69b	7.65		BDL	
Skin/Flesh	Dried	Cs 70a	0.97	0.88 ± 0.13	BDL	
		Cs 70b	0.79		BDL	
Skin/Flesh	Boiled/Dried	Cs 71a	4.82	2.44 ± 3.36	BDL	
		Cs 71b	BDL		BDL	
Skin/Flesh	Boiled/Dried	Cs 72a	476.28	241.09 ± 332.62	0.48	0.26 ± 0.32
		Cs 72b	5.89		BDL	
Intestine	Raw	Cs 73a	BDL		BDL	
		Cs 73b	BDL		BDL	
Intestine	Boiled	Cs 74a	BDL		BDL	
		Cs 74b	BDL		BDL	
Intestine	Fried	Cs 75a	BDL		BDL	
		Cs 75b	BDL		BDL	
Flesh	Boiled	Cs 76a	BDL		BDL	
		Cs 76b	BDL		BDL	
Leg/Skin	Boiled	Cs 77a	BDL		BDL	
		Cs 77b	BDL		BDL	
Breast/Skin	Boiled	Cs 78a	BDL		BDL	
		Cs 78b	BDL		BDL	
Skin	Raw	Cs 79a	0.47	0.47 ± 0.01	BDL	
		Cs 79b	0.46		BDL	