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**DIACHRONIC PALAEODIETARY ANALYSIS  
OF PRAIRIE FRINGE PEOPLES  
OF SOUTHEASTERN MANITOBA**

BY

DENISE A. ENS

A Thesis  
Submitted to the Faculty of Graduate Studies  
in Partial Fulfilment of the Requirements  
for the Degree of

MASTER OF ARTS

Department of Anthropology  
University of Manitoba  
Winnipeg, Manitoba

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## ABSTRACT

Subsistence pursuits are intricately connected to social, political, economic and biological phenomena. The study of subsistence strategies, therefore, is fundamental to understanding a population. The objectives of this study are two-fold. First, is to develop a model of the subsistence that can account for the variability potential used in the prairie fringe of southeastern Manitoba. Second, is to contribute to stable isotope research in Canada.

The principal method of analysis of the human remains from five burial sites is stable carbon and nitrogen analysis of bone collagen. However, this is a multidisciplinary study that incorporates dental palaeopathological, historical, archaeological, and environmental evidence into the analysis. Stable isotope analysis has seldom been used to study palaeodiets in the northern temperate zone in Canada. This study demonstrates the potential of this technique for biological and environmental studies within this region.

The results suggest a tripartite subsistence model for the prairie fringe of southeastern Manitoba. This model suggests that prior to European contact subsistence strategies in this region were quite restricted. One strategy focussed predominantly on aquatic animals, and another strategy focussed on terrestrial animals. The latter strategy is further divided into two groups that either concentrated on boreal forest/parkland mammals, or groups that relied heavily on plains mammals. Furthermore, the highly diverse diet of the seasonal round recorded in historic documents may be a post-European contact phenomenon.

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## **CHAPTER 1**

### **Introduction**

Studies of diets and subsistence strategies are fundamental to understanding the nature of past societies since subsistence pursuits are correlated with all societal needs. Diet is intricately associated with how foods are selected, procured, processed and distributed, thereby linking diet to social structures, complexity and health. Thus palaeodietary reconstructions are important not only in and of themselves, but for reconstructing past socio-economic and socio-political patterns. The goal of this study is to reconstruct some of the past subsistence strategies used in the prairie fringe region of southeastern Manitoba as an initial step towards understanding past human adaptation in this complex region.

Recently there has been considerable interest in palaeodietary studies of the inhabitants of Northern Great Plains of North America (Malainey 1997; Garvie 1993). This renewed interest has been sparked, in part, by new and refined methods of analysis. Following this trend, I examine the diet of early peoples of Manitoba using a broad research design including chemical analysis of human bone collagen and dental palaeopathology in a long diachronic setting. It focusses on the human remains from five sites along the Winnipeg River system that encompass a time span of approximately 7000 years.

The prairie fringe of the Winnipeg River region is unique for its ecological opportunities. It consists of tall grass prairie, aspen parkland, and mixed deciduous and coniferous forest zones. The concentration of three different ecosystems in one relatively

small geographical region provides an opportunity to research the variation of subsistence strategies that were used in such a region. The biotic diversity of this region allows for the human exploitation of a few dietary resources from one econiche as well as the exploitation of numerous resources from multiple econiches, and subsistence adaptation over time.

I argue that the typical woodland versus grassland dietary model sometimes used to describe subsistence strategies of the Winnipeg River region is too simplistic given the complex nature of the resources in the ecological transition zone of the prairie fringe of southeastern Manitoba. In my opinion. The historical seasonal round analogy overestimates the dietary diversity of some populations. Unfortunately, previous research by anthropologists, historians and archaeologists has provided little quantitative information about the diet of the early people inhabiting this region. Most available palaeodietary information is based upon contemporary ethnographic accounts, historical analogies or archaeological evidence. These sources of information, being often circumstantial and vague, can only tenuously be applied to pre-contact peoples. This lacuna is unfortunate since, as noted, dietary information is germane to the reconstruction of many aspects of past societies.

In order to fill this gap, I propose a new model of dietary variability based on stable isotope and dental palaeopathological analysis. The initial hypothesis was that there were three basic subsistence strategies used in the prairie fringe of southeastern Manitoba: 1) a strategy relying heavily upon forest-aquatic resources (i.e., fish); 2) a strategy relying primarily on forest-terrestrial proteins (i.e., boreal land mammals); and 3) a predominantly plains-oriented strategy relying on plains-terrestrial proteins (i.e., primarily bison).

Although the research design of this study emphasises stable isotopes and dental

palaeopathology, it also uses historic, ethnographic, and archaeological data to provide a qualitative and quantitative multidisciplinary focus. Each source provides information either confirming or enhancing possible perspectives of data interpretation. These checks and balances provide a more complete understanding of the region's palaeodietary and cultural variation.

Initially, skeletal evidence of diet and nutritional stress were to be included in this study. After analysis using traditional methods for establishing evidence of stress (i.e., stature, Harris lines and pathological patterning), it was found that the data were inconclusive. There exists some evidence that a wild rice diet may cause skeletal pathological patterns similar to those observed in populations relying heavily on maize (Ens 1998). These data, however, are problematic due to the rare occurrence of these pathologies, their often comparatively slight manifestations, and the limited sample size.

Five sites along the Winnipeg River region of southeastern Manitoba are used in this study. These sites are Fort Alexander, Whaley Cairn, Slave Falls, Bjorklund and Whitemouth Falls (Figure 2.6). They were selected because they are burial sites with good archaeological provenience, and because they are diachronic in nature bridging the archaic to the post-European contact period. Therefore, it is possible to examine the subsistence strategies used in this region over an extended period of time.

The goals of this thesis are:

- 1) to reconstruct diets and subsistence strategies for the five groups of people represented by the human remains at Fort Alexander, Whaley Cairn, Slave Falls, Bjorklund and Whitemouth Falls burial sites.
- 2) to determine if dental palaeopathologies can be used to differentiate between different

hunter-gatherer populations.

3) to provide a model of subsistence variation for the Winnipeg River region that can be subsequently tested using stable isotope analysis and other subsistence research methods.

4) to add to the stable isotope database for freshwater and temperate zones in Canada.

The chapters that follow each contribute, in their own way, to these objectives.

Chapters two through four provide the background information for the study. Chapter two briefly describes the environmental setting and the nature of the study materials. Chapter three provides the archaeological context for the burial sites and the region in general, and possible archaeological associations. Archaeology provides information prior to written history about past cultures that are group and region specific. Archaeological cultures are traced chronologically and spatially through remnants of their material culture (usually by pottery and/or lithic technology). Since subsistence strategies are related to culture, it is important to identify to which archaeological culture each burial belongs. However, burials are specialised archaeological sites, and these particular burials (except for Fort Alexander) did not contain diagnostic artifacts. Chronologies and possible archaeological associations are based largely on radiocarbon AMS dates obtained for this study and corroborative evidence.

Chapter four presents both the historical background and analytic information of the regional history, and historically observed subsistence patterns. Historically, three main groups are known to have inhabited the lands of the Winnipeg River system. These are the Ojibwa, the Assiniboine and the Cree. Although the Ojibwa are currently the predominant Native group within the study region, the Cree and Assiniboine also have a limited presence.

These groups are briefly described in terms of their dietary practices, travel habits and their probable arrival to the Winnipeg River area. This historical reconstruction provides a control for the potential dietary intrusion of European products and influences. This chapter also analyses fur trade documents to reconstruct trading and subsistence systems that may have been in place prior to European contact.

The bulk of the palaeodietary reconstructions and analytical work of this study are contained in the dental palaeopathological (chapter five) and the stable isotope chapter (chapter six). In physical anthropological studies, dental pathological analysis of human remains from archaeological sites has been the traditional source of palaeodietary reconstruction. This type of analysis is invaluable although it is limited by the fact that the data is qualitative rather than quantitative. For example, high rates of dental caries usually indicates high carbohydrate consumption, but “high” is an ambiguous term especially when referring to specific food items. Past studies also have focussed on differentiating between hunter-gatherer and horticultural populations. A primary objective of this study is to determine if there are dental pathological data that will provide a general model for comparing different subsistence strategies between hunter-gatherer societies.

The stable isotope data and analysis are presented in chapter six. Stable isotope analysis builds upon the above dietary reconstructions by potentially providing quantitative assessments of palaeodiets. It determines isotopic composition of human tissues (i.e., bone collagen) that, when analysed, can be used to trace the foods sources from which those tissues were derived. In order to carry out this type of analysis, it is necessary first to establish isotopic values for the plants and animals in the ecozone being exploited by the

humans. Few isotopic studies have been undertaken in freshwater systems and northern temperate zones; however, it is evident that there are regional isotopic variations that must be understood prior to the interpretation of the human data. As demonstrated in this study, archaeological bison bone tested from the Whitemouth Falls site does not have the same isotopic signature as archaeological bison bone from southwestern Manitoba, and factors such as these play a major role in analysis of human isotope values. Stable isotopic research of freshwater systems and northern temperate zones is lacking, and it is one objectives of this study to add to this meagre database.

Although the data resulting from stable isotope analysis may be used to observe gross dietary trends, more precise analysis involves estimating the proportions of various food classes to diet — that is, rather than developing a shopping list of foods, it involves developing a dietary recipe of food classes by quantity (i.e., establishing a ratio of contributions by various food classes). This requires that the isotopic signatures for a number of food classes be established, and some prior knowledge of subsistence patterns (i.e., historical and archaeological evidence) be entertained.

In the past stable isotope studies of the northern temperate zone of Canada (a largely “C<sub>3</sub>” environment) have been dismissed because of the isotopic homogeneity of the region, but I argue that finer distinctions can be made that are relevant to subsistence studies. These distinctions, however, are only evident when both carbon and nitrogen isotopic data is considered. Since this region can accommodate numerous possible subsistence strategies, stable isotope analysis can potentially provide critical insights in differentiating between groups of people with different subsistence strategies.

In sum, the principle objective of this study is to reconstruct subsistence strategies used by the people represented by the human remains from five sites within the Winnipeg River region from circa 5000 BC to AD 1800. Once reconstructed, subsistence strategies will be compared between sites and a model of variation will be developed that can be further tested by palaeodietary analysis.

## **CHAPTER 2**

### **Ecological Parameters and Sample Population**

Canada encompasses numerous regions which are differentiated by their vegetation, soils, wildlife, climate, and water availability. The subsistence strategies used by a population is limited by the resources of the zone, or zones, which they inhabit. Although subsistence strategies are limited within a region, regions with a wide range of resources provide opportunities for greater variability in subsistence strategies. The prairie fringe is a region of potentially high resource diversification, and, therefore, a region possibly supporting multifarious subsistence strategies.

An examination of the prairie fringe and its resources is germane to palaeodietary studies because it provides the opportunity to study the range of subsistence strategies used within a region. Dietary reconstructions based upon populations within fringe regions can provide an opportunity to further study a range of cultural adaptations to the environment.

This chapter reviews the ecology of the study area and summarises pertinent information about the human remains used herein. Since the samples in this study encompass a long time span (approximately 6000 years), it is also necessary to reconstruct the ecoclimatic conditions, as best as possible. The description of the climate and resources of the Winnipeg River region will facilitate a more complete picture of the opportunities that were available to those people (represented by their osteological remains) who used this region.

## 2.1 Research Area and Present Ecology

Southern Manitoba is comprised of three basic physiographic regions: grasslands (prairie), boreal forests and parkland. The transition between these zones in southeastern Manitoba is somewhat compressed (i.e., all occurring within 100 miles at certain points). Nominal references to prairie, parkland and forest give rise to preconceived images of these zones; however, these are complex regions in themselves and the transitional zones between these regions are even more complex. It is necessary, therefore, to define what is meant by grasslands, boreal forest and parklands zones, and the prairie fringe — that is, the areas, the resources, and the range of subsistence strategies that they can support.

The Winnipeg River is situated in southeastern Manitoba, and drains into Lake Winnipeg on its eastern shore. The Winnipeg River basin (Figure 2.1) encompasses 138,565 square kilometres most of which is located in northwestern Ontario. The basin's parameters are Trout Lake, Ontario to the north, the end of the Big Fork River, Minnesota to the south, Lac des Milles Lacs, Ontario to the east, and the end of a tributary (St. Labre Creek) of the Whitemouth River to the west (Steinbring 1980:11).

The present-day Winnipeg River basin is comprised of basically two types of forest regions (Figure 2.2): the Mid-Boreal ecoclimatic region characterised by spruce, pine and fir forming the northern boundary and the Low Boreal ecoclimatic region characterised by conifers (predominantly pines), and the Southern Cordilleran of temperate broadleaf deciduous trees forming the southern boundary (Scott 1995:82-120).<sup>1</sup> The western aspect of

---

<sup>1</sup> Corresponds to Rowe (1972:6 and 11) Boreal Forest region and Great Lakes-St. Lawrence Forest Regions, respectively.

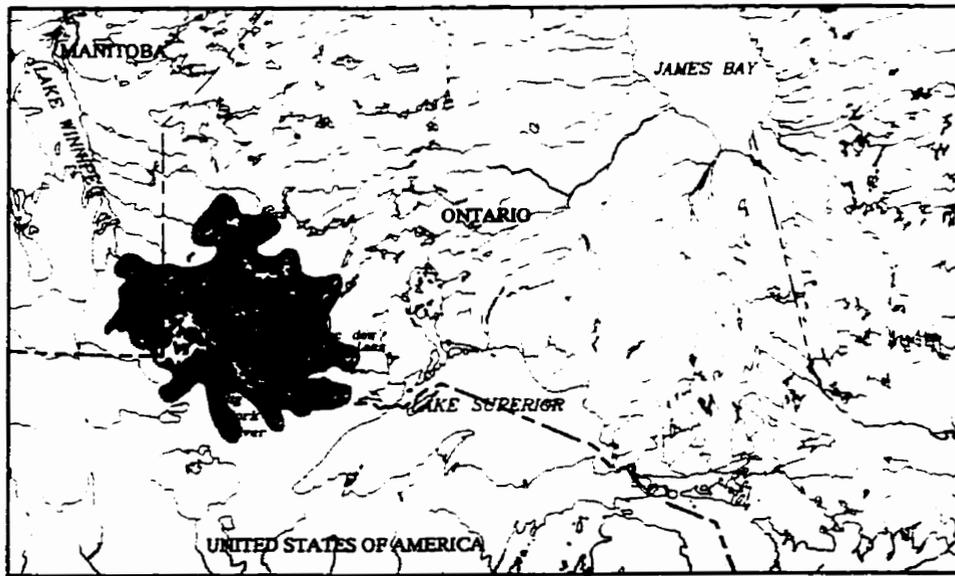


Figure 2.1 - The Winnipeg River Basin  Winnipeg River Basin

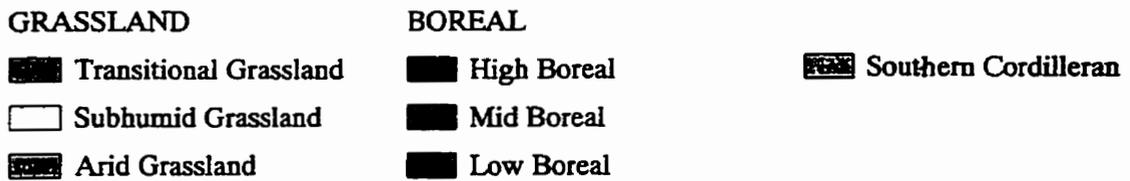
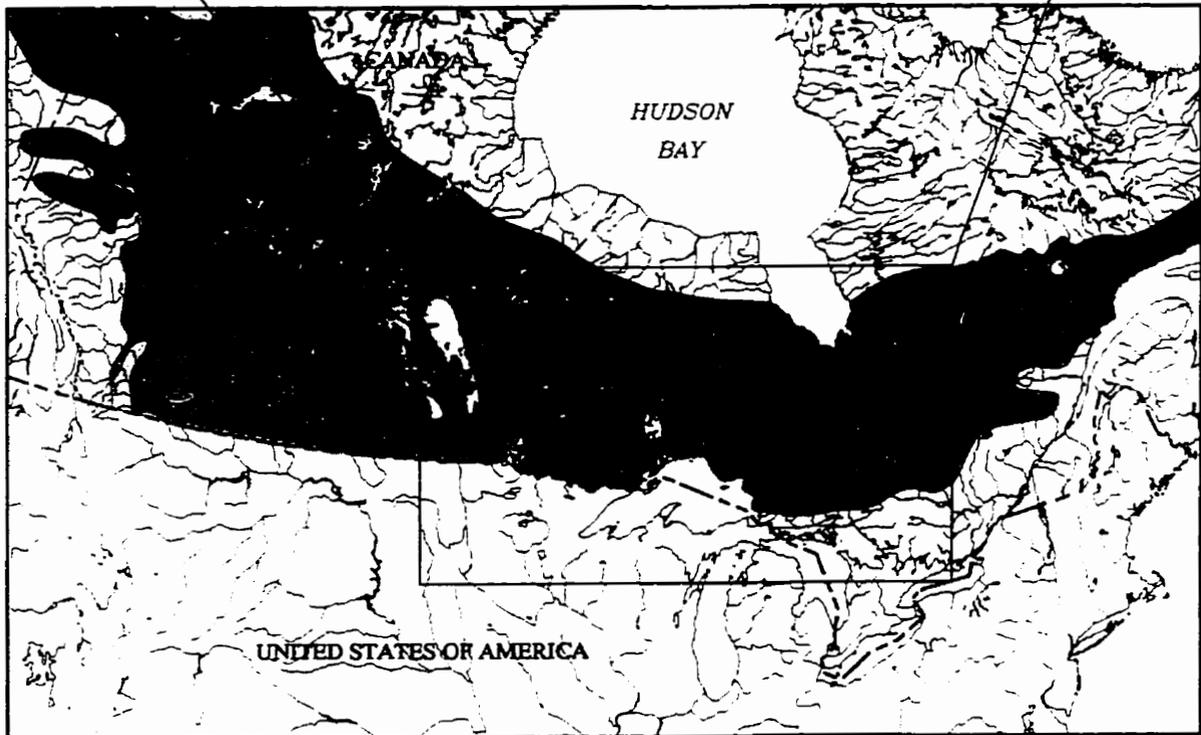


Figure 2.2 - Ecoclimatic Regions of Canada (Scott 1995, Fig. 1.4)

the River system, however, consists of the Transitional Grassland ecoclimatic region consisting of aspen parkland and tall-grass prairies (Scott 1995:129). The transitional grasslands and mixed coniferous-deciduous forests comprises an area commonly known as the prairie fringe of the northeastern High Plains (Frison 1978:1). This division between the grasslands and the forests is roughly demarcated by the lower Winnipeg River and the Whitemouth River which form the boundary of the Canadian Shield (Figures 2.2 and 2.3).

The Mid-Boreal ecoclimatic region surrounds Lake Winnipeg north of the mouth of the Winnipeg River that may be divided into sub-regions by vegetation types: the Manitoba Lowlands (which skirts the eastern shore of Lake Manitoba), and the Northern Coniferous (Rowe 1972; Scott 1995) (Figure 2.4). Black spruce, tamarack, swamps and meadows characterise the Manitoba Lowlands. Black spruce predominates the Northern Coniferous depending on soil depth (Rowe 1972:43). In moist areas, mosses (*Spagnum*, *Carex*, ostrich fern, bunchberry, club-moss), shrubs (horsetail, cowslip, swamp cranberry, grey alder, and wild rice), and various herbs and lichen grow. In dry areas,

*Cladina mitis*, *C. rangiferina* (reindeer lichen), and the feather moss *Pleurozium schreberi* are common, along with herbs such as *Aster laevis* (smooth aster), *Solidago* spp. (goldenrod), *Oryzopsis pungens* (northern rice grass), and *O. asperifolia* (white-grained mountain rice grass). Ericaceous sub-shrubs such as *Arctostaphylos uva-ursi* (common bearberry), *Vaccinium angustifolium* (low sweet blueberry), and *Gaultheria procumbens* (checkerberry) also do well and can be joined by *Rhus radicans* (poison ivy) and the taller shrubs *Prunus pumila* (low sand cherry) and *Rosa acicularis* (prickly rose) (Scott 1995:99-100).

The Mid-Boreal Forest Region of this area is ecologically referred to as the Hudsonian Biotic Province that suffers heavy snowfalls during long, severe winters, but also warm, short summers (Mason 1981:57). Besides human inhabitants, there are numerous

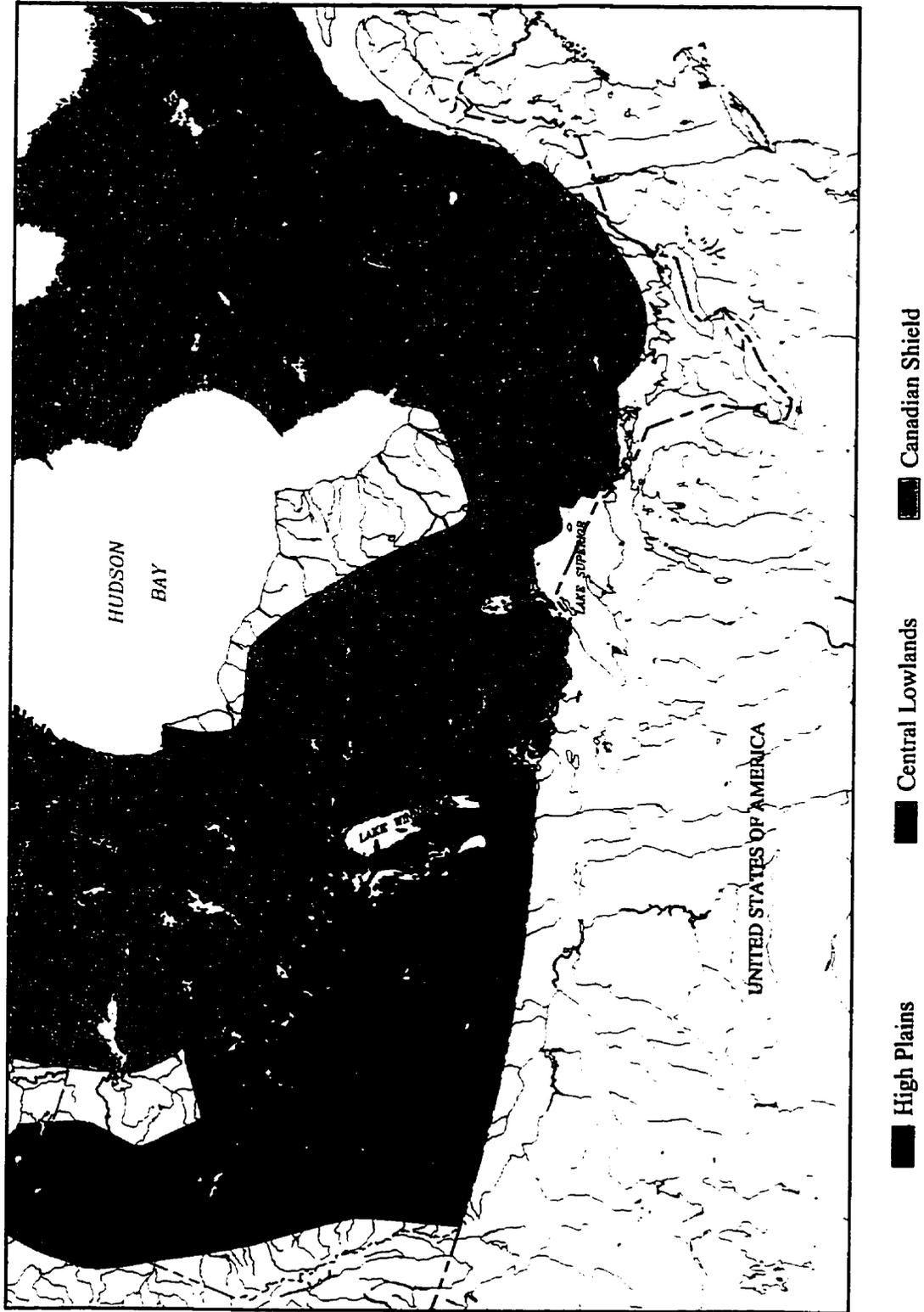


Figure 2.3 - Physiographic Regions of Canada

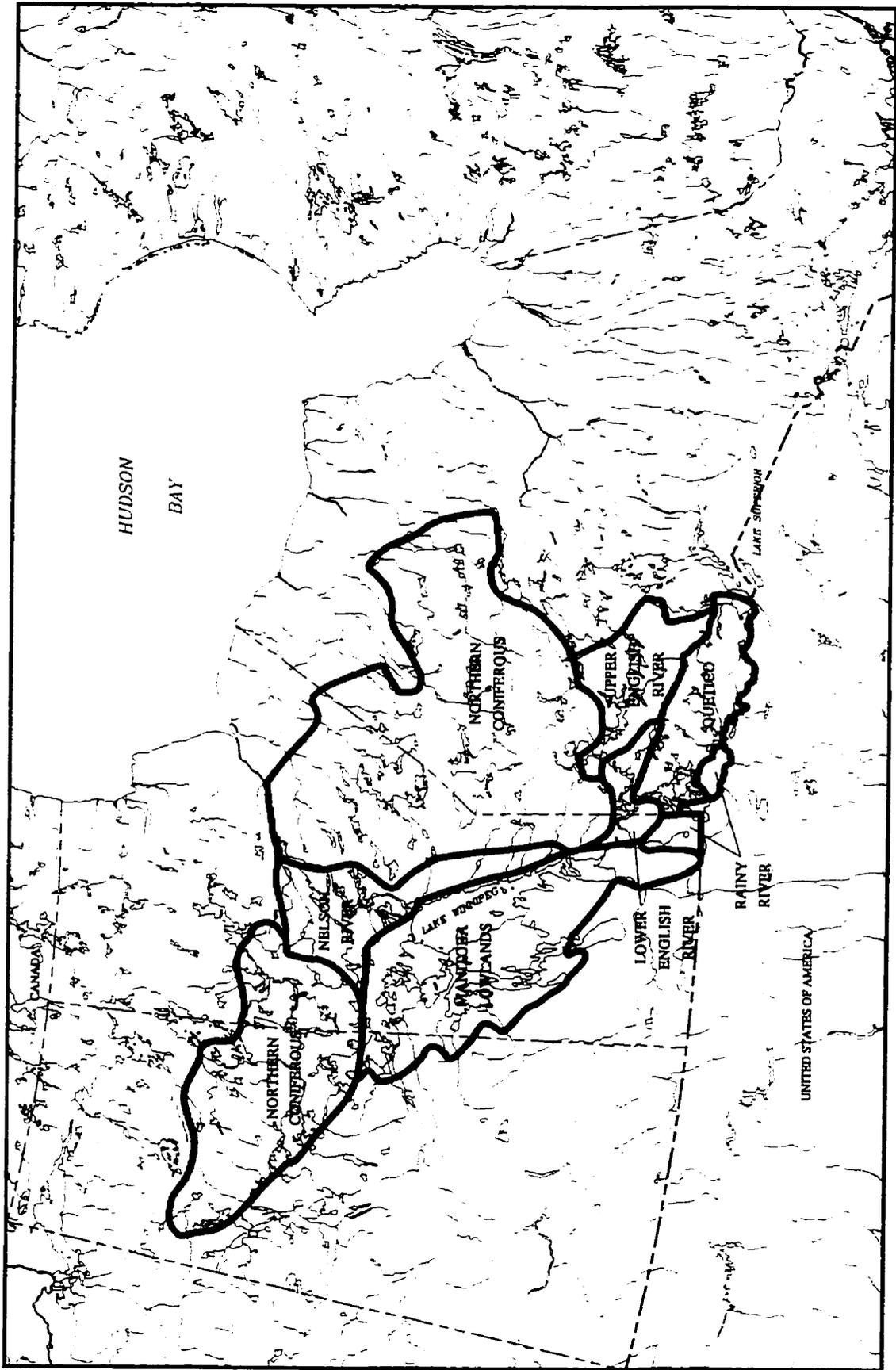


Figure 2.4 - Forest Regions of the Winnipeg River System (Rowe 1972)

mammals (moose, caribou, black bear, wolf, lynx, wolverine, marten, foxes, porcupines, beaver, rabbits and hares, etc.), numerous fish (eg. bass, pike, pickerel, whitefish, lake trout, sturgeon, smelt, perch, catfish, suckers, drum, etc.), birds (eg. loons, geese, ducks, grebes, hawks, falcons, gulls, owls, etc.), and amphibians and reptiles (such as, frogs and turtles) on which humans subsist (Mason 1981; Kroker 1990).<sup>2</sup>

The Low Boreal ecoclimatic region consists of two major vegetation regions — the Boreal forest and the Great Lakes-St. Lawrence Forest region — each consisting of sub-regions. The boreal forests of the Low Boreal region are formed by the Upper and Lower English River sub-regions. The predominant tree species of the Upper English River mainly consists of “black spruce and jackpine with mixtures of white spruce, balsam fir, trembling aspen and white birch” (Rowe 1972:26); whereas, the Lower English River consists mainly of trembling aspen, balsam poplar and white spruce (Rowe 1972:30).

The Quetico and Rainy River sub-regions are categorised broadly as the Great Lakes-St. Lawrence “mixed forest” region although its composition in Manitoba is different than elsewhere in Canada (Scott 1995). The distinctive vegetation in this region is due to the effects of the colder and “drier prairie climate” which “encourages the dominance of pines such as *Pinus banksiana*, *P. resinosa*, and *P. strobus*” (Scott 1995:103). The Quetico area consists largely of pines (i.e., red and white), but is also comprised of red and bur oaks, yellow birch, sugar and Manitoba maples, basswood, and hop-hornbeam (Rowe 1972:110). According to Rowe (1972:111), the Rainy River section demonstrates “the influence of the

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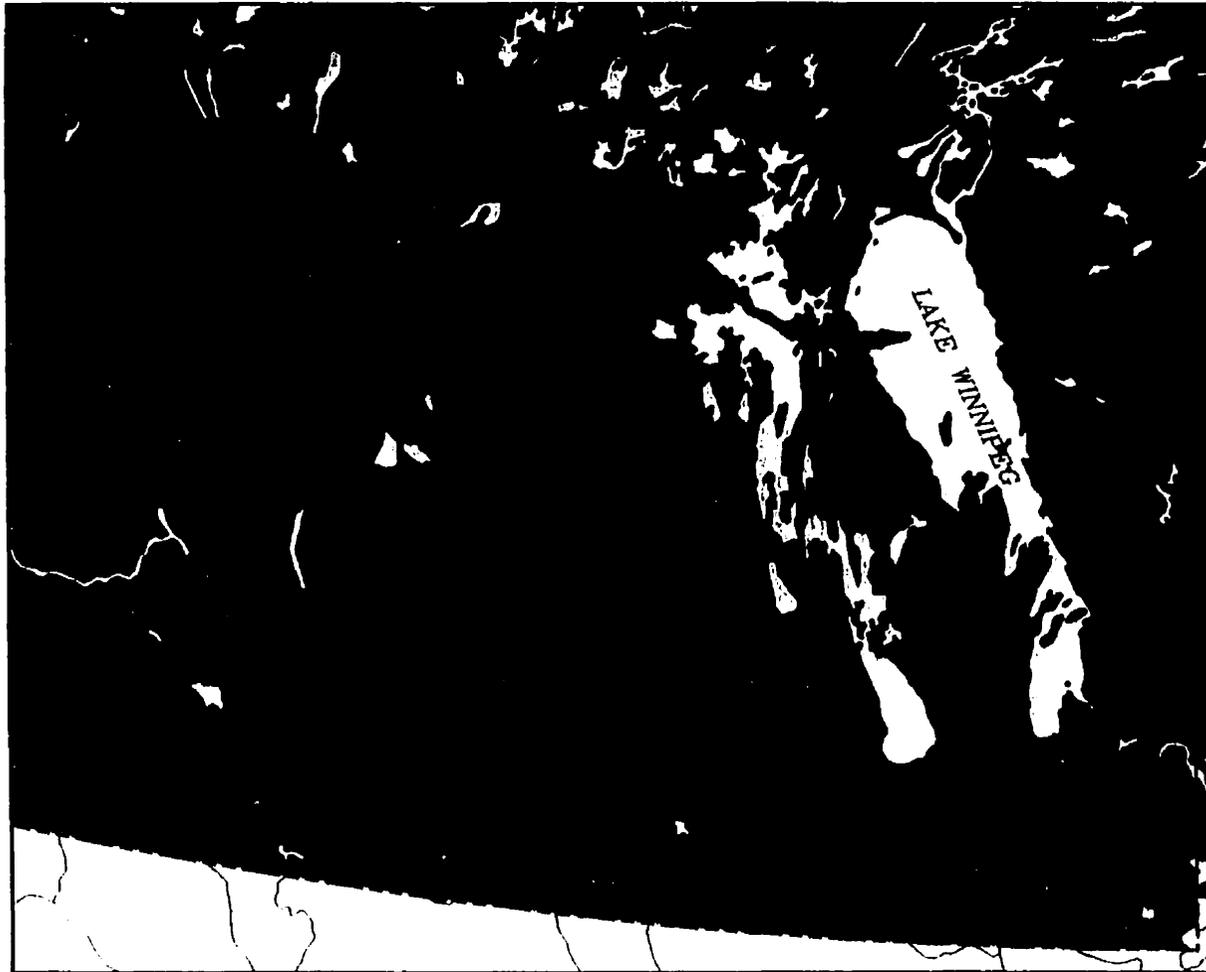
<sup>2</sup> A complete list of fauna for these ecoclimatic regions is beyond the scope of this thesis, therefore only some of the fauna used as primary food sources are noted. For further references to food resource fauna see Appendix I.

tension zone between forest and adjoining prairie to the west.” The low-lying area has grassy openings but is susceptible to swamps with associated patches of black spruce, tamarack, eastern white cedar, willow, balsam poplar, balsam fir and white spruce while along river banks white elm, basswood and Manitoba maple grow. The under storey of these regions consist of :

*Picea glauca*, *Abies balsama*, and *Betula papyrifera* also do well on adequately drained soils. Hardwoods such as *Acer Rubrum*, *Fraxinus nigra* (black ash), and *Ulmus americana* thrive along flood-plains, while on drained lowland soils to the south are hardwood stands dominated by *Acer negundo* (Manitoba maple), *A. saccharum*, *Tilia americana*, *Quercus rubra*, and *Q. macrocarpa* (bur oak). Boggy lowlands still have the typical *Picea mariana-Larix laricina* tree components, while stands of *Thuja occidentalis* (eastern white cedar) are also common, particularly where soils are base rich. *Sphagnum* bogs and *Phragmites* fens are also common (Scott 1995:104).

These sub-regions comprise part of the Canadian Biotic Province that have similar winters to the lower Mid Boreal region of the Winnipeg River but enjoy longer, warmer summers (Mason 1981:59). The Canadian Biotic Province is basically a transition zone between the Hudsonian to the north and the Carolinian Province to the south. Much of the fauna that is present in the Hudsonian is present in the Canadian province, however the warmer temperatures and deeper soils (more characteristic of the Carolinian province) increase the density of deciduous trees and grasses.

Both biota and climate change dramatically between the boreal forest and the Grassland transition region (Figure 2.5). This zone is characterised by aspen (prairie) parkland and true tall-grass prairie (Scott 1995:122). Presently, the tall-grass prairie is only “0.07% [4 km<sup>2</sup>] of its former area” (Scott 1995:130). As noted by Scott (1995:136), “Tall-grass prairie in Manitoba owes its presence to a combination of climate, poor drainage of the



- Boreal Forest
- Aspen Parkland
- Mixed-Grass Prairie
- Transition (mixed forest)
- Tall-Grass Prairie
- Short-Grass Prairie (xeric mixed grass)

**Figure 2.5 - Transitional Grassland (Scott 1995, Fig. 5.7 and 5.9)**

Lake Agassiz Humic Gleysols and Gleyed Chernozems, flooding, and a past history of frequent burning.” In southeastern Manitoba, the remaining tall-grass prairie consists largely of late-maturing *Andropogon gerardii* and *Panicum virgatum* as well as *Schizachyrium scoparium* and *Spartina pectinata* although species present depend on drainage, slope and water table level (Scott 1995:135-136).

Typical Parkland tree species of southeastern Manitoba are: *Populus tremuloides*, *P. balsamifera* and *Quercus macrocarpa* (a species dependent on higher precipitation levels) (Scott 1995: 131). The Parkland is an incorporation of both grassland and mixed forest species (i.e., a transitional zone) whose composition largely depends on water availability. As Scott (1995:133) states,

Effectively, the parkland proper represents a transitional zone between grassland and mixed forest . . . so on its drier margins it consists of grasslands with shrub-like copses of clonal [i.e., root suckers] *Populus* and shrubs such as *Prunus virginiana* (choke-cherry) and *Elaeagnus commutata* (silverberry, or wolf willow) . . ., while on the wetter side, along the mixed-forest boundary, trees produce more or less closed stands.

The river valleys of both, parkland and tall-grass prairie, exhibit a unique deciduous forest type, often referred to as “Riverine Gallery Forest” which are dominated by American White Elm (*Ulmus americana*), basswood (*Tilia americana*), green ash (*Fraxinus pennsylvanica*), Manitoba maple (*Acer negundo*) and willows (*Salix* spp.).

Although the southern parkland boundary has experienced significant changes since the European settlement era, soil grass-opal content studies indicate that the northern boundary “has probably been relatively stable for some time” (Scott 1995:133). It is important to note, however, that these are the ecological characteristics of the present day,

and that it is necessary to consider climatic and biotic changes that may have occurred through time.

## **2.2 Diachronic Ecoclimatic Changes**

The effects of the warming trend that signalled the end of the Pleistocene and the Wisconsin Glaciation require close scrutiny when considering the post-glacial palaeoecology of this region. This warming trend is referred to as the Atlantic or Altithermal Climatic Episode with a time depth of 8450 to 4680 BP, and peaking at 6500 BP (Buchner 1979a:59, 85). Buchner (1979a:86) states that, at the peak of this Episode, historically recorded drought conditions would be somewhat analogous to the arid conditions of that time. Bryson and Wendland (1967:287) describe what must have been a dramatic change,

The jack pine-red pine assemblage in turn disappeared rather abruptly about 8,500 years ago to be replaced by grassland in Minnesota or oak savanna characteristic of the forest-prairie ecotone in eastern Wisconsin.

This increased aridity had drastic effects on grassland peoples who moved to the fringes of the grasslands next to forest zones (Bryson and Wendland 1967; Buchner 1979a:152; Ritchie 1967:229). However, it is an on-going topic of debate as to the degree of ecoclimatic change in various regions.

It is apparent that certain regions with rivers, lakes and other geographical features may have been more stable than others during the middle to latter portion of the Atlantic Episode. Some studies indicate that the forest and grassland regions along the Winnipeg River system in southeastern Manitoba remained fairly stable during the period of study (i.e., 4000 BC to 1800 AD) changing more drastically after the European settlement era (Gregg

1985:111). Indeed, Buchner (1979a) notes that the region of the Whitemouth Falls site — that is, one of the most southerly sites in the region and, therefore, most likely affected by arid conditions — could be characterised as a transition zone between the grasslands and the forests from 5500 BP to the present. He goes on to argue that,

the Winnipeg River . . . is the border between the grassland and the forests at the peak of xerothermy (ca. 4600 BC) and this seems reasonable in the light of the current body of palaeoecological data for southeastern Manitoba. Rivers often do, in fact, serve as ecological boundaries in the region (Buchner 1979a:152).

Since 5000 BP, the Winnipeg River region should be considered a region of relative ecological continuity and consistency.

Apart from the changes induced by the Atlantic Climatic Episode, there is some speculation as to changes that might have occurred during a cooling trend commonly known as “The Little Ice Age” (the Neo-Boreal Episode) from 1579 AD to 1880 AD. Despite earlier claims that the Little Ice Age produced a global cooling trend with higher precipitation that significantly affected the flora of most regions (Lamb 1977), more recent studies have concluded that the climatic and biotic responses would have been region-specific — some areas changing dramatically and others changing insignificantly (Bamforth 1990).

According to Bamforth (1990), the most reliable indicator of the effects of the Little Ice Age (both for temperature and precipitation) is tree-ring analysis. He concludes that, although the southwest plains in North America actually experienced more arid conditions, the northeastern plains might have had slightly cooler winters, but that there is “no evidence for cooler summers” (Bamforth 1990:361); and furthermore, “these studies show no evidence for any substantial increases in total annual precipitation within the period for which ring

sequences are available” (Bamforth 1990:363). Therefore, even during the Little Ice Age, there appears to have been relative ecoclimatic continuity in the Winnipeg River region. However, since ecoclimatic changes are region specific, it is possible to reevaluate the ecology of the study region using historic documentation.

### **2.3 Ecological Reconstruction by Historical Analogy**

It is argued that there was a relative ecoclimatic continuity in the Winnipeg River region for the period of study. Historic documents were examined to verify the changes during the post-European contact period for the region. Although historical references to climate and vegetation are very sketchy and must be treated as circumspect, they do provide some indication of the ecoclimatic conditions at the beginning of the historic period. With this in mind, historical evidence of ecoclimatic conditions were compared to contemporary descriptions summarised above.

Historical descriptions of the Mid-Boreal ecoclimatic region, tend to confirm an ecoclimatic continuity. Duncan Cameron (Cameron 1960), who kept a diary during his years in the “Nipigon Country,” wrote a description of the biota of this region in 1804. This description mirrors the present-day Mid-Boreal ecoclimatic region (Cameron 1960:240-241). The Mid-Boreal faunal and floral markers presented by Cameron were moose, beaver, porcupines, loons, magpies, raspberries, blueberries, gooseberries and sandberries. Alexander Henry, the Elder provides a description of the area in 1775 that also is consistent with Mid-Boreal characteristics (Henry 1969:239).

Continuing west through the Rainy River-Winnipeg River system, in 1857, Palliser

described the Rainy Lake area as “woods and streams that teemed with wildlife and fish” (Spry 1968:75-77). These woods were probably much like the maple and birch woods described by Alexander Henry, the Elder in 1775 (Henry 1969:239-240) and William Cameron in 1823-24 (HBCA B.105/e/3, fo. 1 and HBCA B.105/e/4, fo. 1). During the 1790s Alexander McKenzie described the area around the Rainy Lake fort as a “beautiful meadow surrounded with groves of oaks;” while the north side of the river consisted primarily of groves of oak, maple, pine and cedar, the south side consisted of maple, white birch, cedar and alder (Lamb 1970:106). These historic descriptions of the Rainy River area would be appropriate now. The north-side of Rainy River consists of mixed-woods of the Low Boreal ecoclimatic region, and the south-side begins the Grassland transition zone typical of wetter parklands.

This assessment of the grassland transition zone is also in keeping with an earlier report by La Vérendrye in 1729 while on his journey from Lake of the Woods to Lake Winnipeg down the Winnipeg River (Burpee 1927). To the east of the Winnipeg River, he describes the woods as filled with “plentiful” beaver, moose and marten, and to the west buffalo are abundant (Burpee 1927:59-60). The present-day similarities appear to continue to the mouth of the Winnipeg River at Lake Winnipeg where, in the Fort Alexander District Report of 1822/23, the area is reported to have elm, ash, poplar and aspen appropriate to a Low Boreal ecoclimatic region (HBCA B.4/e/1).

Directly south of Lake Winnipeg close to the mouth of the Red River in 1737, La Vérendrye noted that bison were present at Fort Maurepas I “year round” (Burpee 1927:251). Later in the 1790s, Alexander McKenzie commented that the area around the Red River was

“covered with herds of the buffalo and elk, especially on the Western side” while the eastern side was well-wooded and “abounding in beavers, bears, moose, moose-deer, fallow-deer” (Lamb 1970:111). However, he also states that between the Assiniboine and Red Rivers to the Missouri River, it was “almost a continual plain” that, “produce[d] a short grass. Trees are very rare; nor are there on the banks of the river sufficient, except in particular spots, to build houses” (Lamb 1970:112). That McKenzie speaks of continual short-grass plains, and lack of trees is further supported by Henry Hind in 1857 who states,

The splendid prairies bordering on the southern shores of Lake Manitobah may be said to begin at Oak Point. Their boundary is an imaginary line extending southeasterly towards the Indian Settlement on Red River on the one hand, and to the old lake Ridge, where it is cut by White Mud River on the other; a distance in an air line of one hundred and ten miles. North of this line the country is in general marshy, full of reticulating lakes and low aspen-covered ridges (Hind 1969:76-77).

Although Hind’s report implies that the transition zone is actually north of this line, I would argue that the whole of the area just north of the Assiniboine River (and possibly down the Red River) is the aspen-parkland grassland transition zone. That it appeared as grassland to Hind was due to large bison herds trampling aspens and grazing tall-grasses, and deforestation by fire.

From this brief review of historic literature, I conclude that the present-day Mid-Boreal and Low Boreal ecoclimates are very similar to those of the historic period. I suggest also that only with the elimination of bison herds and a decrease in the numbers of fires, did the prairies described in the past become tall-grass prairies and aspen parklands. Therefore, although the “prairie” region was somewhat extended by disturbance, for the study period the ecoclimatic zones are considered continuous.

## 2.4 Sample Population

The primary focus of this palaeodietary study is on human remains. Although environmental, historic, ethnohistoric and archaeological evidence is considered in this study, the emphasis lies on data directly obtained from stable isotope analysis and dental pathologies of the remains. It is necessary, therefore, to know the composition of the sample population in order to determine its dimensions.<sup>3</sup> Individual summaries, and summary demographic statistics will be presented here.

The skeletal data derive from the following five sites in the Winnipeg River region of southeastern Manitoba: Fort Alexander, Whaley Cairn, Slave Falls, Bjorklund and Whitemouth Falls (Figure 2.6). To date approximately sixty (60) individuals have been recovered from these burial sites. Of these 60 individuals, only 33 are well provenienced and of sufficient completeness to be studied in any detail. (See Appendix II for the individual summary and Appendix III aging sexing methods).<sup>4</sup>

The 33 individuals consist of nine (9) females, six (6) males and eighteen (18) individuals of indeterminate sex. The large number of individuals of indeterminate sex is a

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<sup>3</sup> Typically representation of a population would be incorporated into the statistical analysis of the sample population. However, given the nature of the discovery of the human remains used in this study (i.e., mainly salvage operations), and the diversity of burial practices by various cultures, the reconstruction of sample populations is not possible. It will, therefore, be assumed that the sample is “representative” of the populations from which they come.

<sup>4</sup> Those individuals only represented by one and two osteological elements were only studied for pathologies (including x-rays) but were otherwise disqualified from stable isotope (since definite identification of individuals could not be made) and dental analysis (some displaying possibly modern traits eg., baby bottle syndrome and possible surgical extractions of wisdom teeth). Those remains with questionable proveniences (see Fort Alexander in Appendix II) were also disqualified from all analysis.

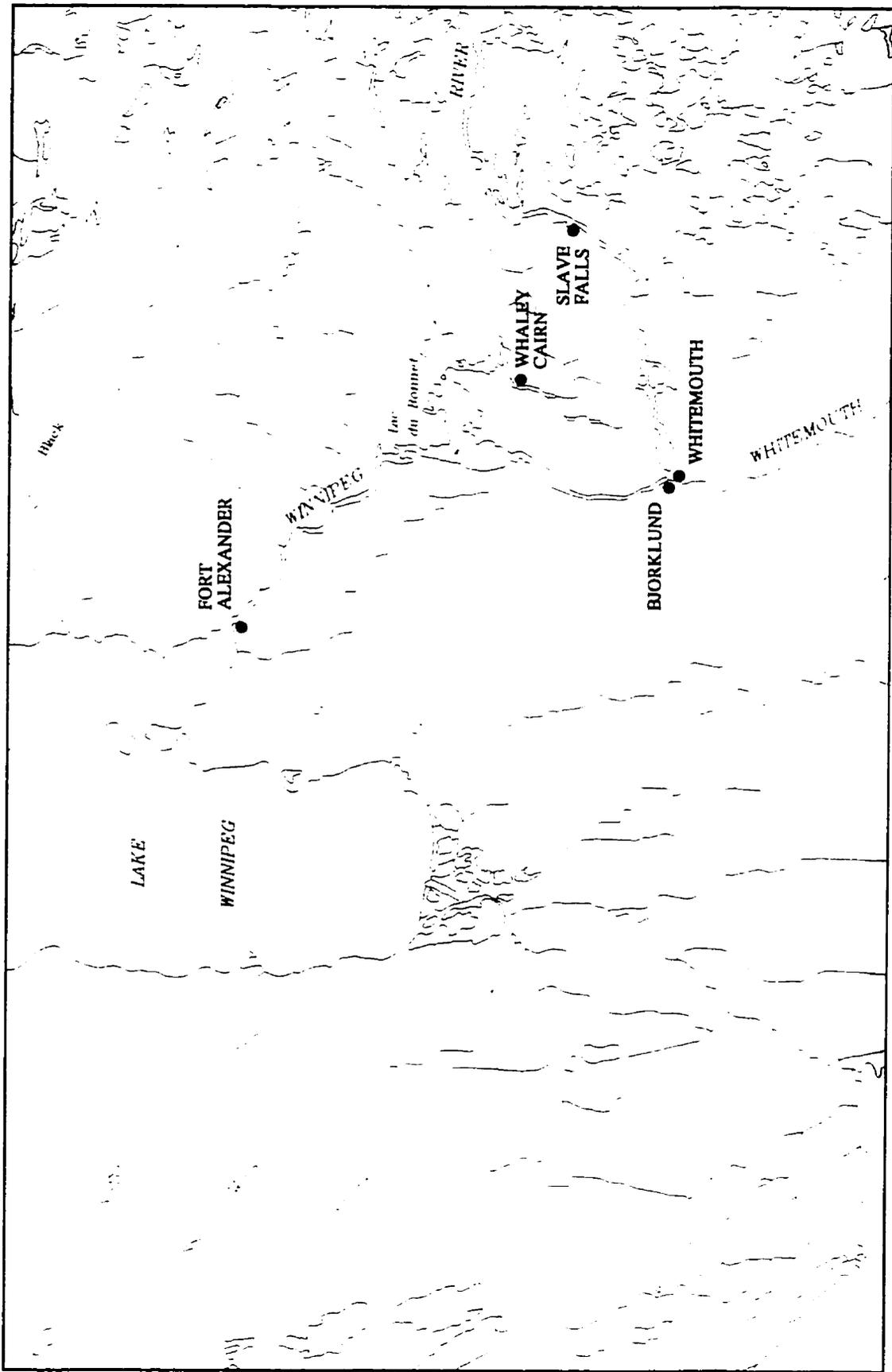


Figure 2.6 - Study Sites of the Winnipeg River Region

function of age. Twelve of the eighteen of indeterminate sex are immature individuals ranging in age from infancy (perinatal) to adolescence (Table 2.1). Females are somewhat better represented than males (27% and 18% of sample, respectively). By age category, middle adults (36%) are best represented by this sample, while infants are not represented at all. Young adults (12%), perinates (6%), children (12%), juveniles (12%), adolescents (9%), and old adults (9%) have similar relative frequencies.

| <b>Table 2.1</b>           |                   |             |              |               |
|----------------------------|-------------------|-------------|--------------|---------------|
| <b>Sex by Age Category</b> |                   |             |              |               |
| <b>Age<sup>5</sup></b>     | <b>Female</b>     | <b>Male</b> | <b>Ind</b>   | <b>Total</b>  |
| Perinates                  | 0(0) <sup>6</sup> | 0(0)        | 2(0)         | 2(0)          |
| Infant                     | 0(0)              | 0(0)        | 0(0)         | 0(0)          |
| Child                      | 0(0)              | 0(0)        | 4(2)         | 4(2)          |
| Juvenile                   | 0(0)              | 0(0)        | 4(3)         | 4(3)          |
| Adolescent                 | 1(1)              | 0(0)        | 2(1)         | 3(2)          |
| Young Adult                | 1(0)              | 1(0)        | 2(0)         | 4(0)          |
| Mid Adult                  | 5(3)              | 4(3)        | 3(0)         | 12(6)         |
| Old Adult                  | 2(2)              | 1(1)        | 0(0)         | 3(3)          |
| Ind                        | 0(0)              | 0(0)        | 1(0)         | 1(0)          |
| <b>Total</b>               | <b>9(6)</b>       | <b>6(4)</b> | <b>18(6)</b> | <b>33(16)</b> |

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<sup>5</sup>

**Age Categories**

(Modified Buikstra et al. 1994:36; Schentag and Meiklejohn 1985)

Perinate pre-term to 3 months post-term; Infant <2 years; Child 2-6 years; Juvenile 6-12 years;  
Adolescent 12-18 years; Young Adult 18-34 years; Middle Adult 34-49 years; Old Adult 50+ years

<sup>6</sup> Bracketed counts are the frequencies used for dental analysis.

The individuals from these five sites represent both pre-European contact and post-contact populations. The pre-contact sample is best represented consisting of twenty-nine individuals (i.e., 8 females, 6 males and 15 individuals of indeterminate sex). The post-contact era is only represented by four individuals (i.e., 1 female and 3 children of indeterminate sex). However, given the significant time span of the pre-contact period compared to the post-contact time span, the sample size is more evenly distributed than is immediately recognisable.

It is the usual practice in diachronic archaeological studies to describe the sample according to “pre-ceramic” and “post-ceramic” groups. The pre-ceramic sample consists of 10 individuals (2 females; 3 males; and 5 indeterminate). However, given the time span of this study this technological division is insufficient. The rather large gaps between radiocarbon accelerator mass spectrometry dates (AMS) for the human bone collagen for these sites required further delineation (especially for the Archaic sample). The 1997 AMS dates are listed in Appendix IV while radiocarbon dates assayed from other studies are listed in Appendix V.

One of the largest problems with further dividing the sample into better sub-units is terminology. Since this study focusses on the plains-forest transition zone, it is difficult to decide which terminology to use (i.e., Woodland or Plains Woodland), therefore, both terms are used depending on region and character (orientation) of the archaeological phase. The categories were divided into Late Woodland/Historic (Fort Alexander), Middle Woodland (Bjorklund), Early Plains Woodland (Whaley Cairn), late Archaic (Slave Falls) and early

Archaic (Whitemouth Falls) (Table 2.2).<sup>7</sup>

According to the archaeological associations which were indicated by the radiocarbon dates, the sample is skewed towards the Woodland/Plains Woodland complexes: Archaic (n=10 or 30% of sample); Woodland/Plains Woodland (n=19 or 58% of sample); and Historic (n=4 or 12% of sample). However, the Woodland Period represents two possible different ecoclimatic zones creating an interesting and important division.

| Archaeological Tradition | Female   | Male     | Ind       | Total     |
|--------------------------|----------|----------|-----------|-----------|
| Early Archaic            | 1        | 1        | 0         | 2         |
| Late Archaic             | 1        | 2        | 5         | 8         |
| Early Plains Woodland    | 5        | 3        | 9         | 17        |
| Middle Woodland          | 1        | 0        | 1         | 2         |
| Late Woodland-Historic   | 1        | 0        | 3         | 4         |
| <b>Total</b>             | <b>9</b> | <b>6</b> | <b>18</b> | <b>33</b> |

Much of the sample is skewed due to the comparatively large sample size of the Whaley Cairn and Slave Falls sites. The Whaley Cairn site comprises over half of the sample size (51%) while the latter site comprises 24% of the sample. The other sites are rather poorly represented — Fort Alexander 12%, Whitemouth Falls 6%, and Bjorklund 6% (Table 2.3).

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<sup>7</sup> See Gregg (1985) for terminology. The terms “early” and “late” Archaic were required for further delineation of significantly different time periods. The individuals were divided into categories according to the 1997 AMS dates.

Some significant gaps in the sample are evident when age category is studied by site (Table 2.4). The Slave Falls site lacks both very young (i.e., infants and children) and very old individuals, and the Whitemouth Falls site is only represented by 2 individuals (i.e., one young and one old adult). Since these sites constitute the Archaic sample, the middle age ranges are well represented but not the young age categories. On the other extreme, the Late Woodland site, Fort Alexander, is clearly better represented by younger individuals than middle-age or older individuals. The Middle and Plain Woodlands samples also demonstrate reasonable representation by age category, but when examined by site present data gaps. The Bjorklund site (i.e., one child and one old adult) is not represented at all in the middle age categories. The Whaley Cairn site contains individuals under each age category with a bias towards the young and middle adults.

| <b>Sex</b>    | <b>Bjorklund</b> | <b>Fort Alexander</b> | <b>Slave Falls</b> | <b>Whaley Cairn</b> | <b>Whitemouth</b> | <b>Total</b> |
|---------------|------------------|-----------------------|--------------------|---------------------|-------------------|--------------|
| <b>Female</b> | 1                | 1                     | 1                  | 5                   | 1                 | 9            |
| <b>Male</b>   | 0                | 0                     | 2                  | 3                   | 1                 | 6            |
| <b>Ind</b>    | 1                | 3                     | 5                  | 9                   | 0                 | 18           |
| <b>Total</b>  | 2                | 4                     | 8                  | 17                  | 2                 | 33           |

The 33 individuals studied were examined for pathologies and other indicators of diet. The dimensions of the sample change slightly for analysis of dentitions and stable isotope analysis since a number of individuals had to be excluded. Sixteen individuals remain

in the sample for dental analysis (see Table 2.1). The sample size used in the stable isotope analysis was 20 individuals (i.e., Whaley Cairn 7 individuals, Fort Alexander 4, Slave Falls 7, Whitemouth Falls 1 and Bjorklund 1). Some of these individuals (n=7) had the stable isotopic analysis repeated at different isotope laboratories, to better compare precision between facilities. These amendments to the general sample are discussed later in the relevant chapters.

| <b>Age</b>   | <b>Bjorklund</b> | <b>Fort Alexander</b> | <b>Slave Falls</b> | <b>Whaley Cairn</b> | <b>Whitemouth</b> | <b>Total</b> |
|--------------|------------------|-----------------------|--------------------|---------------------|-------------------|--------------|
| Perinate     | 0                | 1                     | 0                  | 1                   | 0                 | 2            |
| Child        | 1                | 2                     | 0                  | 1                   | 0                 | 4            |
| Juvenile     | 0                | 0                     | 3                  | 1                   | 0                 | 4            |
| Adolescent   | 0                | 1                     | 1                  | 1                   | 0                 | 3            |
| Young Adult  | 0                | 0                     | 1                  | 2                   | 1                 | 4            |
| Mid Adult    | 0                | 0                     | 3                  | 9                   | 0                 | 12           |
| Old Adult    | 1                | 0                     | 0                  | 1                   | 1                 | 3            |
| Ind          | 0                | 0                     | 0                  | 1                   | 0                 | 1            |
| <b>Total</b> | <b>2</b>         | <b>4</b>              | <b>8</b>           | <b>17</b>           | <b>2</b>          | <b>33</b>    |

## CHAPTER 3

### The Archaeological Record of the Winnipeg River Basin

The study of archaeology is relevant to subsistence reconstruction in a number of ways. One of the most frequently used palaeodietary techniques is faunal and floral analysis of archaeological remains. It provides some evidence of the resources that were regionally available and exploited. Burial sites, however, are specialised sites that often do not contain floral and faunal remains, or, if they do contain these elements, they are ceremonial and have inferences beyond the simple purpose of subsistence.

As archaeological data, the burial sites studied here are difficult to analyse in many respects. The foremost problem is determining to which archaeological culture each burial belongs. All, but one, of the burial sites lack diagnostic artifacts hindering the association with specific archaeological periods or phases.<sup>1</sup> The stratigraphy of the burials yields some evidence as to period, but radiocarbon accelerator mass spectrometry dates (CAMS) were

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<sup>1</sup> Due to the various taxonomies used in archaeology to define groups of artifacts, people, sites, and time periods, it is necessary to indicate the terms that I will use although loosely.

“Phase” (synonymous with “complex”): relates to interrelated sites, features and artifacts that share similar technologies, functions and styles within a given time frame and geographical distribution.

“Period” (synonymous with “tradition”): is a series of phases (i.e., groups of elements passed down through time) that are interrelated by technology and gross subsistence strategy.

“Culture” (read “archaeological culture”): refers to the people and groups of people using and creating the material culture of a “phase.” The people of a single phase are assumed to have similar subsistence and settlement strategies although they may not share a common language. Therefore, “archaeological culture” does not correspond to the anthropological terms of ethnic group, tribe, band or culture.

used to establish much of the chronology. This reliance on AMS dates covering a 6000 year period assumes a degree of error,<sup>2</sup> and allows for only vague archaeological associations necessitating broad descriptions of archaeological cultures and their subsistence strategies. Since archaeological associations of these burials are indefinite, comparisons to other archaeological studies are limited. Another problem encountered is the dearth of floral and faunal remains associated with the burials. Only three of the five burial sites had direct association with faunal or floral remains. Those that did contain flora and fauna samples had ceremonial significance, and, therefore, may not be directly associated with subsistence strategies.

Each of the five sites are unique in time, location and, probably, archaeological association. A very brief summary of the archaeological record of southeastern Manitoba is provided for reference. The sites are examined in chronological order (determined primarily according to AMS dates) — the most recent site first. Each site will be described in terms of its palaeo-environment, mortuary customs, and the associated artifacts present. Since this is a study about subsistence strategies, site specific as well as general subsistence strategies are discussed for each relevant culture. Finally, the sites, burials and subsistence strategies will be compared in order to explicate dietary and cultural similarities and differences.

The prehistory of Manitoba is generally divided into three major temporal “periods”

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<sup>2</sup> Absolute dating techniques, such as AMS, frequently do not clarify the situation. Many dates and ranges recorded in past reports have been changed to calendric dates without having been calibrated. These uncalibrated dates are often slotted into range sequences based on calibrated and non-calibrated dates. Apart from this problem, there is always a degree of error associated with any absolute date. Therefore, the most reliable way of determining an archaeological association of a burial is to have a diagnostic artifact(s) present. Failing this, other methods of determining cultural identity must be utilised.

that are arbitrarily defined by technological changes. Often the names for the periods vary according to region and the archaeological perspective at the time of interpretation. The earliest period in Manitoba's archaeological record is characterised by the Pleistocene-early Holocene big game plains hunters that consists of two periods: the Llano or Palaeo-Indian Period (17,000 - 10,500 BP), and the Plano or Early Plains Indian Period (10,500 - 8,000 BP). The former hunters used lithic spear points (i.e., Pre-Clovis and Clovis) to kill megafauna such as mammoths and ancient bison while the latter hunters primarily exploited bison using spears (Folsom, Plainview, Agate Basin, Hell Gap, Alberta, Cody and Scottsbluff), but may have used spear throwers known as atlatls (Dyck 1983:69-73). Much of Manitoba during this period of time was covered by glacial Lake Agassiz which eventually discharged into Hudson Bay circa 10,000 BP (Steinbring 1980:26). While Clovis points have been confined to surface finds in southwestern Manitoba, Plano points have been excavated throughout southern Manitoba (Pettipas 1970:15-18).

The next major period in Manitoba prehistory is called the Archaic or Middle Plains Indian Period (7700 - 1850 BP). This period coincides with a ecoclimatic change circa 8500 BP from a cooler wetter climate (i.e., the Boreal Episode) to a warmer drier climate (i.e., the Atlantic Episode) (Dyck 1983). The climatic change induced alterations in regional flora and fauna, and, therefore, changes in subsistence strategies and technology. The study area appears to be inhabited largely by Plains Archaic populations (Oxbow, McKean, Duncan, Hanna, Pelican Lake and Sandy Creek) who hunted bison almost exclusively with spears and atlatls (Dyck 1983). Three other complexes (i.e., the Northern Agate Basin, Shield Archaic and the Caribou Lake complex) that primarily exploit caribou occur in the boreal and mixed

forests just north and north-east of the study area. Although the projectile points of these northern groups have been found mainly in northern and central Manitoba, it is possible that they had some influence on the more southern plains-oriented groups (Buchner 1984; Hlady 1970a; Meyer 1983; Wright 1970).

The last archaeological period in Manitoba prior to European contact is known as the Late Plains Indian, Plains Woodland or Woodland period (2000 - 170 BP) in which two major technological advances were made: the production of ceramic pots, and the bow and arrow (Dyck 1983:110; Gregg 1994:74). This period also experienced population growth possibly due to an increased reliance on wild rice circa 1150 BP and subsequent semi-permanent villages (Dyck 1983:126). Another significant adaptation during the latter part of this period was the rise of horticultural practices (known as the Plain Village Complex) from the Middle Missouri region circa 1050-750 BP (Dyck 1983; Gregg 1994). The increased population in the northern Great Plains promoted increased interaction of two fundamentally different subsistence traditions — plains (west) and woodland (east) (Gregg 1994; Meyer and Hamilton 1994).

The first two archaeological phases that include ceramics in their tools kits are the Besant and Avonlea. The Besant phase is the earliest phase in the Plains Woodland period, and, as Vickers (1994:9) argues, demonstrates the characteristics of a culture in transition,

it is apparent that the Besant phase represents a culture in technological transition. Atlatl technology was being replaced by the bow, and ceramics were being added to the material culture inventory.

Both, the Besant and Avonlea, were plains peoples who hunted bison almost exclusively.

Although Besant sites are found in southeastern Manitoba, Avonlea sites typically are located further west in southwestern Manitoba and Saskatchewan. According to the archaeological record in the Winnipeg River region, the later Plains Woodland phases (eg., Laurel, Blackduck, and Selkirk) subsisted on a broader range of resources from both the forests and the plains although they are predominantly described as Woodland phases.

Ceramics were not prevalent in southeastern Manitoba until the appearance of Laurel vessels about the time of Christ (2100-1000 BP) (Meyer 1983). It is debatable whether the Laurel culture moved into Manitoba from the eastern and southeastern woodlands with their knowledge of ceramic pottery technology, or whether they were a culture already present in Manitoba who quickly took up the new technology. Whatever the case, they were the first group in Manitoba to be known for their pottery that soon spread across Manitoba. Another point of debate is whether the Blackduck (1150-550 BP) developed out of the Laurel phase, or if they infiltrated southeastern Manitoba and northwestern Ontario from Minnesota, and quickly swept across southern Manitoba eventually replacing Laurel (Meyer and Hamilton 1994:112; Walde et al. 1995:20). Despite the debate about their origin, the Blackduck appear to have relied on hunting, fishing and wild rice in the forests of Manitoba, Minnesota and Ontario, but hunted bison on the plains (Walde et al. 1995:20). The Selkirk and Sandy Lake phases (550 BP to contact) were the last to occur in southeastern Manitoba, and were present at the time of European contact (Dyck 1983). They, too, appear to have had a dichotomous economy relying on wild rice, fish and small game in the woodlands, and bison on the plains.

The sites used in this thesis represent each period in the archaeological record except for the Palaeo-Indian period. Each site probably represents a different culture and subsistence

strategy adapted to forests and/or plains. Each site is described below. It is apparent that, while there was a fairly distinct split between plains and woodland phases through the Archaic period, the population increase, new technologies and subsistence strategies blurred the plains/woodland distinctions for groups during the Plains Woodland period. Some archaeological cultures remain somewhat easier to define such as the Avonlea and Besant plains cultures, and the Laurel woodland group; however, the degree of interaction between plains and woodland groups obfuscates the true origin of even these phases. A more intensive study of their subsistence strategies can help in rectifying some of these problems since subsistence strategies throughout time are usually maintained until change is necessary.

### **3.1 Fort Alexander (FA3)**

#### **3.1.1 Description of Site, Burial and Associated Artifacts**

The Fort Alexander site is located near the mouth of the Winnipeg River on the eastern coast of Lake Winnipeg within the mixed deciduous and coniferous forest of the Low Boreal ecoclimatic zone (Figure 2.6). Slightly further north and east the vegetation quickly changes to a predominantly coniferous forest of the Mid Boreal ecoclimatic zone. The present vegetation of this area is probably very much as it was during the historic and prehistoric periods. The Fort Alexander area then is a transition zone between the two forest zones.

The four Fort Alexander skeletons (two burial features) were excavated by request of the Sagkeeng First Nations at Fort Alexander in 1976 (Steinbring 1978:9). Two excavations were undertaken to salvage the burials which were eroding out of the

southwestern bank of the Winnipeg River. The first burial was located close to the site of the Fort Alexander post (formerly Fort aux Bas de la Riviere) in a “non-Christian” burial ground. The second burial, also threatened, was located approximately 10 metres away from Burial Feature 1.

The oblong pit of Burial 1, oriented in a west-east direction ( $80^\circ$ ), became discernable at 9 inches (23 cm) depth below surface (dbs) (Steinbring 1978:9). At approximately 30 cm dbs, the pit decreased in size at the west end creating a step which supported the ends of some poles that were covered by bark. Once these structures were removed, an extended primary burial (supine) was uncovered. (See Appendix II for individual identification.) The head lay to the west, and the legs would have extended towards the east, but were disturbed having eroded to the bank bottom. Within the pelvis were almost full-term perinate (foetus) bones; thus, this female may have died due to complications during child birth. The erosion of the bank had undermined the step structure to the east, thus the poles and bark fell upon the remains causing some damage to both interments. Based on oral history, Steinbring (1978:9) concludes that this was an Ojibwa burial,

The interment type is now predictable as an aboriginal Ojibwa (Saulteaux) one with a pole and bark rack arranged above the body. This had been described to the writer by elderly informants at the little Black River Reserve, 20 miles to the north, in 1963 and 1964. The pole rack produces a “spirit chamber” above the body after filling. This was to house the person’s spirit for four days after which it proceeded to the west where it took up its abode in the “land of the dead.” Food was sometimes placed upon the false floor, and a birchbark tube was put down during the fill so that the spirit would have an easy time leaving at the end of four days. The spirit escape tube was not encountered during excavation, but a few pieces of charred wood and some ash were present just above the false floor.

That Steinbring associates this burial as Ojibwa based on oral accounts of a burial chamber is somewhat questionable since Mandelbaum (1979:150-155) was told (also from oral histories collected during 1935-36) of various types of burial chambers made by the Plains Cree. These structures were highly variable depending on seasonality, availability of building materials, location at the time of death, and preferences previously stated by the deceased. During the Late Woodland Period, many ceremonies and customs were shared by various Native groups. For example, the Sun Dance and Ghost Dance are known to have originated in the southwestern plains yet were, and are, performed by cultures of the northeastern plains; and the sweat lodge was not used by a number of groups until historic times (Hultkrantz 1973; Mandelbaum 1979; Milligan 1969; Powers 1977). The burial, then, at Fort Alexander was not necessarily of an Ojibwa woman.

There were a number of associated artifacts. Small white seed beads were found at the wrists and around the neck inferring that they were either jewellery or clothing adornments (Steinbring 1978). Also around the neck were forty blue opaque trade beads that were classified and dated according to Quimby (1966) as "common" between 1760 and 1820 (Hall 1977; Steinbring 1978:10). A square brown gunflint was found folded into this females right elbow and an iron belt buckle in the appropriate position at her waist. Specific dates for these objects should be obtainable but, as yet, remain unknown though obviously historic.

Burial 2 was highly disturbed by bank erosion. The relatively unaffected portion of the burial was excavated in October 1976. Reports of this excavation are scant and recording incomplete. It has not been reported how many individuals were recovered from this burial,

or in what position they were found. According to Steinbring's (1978) article, there only appears to have been one child in this interment; however, incomplete catalogue sheets indicate that two children were present, and there exists a third child's cranium within the FA3 collection which is not noted.

Numerous artifacts are associated with Burial 2. At least 8 types of beads (n=208), were found around the neck and torso area that are not "classifiable under the Kidd or Stone typologies (Steinbring 1978:10). A squared, dark brown gunflint "of British form" was found close to the "area of the right elbow," a spoon and cup were in the area of the lower limbs, and a belt buckle "identical to that found in situ in Burial No. 1 was recovered 'towards the right hand side'" (Steinbring 1978:10-11; and Callaghan 1976 as cited in Steinbring 1978). Red ochre was also associated with the burial; thus mixing the "past" and the historical. An unclassified brass button with the inscribed word "(B)OUSFIELDS" was "not fixed as to position and may not be associated."

One artifact found in association with the burial provides a possible range of dates according to historic artifact typology. An iron trade hatchet, found "at the skeleton's left side," is said to be similar to one shown in Stone (1974, Figure A Type 1) and Russell (1974:231) dated between 1750 and 1760, and similar ones typed by Woolworth and Birk (1975) from Basswood River dating to the late 18th century (Steinbring 1978).

Steinbring (1978:11) concludes that Burial 1 and Burial 2 are related given the placement of the gunflint at the elbow and the presence of the belt buckle, and are of "probable timing of late 18th - early 19th century." He further suggests that the demographics at Fort Alexander is the typical pattern common to epidemics (that is, "either

very young or very old”). He cites evidence of smallpox as a possible cause of death,

La Verendrye had noted a severe smallpox epidemic at the mouth of the Winnipeg River in 1737 (Burpee 1927), but the people affected at that time were probably Cree. The Ojibwa were struck with a major smallpox epidemic in 1770 (Heagerty 1928:45) which spread north and west of Lake Superior. In 1781, Thompson (Tyrrell 1916:321) describes a severe smallpox epidemic along the Churchill River which had spread, in part, from the area embracing the Rainy and Winnipeg Rivers (Ray 1974:105). A further epidemic of smallpox is noted for the Ojibwa at Sault Ste. Marie in 1802-1803 (Heagerty 1928:48), but its possible effect on the lower Winnipeg River is not identified. At present, it seems plausible that some of the burials at the Fort Alexander Cemetery Site may be attributed to late 18th century epidemics. . . . there are, of course, many other kinds of epidemics like influenza and measles which also had devastating effects upon Native populations in the 18th and 19th centuries.

Although a high probability exists that epidemics were involved with numerous interments at Fort Alexander (FA3), given the number of excavated burials (n=4) all of which were young individuals, statements about demographics and epidemics are difficult to make with such evidence. Furthermore, Burial 1 could represent a death by childbirth given the age of the female ( $15 \pm 3$  years) and the perinate (i.e., close to term).

### **3.1.2 Radiocarbon Assays and Archaeological Associations**

Rather confounding evidence is indicated by radiocarbon AMS dates for the two burials. After being dated, it was found that each unit contained individuals from possibly two different periods despite the fact that both burials had the same placement of similar historical artifacts. The Burial 1 AMS date of  $250 \pm 60$  years BP yielded one of two calibrated calendar intercepts of 1780 AD with a  $2\sigma$  range of 1727-1813 AD.<sup>3</sup> This calendar

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<sup>3</sup> See Appendix IV for calibrated dates and ranges ( $2\sigma$ ).

date range corresponds well to the 1760-1820 AD range given for the trade beads found within the burial. The AMS date for Burial 2 ( $450 \pm 60$  BP) yielded two calibration intercepts (1440 AD and 1620 AD) and  $2\sigma$  ranges of 1397-1532 AD and 1558-1631 AD, respectively. These calibrated dates are considerably earlier than those for Burial 1. Given the similarities between the burials and the presence of mid-18th century artifacts in each burial, the AMS date of Burial 2 is circumspect. Both dates, however, do indicate a Late Woodland/Historic association.

Archaeological associations in this region for this time period are Selkirk (300 BP to historic) and Blackduck (1150 to 200 BP)<sup>4</sup> complexes (Syms 1977). There has been little success in trying to determine how these complexes are representative (if they are representative) of the historic Cree, Assiniboine and Ojibwa cultures. It is known that Selkirk pottery, if not Blackduck pottery, was still being made when the Europeans first “entered” the region. Specific historic band associations with ceramic types are difficult to make; however, it is widely accepted that Algonquian-speaking people made Selkirk pottery and possibly Blackduck (Meyer and Hamilton 1994). Although ethnic identity has much to do with diet, this argument is beyond the scope of this paper. More information is given with regards to these historic groups in the next chapter.

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<sup>4</sup> Quoted as passing into the Historic period in Ontario (Syms 1977:101).

### 3.1.3 Archaeological Evidence of Diet by Association

Since these are historic burials the individuals interred were either Cree or Ojibwa. The ethnohistoric and historic evidence of diet of the Cree and Ojibwa is dealt with in detail in the next chapter. However, historic evidence of native diet tends to be skewed towards the perspective of the European observers. In an attempt to compensate for any oversights, the archaeological evidence of subsistence strategies for the Blackduck and Selkirk phases are described below.

In eastern Manitoba, Selkirk and Blackduck complex distributions are very similar except the most western limit of Selkirk sites is the Red River while Blackduck sites are found throughout southern Manitoba. Many sites along the Winnipeg River are multicomponent sites that often include both Selkirk and Blackduck assemblages (Buchner 1982a). Often these sites are in transition zones where floral and faunal resources are highly diverse (eg. Fort Alexander, Otter Falls and Channel Island). This ecological diversity is demonstrated in the archaeological record for these complexes.

Selkirk and Blackduck complexes demonstrate very similar subsistence strategies, not only by their site selection along the Winnipeg River, but by the diverse exploitation of flora and fauna in the region (Buchner 1982a). Amongst the fauna in Selkirk and Blackduck sites of eastern Manitoba, beaver, moose and caribou are prevalent, however, *Canis* (dog/wolf), deer, pike, muskrat, bird, black bear, and rabbits were also exploited (Buchner 1979b and 1982a; Saylor 1977).

Wild rice is believed to have been a dietary staple, but very little archaeological evidence has been found to support this claim. This paucity of evidence, I believe, is more

reflective of the state of archaeological analysis rather than the lack of evidence at sites. Steve Zoltai (1989) found charred *Zizania aquatica* (wild rice) and *Chenopodium hybridum* (Maple-leaved goosefoot) (amongst other plants) in soil samples taken from the 1976 excavations at Wanipigow Lake Beach (EgKx-1). Zoltai (1989:123) states that the presence of these plants at the site demonstrate “a broad knowledge and use of plant resources by the Late Woodland hunter-gatherers of this region,” and “particularly indicated to have been probably intensively harvested plants.” However, Stanley Saylor (1976:26) in a preliminary report for that same field season, states that “wild rice ha[d] not as yet appeared in the floral analysis.” Both Saylor’s and Zoltai’s work demonstrates the need to look for floral evidence in the archaeological record which is often overlooked.

### **3.2 Bjorklund (EaLa-3)**

#### **3.2.1 Description of Site, Burial and Associated Artifacts**

The Bjorklund site is located on the west side of the Whitemouth River near its confluence with the Winnipeg River. This area is presently characterised as a transition zone between the mixed forest to the east, and the aspen parkland and the grasslands to the west. It is a multi-component site ranging from the Archaic to Late Woodland Traditions that was excavated by field school students and professional crews from 1973 to 1974. There were eight features excavated in those years — two of them were burial pits (Feature 6-74, excavation unit S55E30 Level 15, approximately 76 cm dbs; and Feature 1-75, excavation unit S50E25 Levels 2 to 10, approximately 8 to 50 cm dbs).

Burial Feature 6-74 containing a single skeleton (Z17) was found directly under a

“hearth” Feature 5-75 (Levels 9-11, 43 to 56 cm dbs) consisting of approximately 7.5 cm of ash, a “small, plain (Laurel?) sherd, and the remains of fish, beaver, mammal and mollusc shells” (Buchner 1982b:104). Although Feature 6-74 was recorded at level 15, a “sterile” level between Level 3B and 4A (i.e., 15 to 18 cm dbs) is believed to represent some process in the backfilling of the burial pit (Buchner 1976a:2 and Buchner 1982b:6). If this is so, a burial occurring between and including Levels 3B and 4A would indicate a relative date with either Laurel or Blackduck Complexes, or even a transition period between the two complexes.<sup>5</sup>

The anomalous “smooth” Laurel sherd in association with the burial could represent such a transitional phase with Blackduck as represented in ceramic typology at the Bjorklund site. As Buchner (1982b:20) states, “contemporaneity and the considerable overlap in technological, morphological and decorative attributes between the two wares in late Manitoba-Blackduck times is indicative of a genetic relationship.”

The burial (Z17) is an older woman (40 to 55 years of age). She was placed in a flexed position (i.e., legs tightly flexed but not closely “bound” to the torso), semi-prone lying on her right side, legs to the east, head to the west facing in a southwesterly direction. A yellow stain was noted around the ventral aspect of the floating ribs (possibly due to heat penetration from the hearth above). Ochre was used on the remains as well as the burial pit (Buchner 1982b:105).

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<sup>5</sup> In this area of the site, 35 to 40 cm dbs (Levels 7B-8B) was said to be “pre-ceramic;” 20 to 25 cm dbs (Levels 4B-5B) was the “initial appearance of ceramics” (Buchner, 1976a); Levels 2A-5B (8-25 cm dbs) were Laurel levels; Levels 2A-4A (4-18 cm dbs) were “Laurel-Manitoba Transitional Vessels;” and Levels 1- 3B (1-15 cm dbs) were “Manitoba”/Blackduck vessels (Buchner 1982b).

Faunal and lithic artifacts, and ecofacts were associated with this burial, unfortunately none of them were diagnostic. The lithics consist of flakes, bifaces, scrapers and choppers. One rhyolite knife/chopper of considerable size (A29-27000, Buchner 1982b:153, Plate 31a) was placed on top of her upper (left) arm at the elbow. This is somewhat similar to the Fort Alexander skeletons that had gunflints next to their right elbows. Close-by, lying on her left ribs, was a fine-grain quartzite scraper (A29-27025, Buchner 1982b:154, Plate 32j) which Buchner argues is very similar (except in material i.e., chert) to a scraper found “in a pure Laurel context” (Buchner 1982b:105). Another pseudo-diagnostic is associated with this burial,

a finely made sub-triangular biface of grey and white banded chert. No wear patterns were noted on any of the edges. Such artifacts are fairly common in caches throughout the northeast in late Archaic to Middle Woodland times (Buchner 1982b:105).

The relative dating of this biface, therefore, is of little value in associating this burial with a specific archaeological culture.

The faunal artifact/ecofact assemblage of Feature 6-74 consists of two large ungulate rib shafts and three bivalves (two *Pelecypoda* sp. and one *Amblema plicata*). The Pelecypod shells were made into beads (of perhaps a necklace). The holes were of a uniform 4 mm diameter drilled longitudinally (Buchner 1982b:104).

The top of a second burial pit (Feature 1-75) was evident in Level 2 in the form of a clay lens that continued into Level 10 (Buchner 1982b:106).<sup>6</sup> The actual partial remains of

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<sup>6</sup> Although no analysis of this burial is intended, the description of the burial and its associations are included for purposes of comparison.

this child ("Ind 2) were found approximately 86 to 127 cm dba (Levels 17 to 25). The positioning of this individual is not noted, and therefore, may have been of a secondary burial. Two beaver ribs found associated with the burial have 2 mm holes drilled at their ends perhaps for a pendant. As well 3 large mammal bones, fish bones, 3 flakes and some cobbles were found in association with the burial. Four ceramic sherds were also present,

Two sherds bear cord marking while the other 2 are plain (Laurel?). The level from which the unit appears to have been dug (Level 2) contains both Laurel and Blackduck ceramics, as do all the levels to at least Level 5. This mixing is believed to be the result of backfilling of the pit. The shallowness of the mouth of the pit argues for a Late Woodland temporal assignment (Buchner 1982b:106).

A rough estimate of the relative abundances of the fauna across the site is found in Buchner (1982b). Tables 3.1 and 3.2 summarise this data. In addition to this fauna also present were porcupine, coyote, grey wolf, black bears, marten, fishers, wolverines, river otters, turtles, lynx and suckers.

Based on this evidence, Buchner (1982b:109-110) argues that the bison and Plains Pocket Gopher represent an earlier "non-Boreal" or Grassland adaptation whereas the Late Woodland period gives evidence of a subsistence strategy exploitive of more species, or a boreal adaptation. He concludes,

Thus, radiometric and stratigraphic data indicate a shift from a subsistence mode centering around the exploitation of bison, with a secondary dependence upon fish and beaver, to a more diffuse economy dominated by moose, wild fowl, fish and a diversity of smaller mammals with boreal or riverine adaptations (Bucher 1982b:110).

After reviewing the earlier radiocarbon dating forms, however, some of the radiometric data

may be suspect.<sup>7</sup>

| <b>Fauna</b>  | <b>NISP*</b> | <b>Percentage (%)</b> | <b>MNI</b> | <b>Percentage (%)</b> |
|---------------|--------------|-----------------------|------------|-----------------------|
| Beaver        | 298          | 54                    | 7          | 29                    |
| Sturgeon      | 141          | 25                    | 4          | 17                    |
| Pike          | 14           | 3                     | 3          | 13                    |
| Moose         | 58           | 10                    | 2          | 8                     |
| Bison         | 27           | 5                     | 4          | 17                    |
| Muskrat       | 5            | 1                     | 2          | 8                     |
| Snowshoe Hare | 13           | 2                     | 2          | 8                     |
| <b>Total</b>  | <b>556</b>   | <b>100</b>            | <b>24</b>  | <b>100</b>            |

| <b>Fauna</b>         | <b>Preceramic</b> |            | <b>Preceramic /Laurel</b> |            | <b>Laurel</b> |            | <b>Laurel /Blackduck</b> |            | <b>Blackduck</b> |            |
|----------------------|-------------------|------------|---------------------------|------------|---------------|------------|--------------------------|------------|------------------|------------|
|                      | <b>No.</b>        | <b>%</b>   | <b>No.</b>                | <b>%</b>   | <b>No.</b>    | <b>%</b>   | <b>No.</b>               | <b>%</b>   | <b>No.</b>       | <b>%</b>   |
| Beaver               | 24                | 28         | 7                         | 27         | 137           | 69         | 49                       | 52         | 81               | 64         |
| Moose                | 8                 | 9          | 1                         | 4          | 19            | 10         | 18                       | 19         | 12               | 10         |
| Lake Sturgeon        | 39                | 46         | 15                        | 58         | 36            | 18         | 23                       | 25         | 28               | 22         |
| Bison                | 8                 | 9          | 3                         | 11         | 7             | 3          | 4                        | 4          | 5                | 4          |
| Plains Pocket Gopher | 7                 | 8          | -                         | -          | -             | -          | -                        | -          | -                | -          |
| <b>Total</b>         | <b>86</b>         | <b>100</b> | <b>26</b>                 | <b>100</b> | <b>199</b>    | <b>100</b> | <b>94</b>                | <b>100</b> | <b>126</b>       | <b>100</b> |

<sup>7</sup> Many samples provided to the radiocarbon dating laboratories consisted of multiple bone fragments of unidentified/unidentifiable species that could have easily been resituated due to taphonomic disturbances (eg. rodent burrows).

<sup>8</sup> The NISP (i.e., number of identified species) and MNI (minimal number of individuals) given here (and in Buchner 1982b) are not true values in that these numbers indicate the total faunal collection rather than numbers per level. Tables 3.1 and 3.2 are based on Buchner (1982b:108-109, Tables 15 and 16, respectively).

### 3.2.2 Radiocarbon Assays and Archaeological Associations

A 1997 AMS date was obtained for the Feature 6-74 individual (Z17). This date was  $1570 \pm 60$  BP (450 AD intercept;  $2 \sigma$  calibration 384-640 AD). It is in keeping with Buchner's (1982b:115) conclusions based on the stratigraphy that the burial is part of the Middle Woodland Tradition (i.e., Laurel) that "commences considerably after the most recent Archaic date (755 BC/2705 BP) and terminates only slightly before the earliest Late Woodland date (AD 1027/923 BP)."

The proximity of the Bjorklund site to both the woodlands and the plains make it susceptible to usage by Woodland (Laurel) as well as contemporaneous Plains complexes (Avonlea and Besant). However, Meyer and Hamilton (1994:110-112) argue that the Laurel, Avonlea and Besant were "three distinct cultural groups" that demonstrate a pattern of "avoidance and co-occurrence." They also infer a certain degree of hostility between the groups,

it appears that the occupants of the Saskatchewan grassland and parklands (Avonlea) and of southwestern Manitoba (Besant) did not allow movement of peoples of the Laurel culture [southeastern Manitoba and Minnesota] into their bison range (Meyer and Hamilton 1994:112).

If this hypothesis is correct, the Bjorklund site containing significant amounts of Laurel diagnostics would be an unlikely place for an Avonlea or Besant burial. The lack of artifacts from the Avonlea (1750-1150 BP) and Besant (2000-1100 BP) phases, supports Meyer's and Hamilton's statement, and Buchner's association of this burial with the Laurel phase.

The archaeological association of the second burial is slightly more problematic. Buchner (1982b:117) argues,

It is certain that Feature 1-75 can be assigned to the Blackduck Phase and hence the perforation of beaver ribs, possibly for use as ornamentation, is a Late Woodland practice. The lack of comparative data, however, does not support this as a common occurrence.

Since the backfill contained both Laurel and Blackduck (both types of Blackduck) ceramics, and there was an absence of Selkirk ceramics, it is likely that this burial is associated with the Selkirk phase; however, the temporal span of the Blackduck at Bjorklund (i.e., the depth of the Blackduck horizon in the stratigraphy) was sufficient that a later Blackduck group using the site performed the burial. Thus, some Blackduck pottery would be in the backdirt despite the fact that it was a Blackduck burial. Unfortunately, a radiocarbon date was not requisitioned for the second individual from Feature 1-75. A radiocarbon date, however, would not solve this discrepancy given the overlap of complexes in the area during the Late Woodland Period.

It is somewhat questionable that a trait, such as perforated beaver ribs, is proof of cultural association given that there is no further evidence to back this claim. This jumping to conclusions has repercussions. Indeed, Hill (1990:10) “tentatively” associates an infant burial at Whaley Cairn with the Blackduck Complex based on the information from Bjorklund,

The coincidence of perforated ribs associated with immature individuals and the fact that both sites are on the Winnipeg River drainage may indicate that both sites represent the practices of the same cultural group, Blackduck. Radiocarbon assays of the Whaley Site materials could confirm this interpretation of a Blackduck affiliation for the Whaley Site.

As it will be argued later, Whaley Cairn is not associated with a Late Woodland culture.

Clearly, such statements should be avoided until sufficient evidence is found to support them.

### **3.2.3 Archaeological Evidence of Diet by Association**

It is generally accepted that the subsistence strategy of the Laurel culture was a highly diversified hunter-gatherer complex, primarily keeping to the forests and grassland-aspen parkland transition zones (Buchner 1979b, 1982a; Gregg 1985; Steinbring 1980). This subsistence diversification eventually carries out onto the plains where “Laurel and Blackduck culture were also participants in Prairie material culture” (Gregg 1985:125). This is demonstrated by the presence of bison at the Bjorklund site. The typical resources exploited were those already mentioned: bison, moose, caribou, beaver, deer, fish, acorn, chokecherry, raspberry, and wild rice (Buchner 1980, 1982b; Buchner and Callaghan 1980; Gregg 1985; Saylor 1977).

## **3.3 Whaley Cairn (EbKx-10)**

### **3.3.1 Description of Site, Burial and Associated Artifacts**

The Whaley Cairn site is located amongst the mixed forest on the Lee River on the north shore of a small island (Hill 1988a). A salvage excavation was undertaken in August 1988 by the Manitoba Historic Resources Branch to remove a burial that was seen eroding from the island bank. A partially eroded, large, circular boulder cairn (6 metres in diameter) was over the burial. An oval pit depression within the cairn was excavated (excavation unit 1 - XU1) revealing two primary burials. Hill (1988a:2) states the positioning of those interred

as follows:

Individual #1 was lying on its left side facing east, with flexed legs at the base of the articulated vertebral column. The arms were flexed such that the hands were close to the skull. Individual #2 was seated, facing east towards Individual #1. This skeleton had collapsed, with the skull found above and slightly left of the pelvis. One leg was found to the left of the skull, while the other leg was to the right of the skull and pelvis. Vertebrae were located between and in front of the pelvic bones. The arms were to the right and in front of the pelvis.

After laboratory analysis was performed by Dr. Meiklejohn, "Individual 1" was found to be a male and "Individual 2" was female.

Very few artifacts were found within the burial pit (XU1). Those artifacts that were recovered were non-diagnostic lithics made of local materials. Ecofacts consisted mainly of fauna (i.e., a bear tooth, fish bone, bird bones and probably intrusive rodent bones). Due to the rock cairn structure, primary burial type and lack of diagnostics (especially ceramics), negative evidence was cited to tentatively place these burials within the Pelican Lake Complex (Hill 1988a:3).

A second depression in the rock cairn was excavated the following year (XU2-4). Unit 2 was placed directly over the second depression noted the previous year. A pit (Feature 1) was exposed in Level 3 which continued to Level 7 (30-80 cm below surface) (Hill 1990). This feature was surrounded by a brown organic pit lining (Feature 2) starting in Level 4 containing abundant whole fish skeletons, bird bones and egg shell. From this evidence Hill (1990) speculates that unit 2 was a spring or late summer interment.

In Feature 1, unarticulated, fragmentary, burned human bones (XU2F1/I1 and I6) were found on a rock slab. Probably associated with this cremation was a "rolled native

copper bead” that was found in the screen (Level 5), and a perforated bone (possibly a pendant found 40 cm db) (Hill 1990:5-6). The covering rock slab of Feature 1 (“Rock 66) was removed in Level 5 to reveal a granite-slab lined chamber which contained five human crania and a number of disarticulated human bones (probably of secondary, possibly bundle, burials).<sup>9</sup> In the Feature 2 lining, a perinate red ochre secondary burial was found.

Throughout Features 1 and 2 Levels 3 to 7, were numerous fish and bird bones. The artifacts of unit 2, in total, consist of 14 lithic flakes (local materials), 2 perforated bones and 1 copper bead. The cairn structure of unit 2 consisted of seventy -two (72) boulders weighing 5 to 50 kg each (Hill 1990:8).

The faunal catalogue for the Whaley Site unit 2 demonstrates a comparatively large assemblage of fish compared to the other animal classes (Table 3.3). In a rough count of elements by class found in Feature 1 and 2 Levels 5 and 7, fish are overwhelming represented by 1163 elements compared to 59 bird bones, and 66 mammal bones (7 rodent bones excluded). Of the identifiable genera of fish, *Stizostedion* sp. (walleye) represent 56% of the assemblage followed by *Esox lucius* (pike). Mammals are the next largest class by element

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<sup>9</sup> For more information, about these individuals see Appendix II. Unfortunately many of the skulls and vertebrae were disassociated from the remainder of the bodies, and it was not possible to identify many of the remains as belonging to specific individuals. Also, due to the varying numbering systems between the field and the lab, some confusion incurred, but was later rectified. Therefore, some of the older lab work as well as the stable isotope and mtDNA (not used here) results done for this thesis are identified by the old lab numbers. In addition to “individual” numbers, “random numbers” were applied to the 1997 AMS dates, and isotope samples, therefore any confusion between the systems should be rectified using them. (See Appendix II.) The remains, this manuscript and most of the reports, x-rays and miscellaneous materials have been re-labelled according to the field numbering. The primary change consists of using excavation and feature numbers as well as individual numbers so that they are in agreement with the field notes.

count of which *Ondatra zibethicus* (muskrats) forms 45% of the assemblage, 1.5% (1 element) is *Lagomorpha* (rabbit) and the rest are unidentified. *Anatidae* (ducks) constitute 72% of identifiable bird genera.

| <b>Fauna</b>              | <b>Feature 1 Level 5 &amp; 7</b> | <b>Feature 2 Level 7</b> | <b>Total</b> |
|---------------------------|----------------------------------|--------------------------|--------------|
| <i>Stizostedion</i>       | 85                               | 209                      | 294          |
| <i>Esox lucius</i>        | 33                               | 42                       | 75           |
| <i>Lota lota</i>          | 24                               | 34                       | 58           |
| <i>Catostomidae</i>       | 22                               | 27                       | 49           |
| <i>Percidae</i>           | 26                               | 19                       | 45           |
| Unidentified Fish         | 160                              | 482                      | 642          |
| <i>Anatidae</i>           | 8                                | 0                        | 8            |
| <i>Dendragapus</i>        | 3                                | 0                        | 3            |
| Unidentified Birds        | 42                               | 6                        | 48           |
| <i>Ondatra zibethicus</i> | 20                               | 10                       | 30           |
| <i>Lagomorpha</i>         | 1                                | 0                        | 1            |
| Unidentified Mammals      | 6                                | 29                       | 35           |
| <i>Clethrionomys</i>      | 1                                | 0                        | 1            |
| <i>Spermophilus</i>       | 1                                | 0                        | 1            |
| <i>Microtus</i>           | 0                                | 1                        | 1            |
| Unidentified Rodents      | 1                                | 3                        | 4            |

### 3.3.2 Radiocarbon Assays and Archaeological Associations

An AMS date of 1760 ± 60 BP (290 AD intercept; 2σ calibration range 129–422 AD) was assayed for Unit 2 Feature 1 Individual 5.<sup>10</sup> The archaeological associations possible are numerous given this date and the lack of diagnostic artifacts within the cairn. Some possible affiliations include both, plains and woodlands, complexes such as Pelican Lake, Besant, and Laurel phases. The Laurel complex includes burial mounds many of which are in Manitoba; however, these mounds are rarely rock cairns. For this reason and the atypical lack of diagnostic artifacts with the burial, this association is treated cautiously. Both the Pelican Lake and Besant complexes have been associated with multiple secondary burials under rock cairns with subfloors. For example, a Pelican Lake associated cairn is the Bracken Cairn in Saskatchewan (Joyes 1970:213), and the Tufton Cairn in Montana was associated with Besant assemblages (Joyes 1970:215) (Figure 3.1).

The oldest of these complexes is the Pelican Lake complex temporally ranging from 3100–2700 BP in Manitoba (Buchner 1976b). There are a number of sites in Manitoba with Pelican Lake assemblages: Snyder, Krieger, Calf Mountain, Avery, Bjorklund. The occupation at the Avery site is estimated to be between 2400 to 2000 BP which is fairly typical for the region, but makes the 1997 AMS date for the Whaley Cairn site quite late. After the 1988 Whaley Cairn excavation, Gord Hill (1988a) surmised that this site was associated with the Pelican Lake complex due to the cairn structure and the lack of grave

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<sup>10</sup> Earlier AMS dates were also requisitioned by the Museum of Man and Nature in Winnipeg around 1989 and were performed by Earle Nelson at Simon Fraser University, British Columbia on individuals from both Unit 1 (XU1I1) and Unit 2 (XU2F1I5). The same date was obtained (i.e., 1840 ± 60 BP) for both individuals. It is assumed here that the interments of both units occurred within a close time frame.

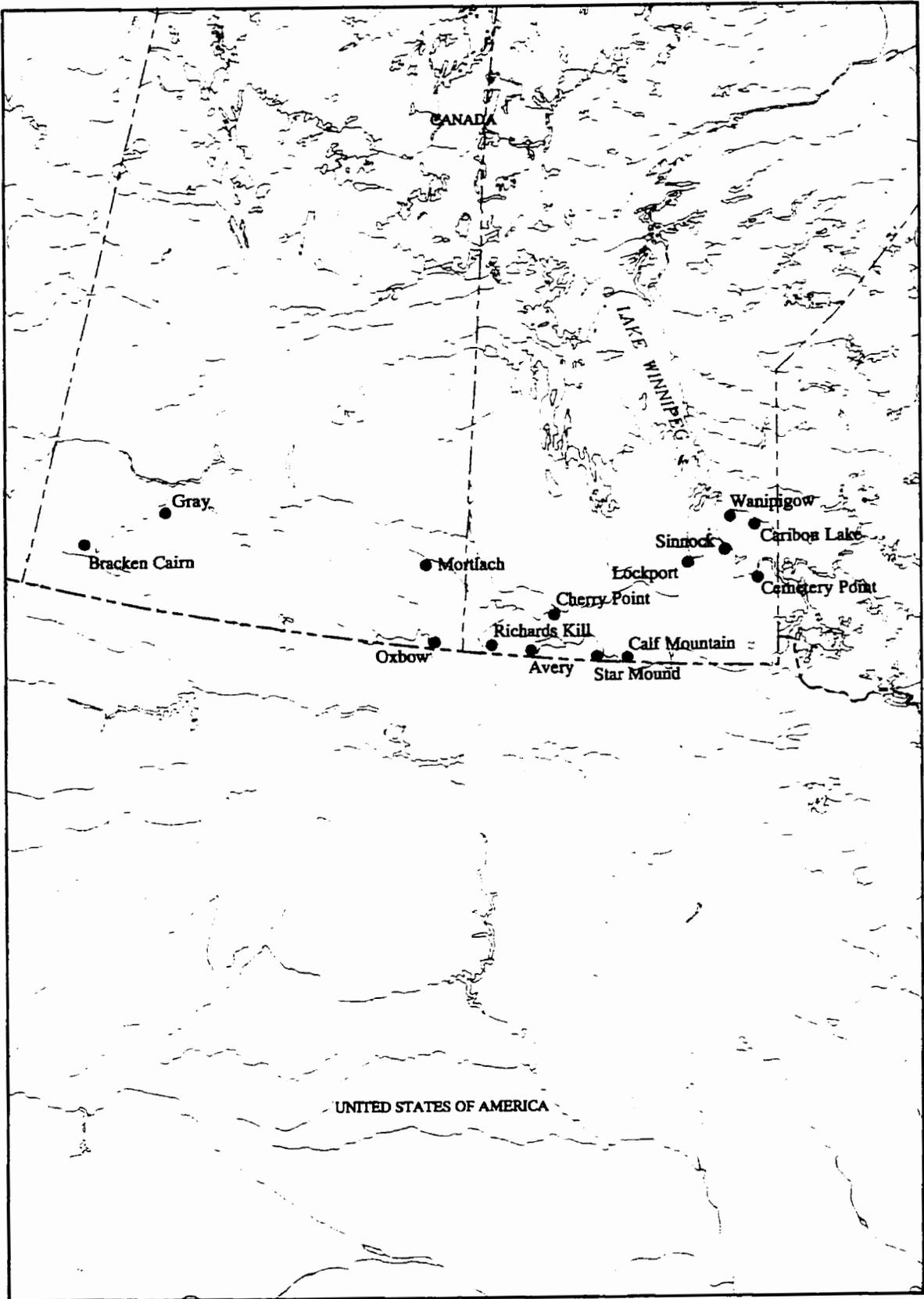


Figure 3.1 - Reference Sites

goods. He later retracted this statement after the 1989 excavation arguing for a Blackduck association based upon the perforated beaver ribs in association with the foetal burial as was the case at Bjorklund (Hill 1990). Despite the similarities between Pelican Lake cairn burials and Whaley Cairn, there are some characteristics present that make a Besant association more logical.

The general temporal range for the Besant Complex is 2000 to 1100 BP (Dyck 1983). In southern Manitoba, Besant dates seem to cluster on the late end of the scale between 1400 BP (Avery site) to 1100 BP at Calf Mountain. An association of this site with the Besant phase could represent one of the earliest Besant occupations in Manitoba as well as one of the most northerly. Yet, there is some evidence that supports a Besant association. A Besant rock cairn at the Mortlach site in Saskatchewan contained bone pendants (Keyser 1979) as did the rock cairn at Whaley Cairn site. Neuman (as cited by Reeves 1970:165) remarks that Besant rock cairn burials in North Dakota contain “entire articulated carcasses, partial carcasses, or simply bison skulls.” While Whaley Cairn did not contain bison remains, it was lined with and contained numerous fish in their entirety as well as other animals demonstrating a mortuary custom of including abundant food resources with the interred.

Another mound in southern Manitoba, the Star Mound, is very intriguing due to its similarities to Whaley Cairn. In the description of the Star Mound, Nickerson (Capes 1963) refers to a number of separate pits or chambers, some containing primary seated individuals facing southeast and others containing secondary bundle burials. Most remains were covered in ochre. He also describes two interments in an adjoining mound (“Star Mound B”),

A skull lay on a flat limestone at a depth of 11 inches, facing southeast . . .

the base of the skull . . . was found nearer the centre of the mound, close to bones lying in very tough sod. . . . The central part of the mound was a mass of boulders, beneath which nothing was found. East of the skeleton parts, fragments of an infantile skull and the tibia and femur of a foetus were found (Capes 1963:53).

In a later passage, Nickerson states that cremation is not as common in Manitoba as it is elsewhere (Capes 1963:83). A number of other characteristics of Star Mound are of interest here: 1) the position of the skull facing southeast on a limestone platform is reminiscent of the Unit 2 Feature 1 remains lying on top of a granite slab; 2) the slab covers other secondary burials; 3) the overlying remains were cremated as were those at Whaley Cairn; and 4) the occurrence of infantile burials on the margins of Star Mound B are very similar to the perinatal remains found in the lining of the Whaley Cairn (i.e., Unit 2 Feature 2). In addition, amongst the Star Mound artifacts were 2 Plains Triangular Points, a large spear point and 3 "Plains Side-notched points." But on examination of photographs of these side-notched points, they tend to more resemble Besant corner-notched points (Capes 1963:130-131, Plate IV). This observation should be accepted with caution, however, since the actual artifacts were not examined.

### **3.3.3 Archaeological Evidence of Diet by Association**

The inferred subsistence related data from Whaley Cairn is considerably more extensive than the other study sites since food remains (seasonal dietary preference?) were directly associated with the individuals. All three of the complexes that might be associated with Whaley Cairn (Laurel, Pelican Lake and Besant) have subsistence strategies which are

fairly diverse. The archaeological evidence of the Laurel diet has already been discussed. The Besant are generally known to be amongst the best bison hunters (Dyck 1983). Yet, as noted by Reeves, there is some evidence that they exploited numerous other resources, such as deer, antelope and fish.

Like previous Northern Plains phases, Besant is characterized by communal bison hunting. Evidence of such practices in Manitoba is seen at the Richards Kill . . . and an unnamed Besant kill located nearby. Some fowling, fishing and shellfish collecting is also engaged in (Reeves 1970:164).

There is no archaeological evidence of the flora that they might have procured and consumed.

The Pelican Lake culture appears to be slightly less diversified. They were large game hunters (bison specifically) whose seasonal round involved exploiting bulls, cows and calves in the season of their prime (Reeves 1970:162). However, at the Larter site, amongst bison bone there were “white tail deer, grizzly bear, muskrat and birds. The presence of a few fish bone and mollusc shells in the Lockport components indicate some utilisation of riverine resources” (Reeves 1970:161). Again little is known about the plants and fruits that they gathered.

The only archaeological culture of the three that are known to consume fish in the quantities inferred by Whaley Cairn was Laurel (Meyer and Hamilton 1994:105), and therefore, by inference, Whaley Cairn may be associated with that culture. While the Laurel phase was the predominant complex in woodlands of northwestern Ontario and eastern Manitoba (Meyer and Hamilton 1994:106), Besant was predominant in the northeastern plains (Dyck 1983:113). It is possible that, in the efforts of the Besant to gain new territory,

certain groups became entrenched in a more forest-oriented subsistence strategy replacing bison with fish and other animals although this seems unlikely since “north of the grasslands proper, Besant may be rare” (Walde et al. 1995:18). Another possibility is that the subsistence strategy and seasonal round of the Besant was far more diverse than is readily apparent in the archaeological record.

### **3.4 Slave Falls (EbKv-34)**

#### **3.4.1 Description of Site, Burial and Associated Artifacts**

Slave Falls is located on a slight southerly-oriented peninsula on the west bank of the Winnipeg River just north of the Slave Falls hydroelectric power station (Hill 1988b). This site is situated very closely to the Cemetery Point site just a few kilometres southwest on the Winnipeg River. It should be noted that the ecology of the region is presently that of the Lower English River (Low Boreal) zone consisting of bur oak, trembling aspen, poplar, and chokecherry. During the 1979 excavations at Cemetery Point, significant accumulations of bur oak acorns, chokecherries and iris seeds were found in association with the middle Archaic, Middle Woodland (Laurel) and Late Woodland (Blackduck) levels indicating a fairly consistent ecoclimatic state from the Archaic to the present (Buchner 1980).

In 1988 salvage excavations were conducted to protect two burials features (Features 1 and 2) which were eroding out of the bank on the west side of the peninsula and another on the east side (Feature 3). Through erosion of the west bank and subsequent displacement of materials, the upper elements of the burials were missing and only the lower limbs remained in situ in Features 1 and 2 (Hill 1988b:1-2). The individuals were in an extended,

supine position with their heads to the west and their feet to the east. Three individuals were found in Feature 1, their lower limbs superimposed. A middle adult male was placed on the bottom of the pit under an adolescent. The adolescent was under the third individual, a juvenile. The depths of the remains were from 80 to 90 cm dbs (Hill 1988b:2). Hill (1988b:3) provides some of the details of the burial as follows:

The clay surrounding the human bones in Unit 1 contained charcoal flecks, red ochre flecks and small granite cobbles that disintegrated when touched. Dark red-brown stains were noticed around the leg bones of the adult in Feature 1. There were 300 flakes and microflakes recovered from the soil in Unit 1, with the occasional fish and rodent bone. One turtle shell fragment was recovered. All three sets of lower limbs in Feature 1 were articulated. Arm and skull positions could not be determined.

The lower limbs of a juvenile were excavated from Feature 2 along with a bifacial fragment, flakes, microflakes, and a turtle shell fragment (Hill 1988b).

The artifacts associated with Features 1 and 2 were lithic flakes of local materials, small granite cobbles and non-human bone fragments (Hill 1988b). An earlier surface collection of the slumped bank produced a shell bead, some lithic flakes and ochre. Subsequent surface collection (part of which was underwater) of the slumped bank provided the skulls, the upper limbs and many of the torso elements. Artifacts recovered during these collections were a corner-notched projectile point fragment, and a number of unifacial and bifacial tools as well as numerous lithic flakes. Unfortunately, these artifacts cannot be positively attributed to the burials.

Feature 3 had undergone more extensive erosion so that excavation was limited to trowelling through the "loose soil" of the slumped bank, and surface collecting below the

water line. Charcoal, burnt bone and a stain in the bank profile indicated that a fire of some size was used during interment. The burning of some of the human remains was also evident (Hill 1988b). Four individuals were excavated from the Feature 3 slumped bank (positioning indeterminate).

### 3.4.2 Radiocarbon Assays and Archaeological Associations

Feature 1 yielded a radiocarbon AMS date of  $4010 \pm 90$  BP (2480 BC intercept; 2 $\sigma$  calibration range 2641-2397 BC).<sup>11</sup> This date would be in agreement with the stratigraphy which, because of sufficient time depth, “had redeveloped since their burial into the ‘normal’ stratigraphy for the area” (Hill 1988b:2). Since there were no diagnostic artifacts found in Feature 1 or 2, the AMS date could be related to a number of Middle Plains Indian/Archaic phases: Oxbow (5000 to 3500 BP) (Meyer 1983), McKean/Duncan/Hanna (4150 to 3100 BP), Old Copper-Raddatz Archaic complex (4950 to 2950 BP) (Buchner 1979b), and the Shield Archaic (6000 to 3500 BP) (Meyer 1983). The manifestations of these complexes within the Manitoba region differ temporally somewhat: the Oxbow at Caribou Lake and Whitemouth Falls sites was 4810 to 3050 BP; Old Copper-Raddatz in eastern Manitoba was 3870 to 3660 BP; and McKean at Whitemouth Falls site was 3730 to 3405 BP (Buchner 1979b, 1982a).

The Old Copper or Raddatz complex was a woodland Archaic phase that developed out of Wisconsin and around the tip of Lake Superior circa 7000 BP (Buchner 1979b; Steinbring 1970). They were a highly adapted lake-forest oriented group that were

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<sup>11</sup> No date was obtained for Feature 3.

contemporaneous with McKean and Oxbow cultures within the forest fringes. Indeed, Oxbow and Raddatz artifacts have been found together.

No Old Copper-Raddatz burials have been located in Manitoba. In Wisconsin, burials are characterised by “primary and secondary (bundle) single and multiple, flexed and extended burials in oval or rectangular pits with ochre and/or cremation and/or ceremonial burning over graves, with copper and/or lithic and/or faunal accompaniments” (Buchner 1979b:88). The Slave Falls burials share many common traits with Old-Copper mortuary customs. The Slave Falls burials are primary, extended pit interments associated with ochre, lithics and ceremonial burning. There is, also, a correlation with the parkland edge setting of Old Copper sites and the Slave Falls burial. It may be considered odd, however, that no copper artifacts were found.

As mentioned above Old Copper-Raddatz components have been found in forest zone Oxbow sites (Dyck 1983). Although Oxbow originated from the northwestern plains, the archaeological record demonstrates that it underwent a number of changes in Manitoba over time. From approximately 6000 to 5000 BP, the Oxbow complex exhibits plains-grassland traits; from 5000 to 4000 BP it occurs within the transition zone between the plains and the forest; and finally, from 4000 to 3000 BP Oxbow sites are found within the boreal forest (Pettipas 1983:54). Although highly speculative, it is within this last phase that the Oxbow might be represented at the Slave Falls site. Despite their co-occurrence with the Old Copper-Raddatz complex within the same region, the archaeological record indicates alliance rather than adversity (possibly due to their differing subsistence strategies).

Bearers of the Oxbow complex were occupying the Boreal Forest and forest

edge at this time, at least during the winter months. Their specialized plains-adapted economy contrasted sharply with the unspecialized mixed-forest adaptation of the Raddatz population to the east (Buchner 1979b:92).

Another culture also might have been inhabiting the forests at this time. The McKean complex had a wide distribution across the northern plains as well as into other ecoregions (mountain, parklands, boreal forests), but its centre was along the river system bordering between Montana and Wyoming (Gregg 1985). Evidence of this complex in the Manitoba and surrounding region is fairly scant with thin horizons at Mortlach, Long Creek, Avery, Larter, Caribou Lake, Cherry Point, Cemetery Point and Whitemouth Falls sites. The only burial attributable to the McKean complex is the single skull found in a cache pit at the type site in Wyoming (Gregg 1985).

All of the above complexes appear to have co-existed in the forest-parkland transition zone of Manitoba during this period. Buchner, in opposition to the theory of contemporaneity of these three cultures, argues rather that they are sequential “regardless of how unfashionable this may seem” (Buchner 1982a:53). This is a very interesting and significant argument with regards to the cultural sway within the forests; however, for study purposes all the aforementioned complexes are considered.

As a precautionary measure another archaeological complex, the Caribou Lake complex (7350 to 5350 BP), should be considered in the possible associations with the Slave Falls burial. This complex is decidedly outside of the temporal range of the Slave Falls site AMS date, however, the location of the Slave Falls site is very similar to those that characterise the Caribou Lake sites. Specifically, Caribou Lake complex sites are typically

located “between widenings of lakes and rivers and on the tips of small peninsulae” with southeast exposure (Buchner 1979b:76). This description could easily be used to describe the Slave Falls site location. However, as Buchner notes, Caribou Lake sites have not been located in this region to date,

Materials attributable to the Caribou Lake Complex have not been identified from any of the numerous sites along the Winnipeg River from Natalie Lake to Nutimik . . . This latter region would probably have been occupied by a vegetation similar to the modern Aspen Parkland during Caribou Lake Complex times. Present evidence, though admittedly scanty, tends to indicate that Caribou Lake Complex peoples were Boreal Forest-adapted and did not venture into neighbouring ecological zones as a part of a seasonal round (Buchner 1979b:76)

If the Slave Falls site does represent a Caribou Lake complex site, it might be that, at a slightly earlier date, the environment was better suited to the Caribou Lake culture; or, that there was a drastic change in ecological zones between Cemetery Point (parkland) and Slave Falls (boreal forest).

### **3.4.3 Archaeological Evidence of Diet by Association**

The subsistence strategies represented by these four complexes (i.e., Old Copper-Raddatz, Caribou Lake, McKean and Oxbow) seem quite different according to the archaeological record. Generally, woodland oriented groups are believed to have exploited a broader range of resources than plains oriented groups. Unfortunately the lack of diagnostic artifacts associated with the Slave Falls burial prohibits even the distinction of plains versus woodland affiliations. In this case, the presence of even a few associated food resources could aid in interpreting this site and a portion of the archaeological record for this area. This

is evident from an examination of the known subsistence strategies for these complexes.

The McKean and Oxbow complexes continued to remain primarily large game (i.e., bison) hunters despite their appearance in forest zones. The McKean cultures are believed to have been in forested regions only during certain seasons: hunting bison in the spring to fall, and cervid, beaver, canid, pocket gopher, cottontail rabbit, birds, bear, deer and fish during the inclement winter (Buchner 1979b:94-97). The Oxbow culture appears to have been somewhat less diverse in its subsistence strategy relying heavily on bison in the plains and grassland fringes, and larger but fewer species in the forests, such as, caribou, moose, canid, fox, rabbit, marten, goose, frog, clams, hackberry, and cherry pits (Buchner 1979b:82-83).

According to the archaeological record, the Old Copper-Raddatz and Caribou Lake cultures were well adapted to forest niches. Both relied heavily on terrestrial as well as aquatic flora and fauna. Fish, which could be caught most of the year, and wild rice were probably staples. Cervids also occupied an important place in their dietary regime. Archaeological evidence of moose, caribou, white-tailed deer, dog, lynx, muskrat, beaver, turtle, waterfowl, fish (drum, bullhead, perch), wild rice, nuts (butternuts, hickory nuts, walnuts, acorns) and wild grape have been found at sites (Buchner 1979b:88-89).

### **3.5 Whitemouth Falls (EaLa-1)**

#### **3.5.1 Description of Site, Burial and Associated Artifacts**

The Whitemouth Falls site is located on the east side of the Whitemouth River across from the Bjorklund site approximately 460 m from its mouth into the Winnipeg River, and

immediately accessible to the aspen-parkland-grassland transition zone. It was collected from and excavated (mainly in the form of field schools) since 1964. On the last day of the University of Winnipeg field school of 1976, a small portion of a burial was unearthed (Feature #10-76) in Unit N5E1 Level 10 (approx. 50 cm dbs). A later excavation revealed the rest of the burial (XU N6E1). No pit feature was noted in the stratigraphy throughout the excavation. Based upon the stratigraphy of the unit, it was concluded that the burial occurred at a “preceramic McKean horizon” in Levels 7 or 8 (approximately 33 to 41 cm dbs) (Buchner and Pujo 1977:3).

This individual was placed in a semi-prone position on the left side, head to the south, legs loosely flexed to the northwest, the vertebral column “oriented in a NW to SE direction” (Buchner and Pujo 1977:3). The upper (i.e., right) arm extended towards the west and the lower (i.e., right) arm was bent under the skull. A number of intrusive artifacts and ecofacts were around the skeleton due to natural taphonomic disturbances. A “shell paint dish located two feet [61 cm] south of the cranium,” and a bison skull “placed over the lower limbs” were in definite association with the burial (Buchner and Pujo 1977). The bison skull and much of the interred human skeleton were covered in ochre. An Oxbow projectile point found slightly higher than the burial in Level 10 (approximately 51 cm dbs) may be associated with the burial,

Although its vertical location is somewhat higher than the feature, it may be possible to explain this in terms of its placement near the deceased toward the side of a round-bottomed burial pit. No evidence of disturbance due to rodents or root action was noted in the immediate vicinity of this artifact. At present, it appears that this specimen is the only piece of evidence to support the association of Feature 10 with a known archaeological culture (Buchner and Pujo 1977:4-5).

### **3.5.2 Radiocarbon Assays and Archaeological Associations**

The recently analysed AMS date of  $6090 \pm 90$  BP (5010 BC intercept;  $2\sigma$  calibration range 5260–4787 BC) would seem to contradict an association with the Oxbow complex (5000–3500 BP), or McKean complex (4150–3100) in the Northwest Plains in favour of an earlier Middle Plains Indian/Archaic phase (Dyck 1983) although the reliance on single event radiocarbon assays need careful consideration. The possible Oxbow association with the Whitemouth burial made by Buchner and Pujo (1977) is even more suspect since the earliest Oxbow dates range from 4810 to 3050 BP in southwestern Manitoba. The Logan Creek-Mummy Cave Complex (7700 to 4700 BP), from which some archaeologists think the Oxbow were derived (Buchner 1979b:83; Dyck 1983:96; Gregg 1985:107), is an earlier possible Middle Plains Indian phase that may correspond better to the 1997 AMS date from the Whitemouth Falls site. However, if this is indeed an Oxbow Complex burial, it may be one of the earliest (transitional Oxbow-Mummy Cave?) burials in the northeastern Great Plains.

The Logan Creek-Mummy Cave phase is centred around plains of the middle Missouri River (Dyck 1983). Increased dessication during the peak of the Atlantic Episode, might have driven these people, and the bison on which they depended, north toward the more temperate plains that bordered the parklands. The Whitemouth Falls location, therefore, would have been ideal. Little is known of the Mummy Cave mortuary customs although there is a possible Logan Creek-Mummy Cave primary pit burial (Gregg 1985:102).

### **3.5.3 Archaeological Evidence of Diet by Association**

Just as the Caribou Lake culture was well-adapted to the diverse subsistence strategy of the forest ecology, the Logan Creek-Mummy Cave culture was well-adapted to the specialised subsistence strategies of the plains. These people were primarily bison hunters. At a site in Wyoming, the archaeological record indicates that they also exploited antelope, mule deer and wolf (Gregg 1985:102).

### **3.6 Site Comparison and Discussion**

It is evident from the above descriptions of these burials that there is little artifactual evidence to support conclusions about archaeological associations and/or subsistence strategies. The one exception to this is the Fort Alexander burials which were associated with a number of historic artifacts; yet, even here, there is a question of ethnic affiliation and archaeological phase represented — that is, whether the individuals were Cree, Ojibwa, Blackduck, or Selkirk. Even with the added information attributed to more complete site excavations, unless diagnostic artifacts are in direct association with the interred, archaeological association often remains ambiguous. For burials, however, there are traits, other than diagnostic artifacts, that may aid in determining archaeological associations.

Burial sites are usually highly specialised sites. People tend to take great care when burying their dead. Often there are very particular, culture-specific mortuary practices that are undertaken. These mortuary customs are, in a way, “diagnostic artifacts.” Mortuary customs, or traits, that are frequently studied include: interment structure (eg., cairn, pit, spirit chamber); number of interments (i.e., single or multiple burials within a single structure); body position (eg., extended, flexed, supine, prone, semi-prone); head orientation (i.e., east, west, north south); articulation (i.e., primary or secondary); skeletal treatments

(eg., fire, ochre, manual posthumous disarticulation); and, grave goods (eg., food, tools, ornaments, flowers).

Each site has been assessed for many of these traits in order to ascertain possible archaeological associations. All of the sites have multiple possible associations according to their AMS dates: Fort Alexander (Cree or Ojibwa and Blackduck or Selkirk); Bjorklund (Laurel, Avonlea or Besant); Whaley Cairn (Laurel, Besant, Pelican Lake); Slave Falls (Oxbow, McKean, Old Copper or Shield Archaic); and, Whitemouth Falls (Oxbow, Mummy Cave-Oxbow transition). Unfortunately, the comparisons of the mortuary practices of these sites to those of the possibly associated phases only aids in the Whaley Cairn case, and only circuitously. In North Dakota large amounts of bison were left in Besant burials (Reeves 1970). It is possible that grave goods, in the form of large amounts of food, is a mortuary trait. If this is true, the large amount of fish remains in the Whaley Cairn burial may be a related Besant trait. Also, the rock cairn structure and a number of the other mortuary traits of the Whaley Cairn site are very similar to the traits of the Star Mound cairns. The phase to which the Star Mound cairns belong is unknown although possibly Besant. A comparison of the mortuary traits between sites, however, provides some evidence for grouping certain sites together, thus, inferring possible links between sites. Table 3.4 summarises the results.

Comparisons of individual mortuary traits between sites often have little significance. The one exception is the placement of a lithic/gunflint at the elbows of both Fort Alexander and Bjorklund burials. This specific placement of a specific grave good could represent a connection between the Cree/Ojibwa or Blackduck/Selkirk phases at the Fort Alexander site, and the probable Laurel phase represented at the Bjorklund site. The co-occurrence of

multiple mortuary traits at sites, however, may infer a greater affiliation between specific sites and the archaeological phases they represent.

Although the significance that these mortuary customs may have had for the people performing them is unknown, it is interesting to contemplate what characteristics may divide or unite sites and phases. The mortuary traits listed in Table 3.4 demonstrate that at least one burial feature from each site included ochre as a burial treatment, and contained primary burials. Slave Falls and Fort Alexander shared the greatest number of mortuary traits (i.e., ochre, head to west, multiple interments, and extended primary burials). The Bjorklund site shares many of these same traits except for extended burials. The other group of sites that shared multiple mortuary traits (i.e., ochre, head not oriented to west, and flexed primary burials) are Bjorklund, Whaley Cairn and Whitemouth Falls. It would appear that possibly two mortuary traits (i.e., extended versus flexed primary burials, and west versus non-west orientation of the head) divide the sites into two groups. The Bjorklund site is common to both groups perhaps indicating that it represents a culture in transition, or is an intermediate between two extremes.

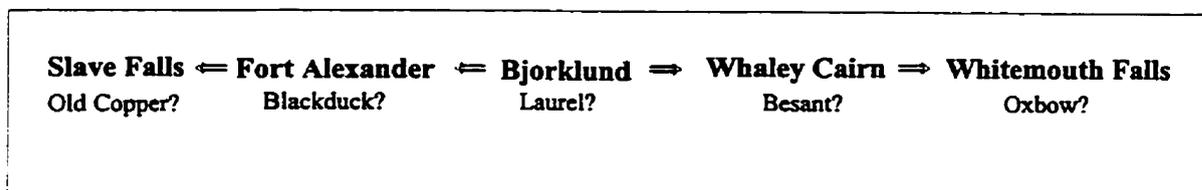
This scenario becomes even more interesting if possible archaeological associations are considered. If the Fort Alexander burial is indeed associated with Blackduck, Bjorklund with Laurel, Whaley Cairn with Besant, Slave Falls with Old Copper and Whitemouth Falls with Oxbow, there would be an apparent split in the mortuary customs between woodland-oriented and plains-oriented groups (Figure 3.2). If this hypothetical scenario is carried one step further with the assumption that the mortuary case reflects other cultural traits such as subsistence practices, this would infer that the Laurel phase at the Bjorklund site

**Table 3.4**  
**Summary of Burial Traits by Burial Feature**

| <b>Trait</b>            | <b>FA3<br/>B1</b> | <b>FA3<br/>B2</b> | <b>Bjork<br/>Z17</b> | <b>Bjork2</b> | <b>Whaley<br/>XU1</b> | <b>Whaley<br/>XU2</b> | <b>Slave F1</b> | <b>Slave F2</b> | <b>Slave F3</b> | <b>Whitemouth</b> |
|-------------------------|-------------------|-------------------|----------------------|---------------|-----------------------|-----------------------|-----------------|-----------------|-----------------|-------------------|
| <b>Primary Burial</b>   | Y                 | Y                 | Y                    | N             | Y                     | N                     | Y               | Y               | n/a             | Y                 |
| <b>Extended</b>         | Y                 | n/a               | N                    | n/a           | N                     | n/a                   | Y               | Y               | n/a             | N                 |
| <b>Flexed</b>           | N                 | n/a               | Y                    | n/a           | Y                     | n/a                   | N               | N               | n/a             | Y                 |
| <b>Secondary Burial</b> | N                 | N                 | N                    | Y             | N                     | Y                     | N               | N               | n/a             | N                 |
| <b>Multiple</b>         | N                 | Y                 | N                    | N             | Y                     | Y                     | Y               | N               | Y               | N                 |
| <b>Heads West</b>       | Y                 | n/a               | Y                    | n/a           | N                     | n/a                   | Y               | Y               | n/a             | N                 |
| <b>Fire Used</b>        | N                 | N                 | Y                    | N             | N                     | Y                     | N               | N               | Y               | N                 |
| <b>Ochre*</b>           | N                 | Y*                | Y                    | N*            | N                     | Y*                    | Y*              | N*              | n/a             | Y                 |

\* Child burial.  
Y=trait present; N=trait absent; n/a=undetermined

incorporated both, plains and woodland practices into their subsistence strategy.



**Figure 3.2 - Divisions of Sites by Mortuary Traits**

A number of archaeologists have argued that the Laurel in southeastern Manitoba indeed were in transition, and/or exploited both plains and woodland resources. Steinbring (1980:70-72) argues that the Laurel culture emigrated from northern Minnesota into southeastern Manitoba “displacing” the in situ “grassland-parkland” oriented population. He states that,

Decline in population [in southeastern Manitoba at the time Laurel pottery was introduced] may represent the actual movement of peoples into the area who were not as familiar with the environment as those they may have been tending to displace, at least at this particular locus (Steinbring 1980:71-72).

Meyer and Hamilton (1994) also note that the niches where Laurel sites are found depend on the region and, perhaps, the political climate. Subsequently, the subsistence strategies of Laurel were also region specific.

In Saskatchewan and western Manitoba, Laurel occupations have not been found in the parklands, but Avonlea and Besant components are common in the parklands and are sometimes present in the edge of the forest. *The situation is not so clear in southeastern Manitoba or adjacent northwestern Minnesota; there Laurel components are in the parklands.* Given the opportunity, Laurel peoples apparently were willing to leave the forest and exploit the rich seasonal resources (especially bison) of the parklands (Meyer and Hamilton 1994:110, emphasis mine).

These statements support the hypothesis that the Laurel in southeastern Manitoba were in a state of transition as is indicated by the mortuary traits at the Bjorklund site. This point, however, is only hypothetical and based purely on speculative archaeological associations.

The Whitemouth Falls site had the fewest traits in common with other sites. This, too, should be expected if the Whitemouth Falls burial represents a true plains-oriented phase (i.e., Oxbow) amongst other sites with some degree of woodland-orientation. This raises another point. To what degree were the Besant (primarily considered a plains oriented group) associated with the woodlands? The origin of the Besant phase is still debated; however, some archaeologists entertain Reeves' (1980:14) hypothesis, based primarily on projectile point characteristics, that the Besant are derived from the Sandy Creek phase of the plains-parkland of Alberta and Saskatchewan (Vickers 1994:11-13) which is derived from Oxbow (Dyck 1983:108-109). It is generally accepted that the Besant were well adapted to the plains representing "the climax of the bison hunting cultures" (Vickers 1994:13), but also demonstrated certain eastern Woodland influences such as burial mounds and ceramics, and may have sites in forests (Dyck 1983:120; Vickers 1994:13-14). If Whaley Cairn is indeed a Besant burial, the amount of fish remains in burial indicates a rather major subsistence transition from plains to forest resources.

The significance of determining cultural association and origin is germane to the study of subsistence. Groups of people are known to occupy those environments to which they are best adapted. Therefore, their region of origin dictates the resources that they prefer to use and their method of acquiring them. Only when forced or enticed to move into new environments will a group change their subsistence strategy to include new dietary resources

and, even then, preferences for the “old way” will be maintained for a significant period of time. Yet, people and populations do change. The Bjorklund and Whaley Cairn site possibly represent phases in just such a transitional mode. The Bjorklund site (Laurel?) could be representative of a primarily woodland-adapted group that is incorporating parkland-plains resources into their subsistence strategy. The Whaley Cairn culture (Besant?), on the other hand, may have been changing from a predominantly plains-grassland subsistence strategy to one that includes forest resources. The Fort Alexander site may represent a different type of subsistence change from a “traditional” diet of more indigenous foods to one that incorporates European consumable products. It is not known what changes may have been taking place at the Whitemouth Falls or the Slave Falls sites. It is assumed that their diets were very different from each other — one plains-oriented and the other forest-oriented, respectively.

The lack of diagnostic archaeological evidence at the study sites necessitates broad speculation with regards to cultural association and diet. Without this information, comparisons to other archaeological sites and data bases are severely limited and few conclusions can be drawn about subsistence strategies. The use of radiocarbon AMS dates helps to shorten the list of possible archaeological associations for each site, but there remains a considerable number of options and chance for error. Hypothetical scenarios based on mortuary customs can be tested as models in further studies such as dental palaeopathology and stable isotope analysis. The above scenario of econiche and dietary change, and subsistence variation between sites will be some of the problems explored in subsequent chapters.

## **CHAPTER 4**

### **Ethnohistoric Reconstruction of the Winnipeg River Region**

A number of the human remains described in this thesis have been dated to the post-European contact era and were associated with historical artifacts. In particular, the burials from Fort Alexander were associated with historic fur trade artifacts. For this reason, historical documents were examined to reconstruct the early fur trade era and Native subsistence pattern in the region. The review encompasses a survey and summary of the “history” of the Winnipeg River region (i.e., largely the fur trade and fur trade post history) from the late 17th century to the mid-19th century. This information provides some insights on the dietary regimes of prairie fringe peoples.

The historic record cannot conclusively answer the questions raised concerning diet and subsistence within the prairie fringe, but it can provide some context and information about the groups that occupied and used the woodland-parkland-grassland ecosystems in the historic period. This information will be used as a basis for more scientific analysis. It is further argued that while the European fur trade significantly altered the movement and territories of the various Native bands in the Winnipeg River region, it did not immediately alter the exploitation of resources for some groups in the region. For this reason early historic records should shed some light on the exploitation of resources prior to contact.

This objectives of this chapter are three-fold. Firstly, the establishment of the European fur trade in the Winnipeg River region will be outlined, and the recorded territories

of various Native groups will be summarised. Although very little information is documented in historic journals pertaining to Native diet specifically, some group movements and territories were noted that provide information about possible band interaction and, therefore, the influence they had on one another (i.e., social, dietary, etc.). Secondly, this chapter will examine trading practices and the distances travelled by Natives in order to trade at the posts in the region. This examination of band movements provides some indication of the distances traversed by indigenous groups, and how diverse an area they exploited to trade and hunt. Lastly, the documents will be used to assess Native subsistence strategies in the historic period, and what impact, if any, Europeans may have had on Native diets.

The problems associated with reconstructing diets from regional history and historical documents are many. For example, early European accounts of Natives are sketchy and heavily ethno- and gender-biassed rendering only a cursory indication of indigenous subsistence strategies. Similarly, post and trader journals were variably kept — that is, some contained more constant and complete observations of the region and its inhabitants while others were quite vague and unreliable. It is also true that European influences were experienced in this region prior to actual contact between Europeans and local bands. Yet, in historic documents, many Europeans assumed that they were observing bands in their original environs and performing tasks as they always had. Although traditional subsistence and social strategies did continue, new alliances and territories were entered into as the fur trade pulled some groups further west, drew other groups east and others north, and intensified the industry of fur procurement and processing. Despite these problems, the ethnohistoric record does provide useful contextual information, and provides “a baseline for

measuring change — which can be augmented and corrected with other kinds of evidence” (Peers 1994:xii).

#### **4.1 The Fur Trade and Band Territories in the Winnipeg River Region**

During the late 17th and early 18th centuries, two primary fur trade companies were firmly established around and north of Lake Superior. The Hudson’s Bay Company (HBC) had established its forts along the southwest shore of Hudson Bay while the French had set up forts along the Great Lakes from Montreal to Lake Nipigon along the northern shore of Lake Superior. It was the French, however, that initiated trade in the Winnipeg River region and established many of the historic trading patterns. The 17<sup>th</sup> century French employed the Ojibwa, Ottawa and Huron middlemen who would journey inland (westward) from the Great Lakes to trade for furs with Natives, and then transport them back to main posts where they would trade the furs for goods (Friesen 1984:29; Ray 1974:4-12). As the fur trade moved west, the Ojibwa predominated as the principal middlemen of trade.

The Ojibwa are Algonquian-speakers who are also known as the Chippewa, the Anicinabe (the “original man”), the Saugeen, and the Saulteux (due to their residence at the Sault). According to a Native historian, William Warren (1885 as taken from Densmore 1929:8-9), the Ojibwa originated east of what is now Montreal, moved to the Montreal area, to the outlet of Lake Superior, and eventually to the western tip of Lake Superior where they lived “long before the pale face appeared among them.”<sup>1</sup>

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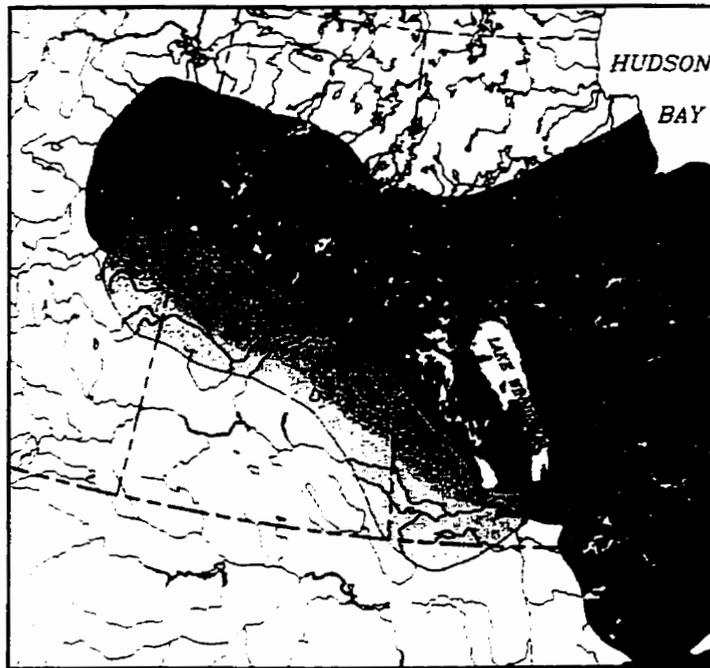
<sup>1</sup> This final destination is actually referred to as a ritual centre on the island of La Pointe near Chequamegon Bay on Lake Superior (Densmore 1929:9).

The pre-contact Ojibwa (or linguistically referred to as proto-Ojibwa) were believed to have lived as small, regionally isolated, intensively communal groups (possibly clans) who practised hunting, fishing and gathering. They were, by and large, independent of one another, but shared a common world view and intermarried (Hickerson 1970: 49; Mason 1981:9). Each group was identified individually rather than collectively. Some of the group names were the *Amikwas* (Beaver), the *Mississaugas*, the *Maramegs*, the *Noquets* (Bear Clan), the *Ouasouarinis* (Fish-people), *Nopemings*, the *Saulteurs*, the *Makinacs* and the *Outchibous*. The disruption by the fur trade, increased warfare, and population depletion due to disease resulted in the eventual amalgamation of these clan societies into the people historically known as the “Ojibwa.” As Hickerson (1970:40) explains the development of the Ojibwa Nation,

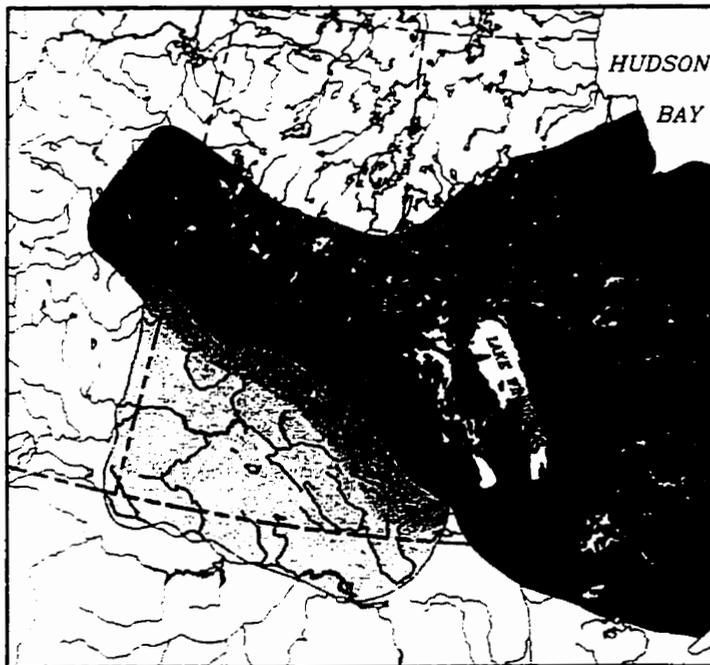
The large villages of the eighteenth to nineteenth centuries were made up of members of many clans who unified under village *tribal* council. At first there were only a few large villages, but these later split into numerous smaller villages, not along clan lines, as might be expected, but in such a way that each daughter village contained all or most of the kinship elements [i.e., clan representation].

Densmore (1929:9) argues that, in spite of these changes, “the Chippewa were always a timber tribe and their principal native industry was the trapping of wild animals.”

The Ojibwa were the primary middlemen of the French fur trade along the Great Lakes, and for much of the 17th century they travelled into northwestern Ontario to trade with the Cree and Assiniboine of the area. Available evidence suggests that some Ojibwa left the Lake Superior region in the last decades of the 18th century and began moving westward into the prairies and parkland (Figure 4.1). They moved westward attracted by new



Tribal Distributions ca. 1765 (Ray 1974, Fig. 9)



Tribal Distributions 1821 (Ray 1974, Fig. 33)

■ Ojibwa                      ■ Assiniboine                      ■ Cree

**Figure 4.1 - Tribal Distributions**

opportunities in the fur trade and because of the effects of over-hunting and smallpox in their homeland (Peers 1994:3). While the dates of this move cannot be conclusively confirmed, there are a number of clues that support the timing of these movements. La Vérendrye and his sons, travelling and trading through the “Little North”<sup>2</sup> in the period between 1728 and 1757 make no mention of the Ojibwa (Burpee 1927). They noted that the inhabitants of the region were Cree, Assiniboine and Monsoni. The first reports of the Ojibwa occupying this region occurred only in 1767 (Peers 1994:4). As the pre-eminent expert on the Western Ojibwa, Laura Peers (1994:5) argues,

. . . some time between the 1730s and the mid-1760s, people identified as Ojibwa began to occupy Rainy Lake, Lake of the Woods, and much of what is now northern Ontario. By 1775, when Alexander Henry the Elder travelled along the Rainy River, the Ojibwa were so established there that they were charging tolls to traders “on account of the ability they [the Ojibwa] possessed to put a stop to all trade with the interior.”

The HBC, which was established almost half a century later (in 1670) than the initial establishment of the eastern Native-French network, employed Cree and Assiniboine as middlemen (Friesen 1984:29; Ray 1974:13) (Figure 4.2).<sup>3</sup> The Cree and Assiniboine, who had previously traded with the Ojibwa middlemen to the east, were drawn to the more readily accessible HBC posts along the Hudson Bay and soon became employed as middlemen

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<sup>2</sup>The Little North is defined by Lytwyn (1986:i) as “the area bordered on the south by Lake Superior and on the west by Lake Winnipeg. To the north it stretched to the edge of the Hudson Bay Lowlands; and east to the divide between the Albany and Moose rivers. It excluded the Hudson Bay Lowlands because fur bearers were not plentiful there, and fur traders avoided these marshy wetlands.”

<sup>3</sup> Amongst the first HBC forts were York Factory (est. 1670), Moose River (est. 1672), Nelson House (1682), Fort Albany (1683), Severn House (1685), East Main Factory (1685) and Churchill Factory (1689).

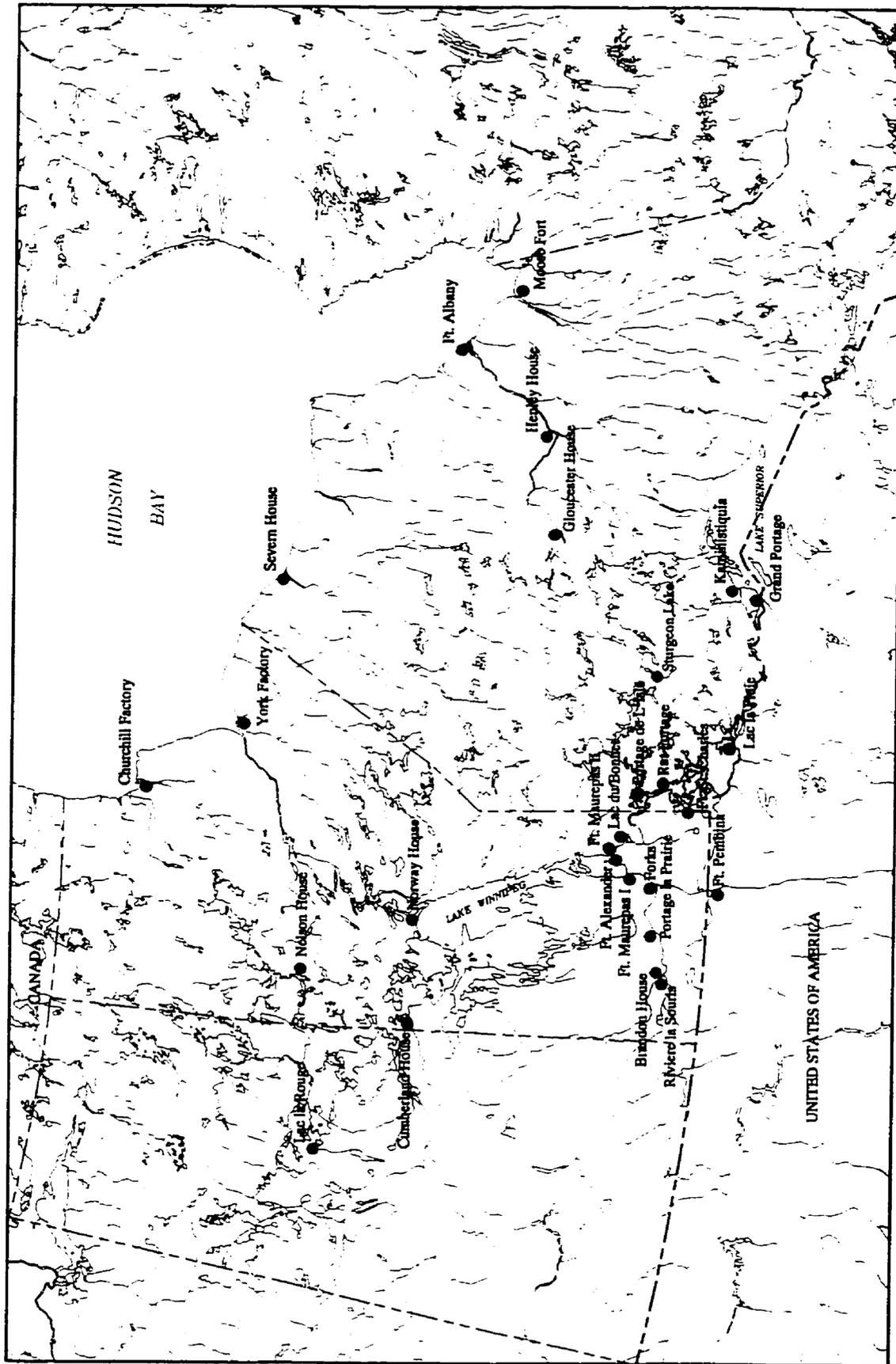


Figure 4.2 - Historic Forts

establishing trade networks further west and south.

The extent of the Cree and Assiniboine territory around the 1680s is much debated although Lake Nipigon is believed to be the eastern margin. The Assiniboine were reported to be at least as far east as Lake of the Woods (also known as Lac des Assinibouels) in 1688 and the Touchwood Hills of central Saskatchewan by 1691 (Ray 1974:11-12). Later, from 1832 to 1856, Denig (1961:64), who had spent much of his life in North Dakota, describes the territory “hunted exclusively” by the Assiniboine as 20,000 square miles from west of the Souris River to the Cypress Hills, the northern boundary ran south of and parallel to the Assiniboine River (including Wood Mountain), and the southern boundary followed the Missouri and then the Milk River (Figure 4.1).

The Assiniboine, also known as the Nakota or the Stoney, are Siouan-speaking people. Based upon linguistic evidence and reports from the Jesuits, the Assiniboine are believed to have split from the Yonktonai Dakota Sioux at approximately 1640 not long before they came in contact with Europeans. The historic Assiniboine were comprised of two main groups — a southern “plains” group resembling the Blackfoot, and a northern Assiniboine group who “were more similar to their Cree neighbours” (Russell 1991:184-185). Although it is not clear with whom the two groups traded (i.e., the Cree and Ojibwa, or also some of the western and southern bands), or which of the groups were present along the Winnipeg River system, it appears that they followed two separate subsistence strategies — one plains, and the other a more transitional woodland strategy.

The documentation about the Cree during the early era of the fur trade is scant. Ray (1974:12) notes that the Jesuit *Relations* of 1658 places the “Western Cree” between James

Bay and Lake Nipigon, while other sources indicate that the western boundary of their territory bordered on the Assiniboine's eastern front where the two groups lived in harmony (Figure 4.1). The Cree are Algonquian-speakers who, despite linguistic differences, historically were close allies with the Assiniboine (for the most part) from the fur trade until the signing of the treaties. Indeed some even amalgamated to form Cree-Assiniboine groups (Mandelbaum 1979). Like the Assiniboine, the Cree were divided into two very different subsistence groups — that is, a plains group and a woodland group. According to Mandelbaum (1979), prior to their assignment to reserves, the Plains Cree and Cree-Assiniboine were manifestations of a plains people relying on bison for most of their needs. Russell (1991:218) describes the Plains Cree as being more plains-parkland oriented, than solely plains oriented as Mandelbaum (1979:15) suggests.

As HBC middlemen, the Cree and Assiniboine occupied a strategic position in the fur trade along the Nelson, Hayes and Severn Rivers which cut sharply into the French trade. In response, the French encouraged Dakota Sioux attacks against the Cree and Assiniboine temporarily pushing them out of the Rainy Lake/ Lake of the Woods region further northwest circa 1720 to 1730 (Ray 1974:14). The French also commenced expeditions (such as LaVérendrye's in the 1730s) to establish posts further into Manitoba and Saskatchewan during the early to mid-eighteenth century (Ray 1974:51-53). The establishment of these inland posts diminished the need for middlemen as some groups would come to the posts to trade directly. Despite the Sioux attacks and the attempts of other bands to trade directly with the posts, the Cree and Assiniboine maintained a virtual trade monopoly in the central part of the Little North supported by the readily acquired firearms from the nearby posts (Friesen

1984:29; Ray 1974:13-16). Ray (1974:23) summarises these hostilities and the resultant migrations as follows:

By 1763 the distribution of Indian tribes had changed radically from that of 1690. After having initially been drawn eastward as trappers into the French-Ottawa trading system before 1670, the Assiniboine and Cree began moving rapidly in a northwesterly direction after 1670 as they became involved in the Hudson's Bay Company trade. Using the arms they obtained at the Bay, they quickly assumed the role of middlemen in the evolving trade network and expanded their trading areas with force. By 1720, the bulk of that expansion appears to have been completed and a somewhat more peaceful period began as inter-tribal trading patterns became well established.

Travelling further and further into the Little North, the French traded furs directly with the local bands. These furs would be sent back to the larger French posts at Kaministiquia, Lac la Pluie (i.e., Rainy River) or Lac des Assinibouels (i.e., Lake of the Woods) and eventually to Montreal (Eccles 1984:4; Lytwyn 1986:5). By the 1720s, the French had infiltrated the Little North past Lake of the Woods establishing a trade route along the Rainy and Winnipeg River systems. The Assiniboine and Cree, no longer needing to travel to the HBC posts, remained closer to their trapping grounds and traded with the French, or the HBC as they chose (Ray 1974:69). However, the French stronghold in the region was broken by a disruption of trade goods due to the Seven Years War which led to the fall of New France in 1760 (Lytwyn 1986; Ray 1974).

The French withdrawal allowed a new group of more-or-less independent traders, known as the "Canadians," (provisioned by Mr. Solomon in Montreal) to quickly establish themselves throughout the Little North (Lytwyn 1986:9). By 1766 the Canadians were well established at least as far southwest as the "Forks" of the Assiniboine and Red Rivers (i.e., presently Winnipeg), and as far northwest as The Pas (HBCA B.198/a/9, fo. 36-36d). Once

again HBC profits were drastically affected by the Canadian inland trade.

During the early to mid-1770s in response to the Canadian advances, the HBC commenced inland expeditions and established outposts along the Albany and Moose Rivers (Lytwyn 1986:28). In 1775 HBC established Henley House and two years later Gloucester House at Washi Lake in order to further curtail the Canadian incursions and enhance their own regional trade. The HBC also sent expeditions further west to such places as Sturgeon Lake and the area just east of Lake Winnipeg only to find that the Canadians already trading there and on the west side of Lake Winnipeg (HBCA B.3/a/73, fo. 20d).

The density of the posts within the Little North eliminated the need for middlemen altogether. The Assiniboine and Cree, however, already exploiting bison quickly adapted to a new industry — that of post supplier. As Ray (1974:131) notes,

Of significance to the Assiniboine and Western Cree, the increasing size of the provision requirement of the fur trade offered them new economic opportunities when their traditional role as middlemen in the fur trade was being undermined by the flood of pedlars into western Canada. The Assiniboine were the first to respond to the changing conditions, and the historical records suggest that they shifted the primary focus of their trading activities from the exchange of furs to the bartering of dried meat and grease in a relatively short period of time.

Although the participation of the Assiniboine and Cree in the fur trade changed, their divided trade between the Canadian and HBC posts maintained the competition between the two companies. The concentration of small Canadian posts, however, still drew more trade. The Canadian stronghold continued until 1782 when a devastating smallpox epidemic swept through the region from Lake Nipigon to Sturgeon Lake. As Lytwyn (1986:44) notes, the severe effects of the disease on the Native populace and morale also had severe effects on

the fur trade; “The smallpox epidemic that had so ravaged the Indian population had also destroyed Solomon’s trading empire.”

It did not take long, however, for another company (i.e., the North West Company) to replace the void left by the demise of Solomon’s company. Indeed, by 1784 Edward Umfreville of the North West Company (NWC), employing primarily Canadian traders, was established inland from Gloucester House (Lytwyn 1986:48). Throughout the 1780s and 1790s, competition between the NWC and HBC intensified as both companies expanded inland. By the 1790s, both companies, as well as other fur trade companies, had expanded westward at least as far as present-day Edmonton, Alberta. Once the NWC merged with the remaining Canadians in 1795 and the XY Company in 1799, trade competition between the HBC and NWC intensified in the Little North peaking in 1805. The intense competition for furs, resulting in the overexploitation of fur bearing animals, and an outbreak of measles amongst the Native population in 1819 led to a fundamental change in the fur trade pattern in the region. The merger of the HBC and the NWC in 1821 accentuated this change (Lytwyn 1986:87-157).

The resulting monopoly of the HBC in the Little North no longer necessitated the support of the extensive network of fur trading outposts, and the HBC closed many of the posts in the region. These closures initiated the migration of some Native groups closer to the remaining posts in the region and increased the competition with resident groups. Other bands remained where they were simply withdrawing from the European fur trade (Lytwyn 1986:161).

## 4.2 Historical Evidence of Trade Movements

It is important to determine who and how far groups and/or trading Natives were willing to travel for trade. If interecosystem travel can be established during the fur trade, then the notion of interecosystem travel prior to the fur trade can also be entertained. It is apparent that, historically, Natives did travel quite extensively, and were willing to be commissioned for the purpose of guiding and conducting inland trade. This can be observed in the early history of these groups.

The Assiniboine are said to have originated at least as far east as the eastern woodlands of Minnesota prior to European contact, but westward migration was rapid following the inception of the European fur trade (Denig 1961:69; Lowie 1909:7). The northern Assiniboine bands utilised canoe and water transport while the Plains Assiniboine also used terrestrial transportation (such as, dog travois, walking, etc.) especially after the arrival of the horse.

Likewise, the Ojibwa, who were amongst the first middlemen and guides, travelled past the Great Lakes with the fur trade. Despite the great distances they travelled, a number of historians argue that their lifeways were little affected. For example, Peers (1994:28) argues that the Ojibwa were able to move onto the plains, into the parklands and back into the boreal forest. Their ability to traverse these different ecosystems was facilitated by geographical features such as river basins that consisted of similar resources throughout the various ecosystems “that bound the Ojibwa to their eastern villages.” She concludes by stating that, “To a canoe-oriented people [as are the Ojibwa], the Winnipeg River, the Manitoba lakes and rivers that surrounded them were highways rather than barriers to

movement” (Peers 1994:29). Likewise, Friesen (1984:24) argues,

Some Ojibwas seem to have travelled there [to Hudson Bay to HBC posts]— a distance of 1,000 miles — to obtain an alternate source of goods. Many Ojibwas moved west into the country north of Lake Superior in the following generation (1690-1730), perhaps in company with the expansion of the French fur-trade network. . . . during the next century, they became greater travellers and traders as they participated more determinedly in the European-Native trade network. Aside from the migration northeastward and the increased emphasis upon travel, they remained a separate cultural group.

The woodland Cree, like the woodland Assiniboine and Ojibwa, were oriented towards water transportation. Places they could not reach by waterway, they got to by foot. By using the waterways, the Cree could travel inland collecting foods (such as, wild rice), trapping, and returning to the fur trade posts with relative ease. That the Cree were highly nomadic, “even much more nomadic than other tribes,” was quite evident by numerous historic accounts including one by Father Allouez, in 1666, in which he indicates that the Cree apparently had no fixed territorial boundaries, such as villages or fields (Mandelbaum 1940:169).

Travel during the early fur trade did not simply relate to trade. It is generally accepted that the Ojibwa, Assiniboine and Cree needed to travel for subsistence. This type of travel, or seasonal migration, was made necessary by the availability of different types of resources in different areas at different times of the year. Historically, the bands of southern and central Manitoba exploited two primary ecosystems during different times of the year (Mandelbaum 1979; Ray 1974; Russell 1991). The ecosystems used depended on the band’s basic subsistence strategy — that is, whether a band was woodland or plains oriented. Woodland groups would hunt and fish in the forests during the summer months, and would head to the

parklands during the fall and winter to hunt moose, beaver and bison. Plains groups also would head to the parklands for the fall and winter for the same hunting strategy, but would return to the plains in the spring and summer to exploit the large bison herds.

Ray (1974:46) elaborates on this model arguing that from 1690 to 1765 “the Cree and certain bands of the Assiniboine who maintained direct contact with the Hudson’s Bay Company posts” would spend the fall in the grassland-parkland margins exploiting beaver and moose, then winter in the parkland with the Assiniboine hunting bison, wolves and fox, and finally, in spring would return to the forest rivers and lakes “to build their canoes, trap furs, fish, and hunt waterfowl.” On the other hand, “typical” grassland-parkland Assiniboine “who had only indirect contact with Hudson Bay through Cree or Assiniboine middlemen, or, in other cases, who traded principally with the French” would weir sturgeon in the parkland during the spring, and would make trading trips into Mandan villages for maize in the fall (Ray 1974:46).

Ray’s (1974) more elaborate model of the seasonal round is supported by a number of documents. For example, in January 1734 La Vérendrye notes that some of the Cree and Assiniboine who travelled from the “lower part of Lake Winnipeg” to Fort St. Charles on the Lake of the Woods planned to leave in spring to go to the Mandan to buy corn (Burpee 1927:153). While he was at Fort Maurepas I in 1737, he asked some Assiniboine where they planned to spend the summer to which they replied that, “on returning from the war they would go to the country of the *Kouathéattes* [Mandan] to buy Indian corn and beans” (Burpee 1927:253-254). However, La Vérendrye also notes that a group of Assiniboine planned to return to Lake Winnipeg from St. Charles in early January 1734 while the Cree

were planning to stay until spring (Burpee 1927:163). That this latter group of Assiniboine left the parkland margin for denser woods in winter is in contradiction to Ray's model, and raises the issue of whether the bi-ecosystem seasonal cycle was the norm and, if so, who and how many individuals/groups did not follow this pattern.

In order to assess how typical the bi-ecosystem seasonal round was for certain groups, I studied a number of post and trader journals for accounts of individuals of "known" origin who would frequent or visit posts to determine how far they travelled, and at what time of year. While these data are biased in many respects, they do provide valuable information about the variability of and adherence to the practice of the seasonal round.<sup>4</sup>

For Brandon House (i.e., a plains post), Old Muskegs made the longest noted trip between the period 1793 to 1800 from west of the Red River probably along the Assiniboine in January of 1793 — a linear distance of approximately 140 kilometres within one ecosystem (HBCA B.22/a/1-7). However, there were many other arrivals of travellers noted in the Brandon post journals, but for whom origins were not reported. For example, the Black Man Cree (also known as L'homme Noir at Rainy Lake), was recorded as being at Brandon House in October 1795 and January 1799, and was also recorded as journeying from Kenora to Rainy Lake in October 1805. These wide ranging movements are in keeping with Ray's

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<sup>4</sup> Some of the ways in which this information is biased are: 1/ Since this thesis concentrates on the Winnipeg River region, only those posts more closely pertaining to the thesis were studied; thus the distances and areas travelled only relate to this area; 2/ There are considerable differences in the thoroughness of reporting by postmasters and traders; therefore, this study only takes into account a small minority of native travellers, and some posts are better represented than others; 3/ There were numerous individuals who had frequent visits, yet no origin was given. 4/ Those individuals whose origins were given, were often given as vague locales, such as, Camonawish arriving at Fort Alexander from the Dead River (HBCA B4/a/5, fo. 15d).

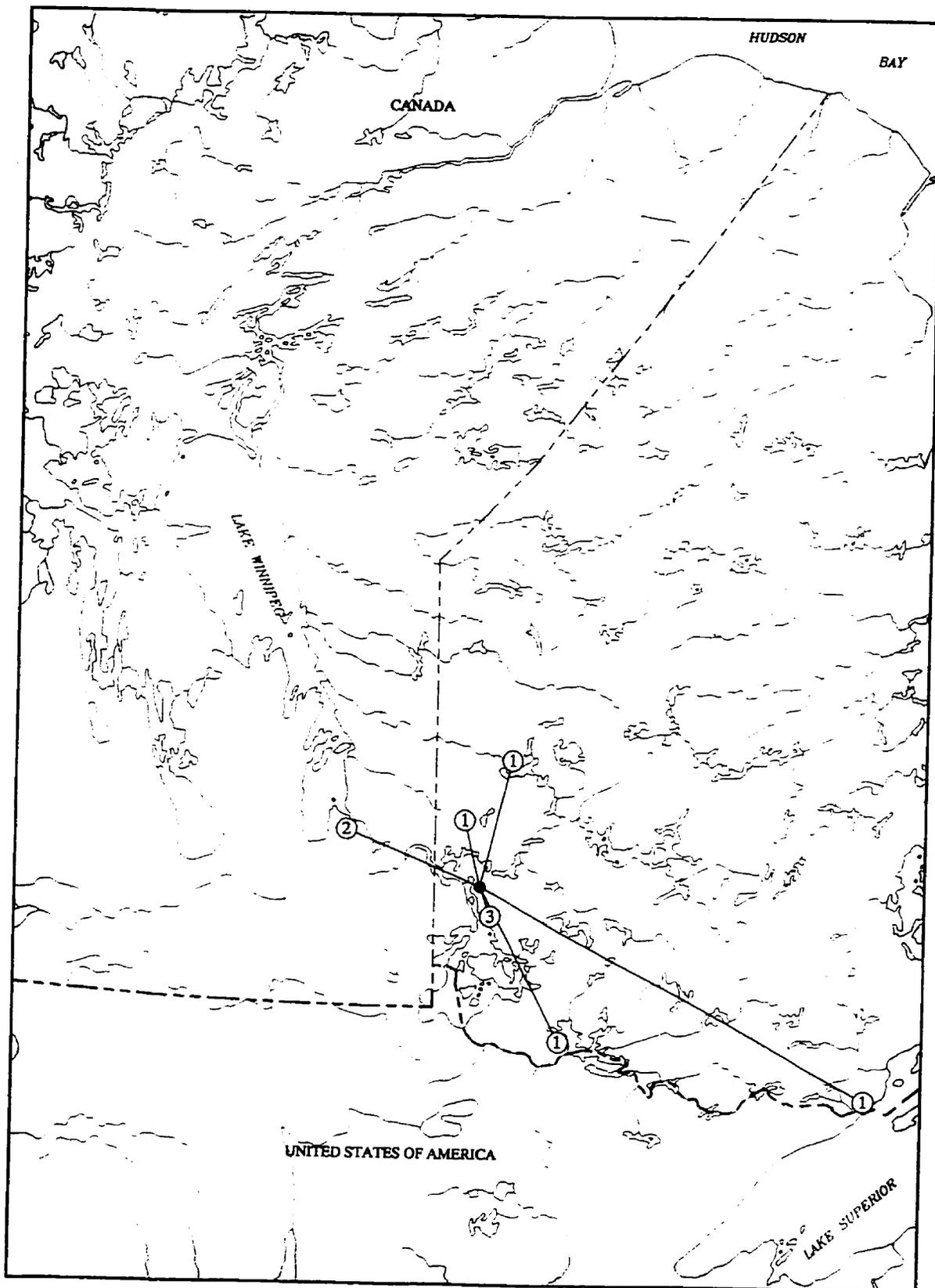
model of the seasonal round of the Woodland Cree (HBCA B.22/a/2; HBCA B.22/a/7; Gates 1965:215).<sup>5</sup> The Black Man was not the only Native recorded as travelling far to visit Brandon House. Other Native traders of unknown origin included the Cree, Assiniboine, Saulteaux, Mandans and Gros Ventres (HBCA B.22/a/1-3) of which the first three may be either plains or woodland oriented, and the Mandan and Gros Ventres being plains oriented and remaining on the plains. For all of these travellers, 140 kilometres was probably not considered exceptional.

Prior to the opening of Fort Alexander in 1795, Portage de l'Isle (i.e., a boreal forest post) received much of the business that would later flow to Fort Alexander. Portage de l'Isle is further into the boreal forest, and it is assumed that the Native traders there would have been mostly woodland oriented people. For the period 1793-1795, 1794 was the only year in which Portage de l'Isle journals reported Native traders of known origin (HBCA B.166/a/1-3). The average distance travelled to reach the post was 80 kilometres, these visits occurred year round, and remained mostly within one eco-system (HBCA B.166/a/1-3) (Figure 4.3a). The only exception was a person who travelled from Lac la Pluie in September (a distance of at least ca. 300 kilometres); thereby, travelling from parkland to forest during the fall — that is, just the opposite of “model” behaviour.

During the period from 1795 to 1834, Fort Alexander records provide only a few years of journal entries (i.e., 1798, 1805, 1822/23 and 1833/34) where both Native traders and their origins were noted (HBCA B.4/a/1-7). In these years, there are two different travelling

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<sup>5</sup> Although his homeland is not indicated in the Brandon House or Rainy Lake journals, “L’homme Noir” signed the Selkirk Treaty of 1817 ceding the territory from the Forks to the Mus Rat Root River beyond Portage la Prairie (Morris 1991).



**Figure 4.3a - Trade Travelling Distances To and From Portage de l'Isle 1793-1794**  
(Circles indicate place of origin. Numbers represent number of trips reported.)

patterns (Figure 4.3b). The first type of travel involved distances of approximately 50 kilometres, or less — that is, from just downstream or from such places as Lac du Bonnet or Nettly Creek (HBCA B.4/a/5 and 7). These were year round trips involving both individuals and groups who made repeated excursions to the post from the same locale. This type of behaviour is consistent with bands that remained year round near the various posts primarily to provision them through the winter. They became, in effect, “House Indians” much like the “Homeguard Cree” of the posts along the Hudson Bay. By 1822 HBC traders at Fort Alexander noted “Freemen” were settling on the opposite side of the river from the post (HBCA B.4/a/5, fo. 6d and fo. 8d).

The other type of journeys involved comparatively longer distances of 100 to 170 linear kilometres but within one ecosystem. According to the post journals of 1822/23 and 1833/34, these trips took place mainly between August to October (fall), or March to June (spring/early summer). These visits to the trading posts coincided with the seasonal rounds of the Ojibwa in this area (Peers 1994:22-25). They occurred just before travelling out to their wintering hunting grounds and just after returning from them in spring. Judging by these two years in a ten year span, this pattern does not appear to have altered within this period.

In the period after 1797 another dynamic that affected band movements was evident in the Winnipeg River region. The overtrapping of beaver and large game animals in the Little North induced both the Cree and Ojibwa bands in the area to devise new coping strategies (Peers 1994:39-67). By 1801, a Fort Alexander trader noted that the prospects of trade were the worst he had known. The NWC had abandoned their post because they could



not obtain provisions at this “accursed miserable Place” (HBCA B.4/a/4, fo. 12d).

### **4.3 Ethnohistorical Evidence of Native Diet**

The information used in this section comes from two different, yet complementary, types of sources: ethnohistorical sources for the diets of Ojibwa, Cree and Assiniboine, and the post journals from Fort Alexander, Portage de l’Isle, Brandon House, Gloucester House, and Lac du Bonnet. The ethnohistorical reports tend to be more complete, but were usually written after the decline in the European fur trade, and often after the establishment of reservations. The reconstruction of Native diet using post journals relies primarily on the assumption that some of the trade items at the posts reflect, at least indirectly, Native diet. Each provide a slightly different aspect on Native diet in the Winnipeg River region during the fur trade era.

One of the prominent authors of Ojibwa dietary information is Frances Densmore.<sup>6</sup> She (Densmore 1929:7-8) reports that, in 1822, the Ojibwa at the “foot of Lake Superior” were cultivating corn and potatoes “to a limited extent,” and still spent much time hunting, fishing and gathering. Plants, however, were a prominent part of Ojibwa diet.

The plant products and by-products that were typically consumed by the Ojibwa can be divided into several categories: staples (wild rice, corn, pumpkins and squash, wild and white potatoes), fruits and berries which were eaten separately as well as added to other

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<sup>6</sup>Her interest in the Ojibwa culture began in the mid-19th century. Many of her observations incorporate historic information told to her as well as her own observations. Therefore the information from her work presented here should be considered pertinent to the later part of the fur trade until the early part of the 20th century.

foods such as, moose fat or deer tallow (especially blueberries), seasonings (maple sugar, wild ginger, bearberry, mountain mint), other cooking aids (corn silk and dried pumpkin blossoms for flavouring and thickening broths), beverages and decoctions (wintergreen, raspberry, spruce, and snowberry leaves, and wild cherry twigs), and miscellaneous plant foods (milkweed flowers, bulrush roots, and basswood, aspen and woodbine sap) (Densmore 1929).

According to Densmore (1929:40), “a typical complete meal [of which there would be one or two per day] comprised meat or fish, broth, rice with maple sugar, and dried berries prepared in some way.” The food present for meals depended largely on the season and what had been stored. Peers (1994:22-25) describes a typical Ojibwa seasonal round at the Boundary Waters. After leaving their wintering grounds, the Ojibwa would head to the parkland in early spring then move on to the sturgeon runs in large groups once the trees stopped running. Peers (1994:24) notes that “after the spring gathering, the Ojibwa dispersed for the summer” but would gather again in late summer for hunting waterfowl and gathering wild rice. Fall would also be the time of fishing for whitefish, heading to wintering grounds, and hunting deer, moose and bear. Peers (1994:24-25) remarks on the importance of this last hunting period,

Once they arrived at their winter hunting grounds, a fall hunt was made to take a number of fat deer, moose, or bear; this meat, the amount of small game such as raccoons that they were able to obtain during the winter, and the size of the caches of stored foods, determined the amount of time the Ojibwa spent trapping, rather than hunting for food.

Densmore (1929) notes a number of food preparation methods. For example, wild rice was boiled in water or broth, and corn, when fresh was roasted in its husks or parched,

or, when dried was boiled. Unleavened bread was made of flour, salt, water and soda or lye, and cooked in a pan or on a skewer next to a fire. Much of the cooking took place in a kettle hung from a tripod or a slanting stick (depending on the permanency of the camp) (Densmore 1929:41).

Fish was cooked fresh in a variety of ways:

- 1) The fish was cleaned and placed between the sections of a split stick, which was thrust into the ground before the fire. By this means the fish could be turned so the all sides would be equally cooked. . . .
- 2) The fish, without being opened, was impaled head upward on a stick, which was placed upright in the ground before the fire. . . . When thoroughly cooked the fish was split open and seasoned with maple sugar.
- 3) The heads of fresh fish, especially suckers, were boiled and greatly liked.
- 4) Fresh fish were boiled and the broth used.
- 5) A large fish was selected which was rich in oil. The intestines were cleaned and turned, and with the roe were fried in grease and seasoned with maple sugar.
- 6) . . . When the fish was partly dry the skin and bones were removed, the fish was then spread on clean birch bark and again allowed to dry slightly, after which it was rubbed with the hands until very soft and fine. It was then mixed with new sugar and packed in makuks [bags]. Fish prepared in this way would keep a long time. It was eaten with a spoon and considered a great delicacy.
- 7) Fish eggs were boiled or fried with the fish (Densmore 1929:42).

Birds (waterfowl and other wild birds) were boiled into stews with wild rice, potatoes and other meats, cooked (feathers and all) on hot ashes, or defeathered, cleaned and skewered over the fire in a manner similar to fish. Likewise, deer and moose meat were boiled, or cut into strips and skewered while the tallow was rendered and stored in containers made from the large intestines or bladder. Rabbits were snared and skewered throughout the winter, and eaten with the bone grease. Bear meat was prepared in a similar manner as deer and moose, however, the meat and several organs were considered a delicacy because of the high fat

content. The portions of bear that were especially favoured were the liver and intestines (very rich in fat) which were cleaned and fried to a crisp, the stomach which is the source of "bear's grease," and the paws and head contents which were boiled. Beaver tail was also known as a delicacy for its fat content. Apparently only one animal (i.e., marten) caught in traps was not eaten. No reason is given for this dietary disdain (Densmore 1929:43-44).

Some portion of food was usually preserved and stored. Plants were parched or dried. Foods (such as, wild rice and sugar in *makuks*, seed potatoes and seed corn, and other vegetables) were often stored in separate storage pits that were usually six feet deep, lined with birch bark, separated into layers by hay, and sealed with hay or birch bark, wood and earth (Densmore 1929:40).

Fish were dried on a rack over a fire or by the sun from spring to fall and "freeze-dried" uncleaned during the winter, and bundled whole, or pounded and usually mixed with fat and berries (Densmore 1929:39-41). The preservation of deer meat depended on the season of the kill. As Densmore (1929:43) explains,

The method of drying deer meat depended on the time of year. If the deer were killed during the winter season, it was customary to dry the meat only enough so that it would keep until spring, when the drying process was completed in the sun. A good supply of meat usually obtained during the winter and was thus partially dried on a large frame over the camp fire. If the deer were killed in the autumn, a portion of the meat was cut in strips, dried on a rack over a slow fire, and wrapped in large packets, an entire deerskin tanned with the hair on it being sometimes used for this purpose.

The dried meat was then boiled, mixed with bear grease, and was pounded or stored in layers. Rabbit meat (dried and mixed with its pulverised bones and bone grease) was eaten uncooked.

Generally, very little is known about the dietary practices of the Assiniboine, possibly because of their late schism with the Yonktonai, and subsequent subsistence shift during the fur trade to a plains lifestyle. Besides the Assiniboine's heavy participation in the historic bison trade, Denig (1961:68) notes that "wild turnips, artichokes, service berries, chokecherries, red plums, rose buds, bull berries, gooseberries, currents, sour grapes and a plant similar to garden rhubarb are principal fruits and are greatly sought after by the Indians."

It may be assumed (under the most tenuous circumstances) that the northern Assiniboine subsistence behaviours in some way reflected those of other Dakota residing in the woodlands of Minnesota, or to the Woodland Cree. Under this assumption the Assiniboine would be water-oriented (i.e., canoe users) people who fished, hunted, and gathered foods, and perhaps planted some corn or maize. Pond (1986:27-28) describes the subsistence strategy of the Dakota Sioux as using plants, berries, nuts, fruit, wild turnip, water-lily and wild rice as well as "psinchincha" (marsh roots shaped like eggs) as staples. For meat, Dakota Sioux relied mostly on deer (60 or more per hunter per year) (Pond 1986:29), but also hunted moose, beaver, waterfowl, muskrat, porcupine, dog, fish and turtles (Lowie 1909:12; Pond 1986:29-30; Stevens 1972:10). However, this information is nothing more than purely speculative for the Assiniboine.

The importance of bison to the southern Assiniboine and Plains Cree as a food source cannot be overstated, however, bison products in the late historical period were more important as currency for obtaining other food stuffs and supplies from trading posts (Mandelbaum 1979:51). Prime cuts of meat (tongue, shoulder, etc.), organs (liver, teat fat

and heart), and bones (for marrow and bone grease) were procured and taken back to the campsite (Mandelbaum 1979:58). Here, the meat was dried on drying racks, saved as strips or made into pemmican (pulverised meat, fat and dried berries), and stored in storage pits or caches. Soups or stews would be made in kettles over fires, or in boiling pits, consisting of “meat, berries, fat and Indian turnips” (Mandelbaum 1979:59).

Moose and elk, although available in wooded areas were generally not hunted due to the greater efforts required in hunting them than bison (Mandelbaum 1979:68). Deer, antelope, wolves, coyote, badger, lynx, rabbits, gophers, birds (prairie-chickens, wild turkeys, partridge, magpies, hawks, owls, etc.), waterfowl (mallards, ducks, teals, herons, geese, swans, etc.), and infrequently fish were also caught, and eaten (Mandelbaum 1979:69-70). However, there were certain animals that would not be eaten (such as, loons, buzzards, cranes, ravens and crows, night hawks, small night owls, pelicans, humming birds, snakes, ground squirrels, frogs, and insects).

Plant foods consisted of Indian turnip (*Psoralea esculenta* or grass berry) primarily, other roots (earth peel, little dog teeth, wood carrot), maple sugar, wild honey, and berries and fruits (saskatoons, chokecherries, wild raspberries and strawberries, black currants, red willow cherries, gooseberries, pin cherries, high and low bush cranberries, mooseberries, ground cedar berries, buffalo willow berries, blueberries, bearberries, rose berries, big thorn berries, dogfoot berries, dewberries, wolf berries, mountain ash berries, cactus fruit).

It is evident that ethnographic sources often only provide the most general information about Native diet. Frances Densmore's description of the Ojibwa diet is exceptional in its detail, and few, if any, compare with her observances of their way of life.

Generally, the foods that were noticed by ethnographers of her era were those that were obvious, such as, bison, wild rice and berries. However, many other foods and substances that were ingested go unnoticed.

The fur trade journals provide slightly different information about Native subsistence. Often it is difficult to distinguish between Nations trading at posts since it was common practice for the post masters to refer to Native traders simply as “Indians.” However, some general comparisons can be made with regards to ecosystems and periods of trade. By comparing the items traded at Fort Alexander, Portage de l’Isle and Brandon House and assuming that those provisions traded, at least indirectly, give evidence of Native diet, a distinct split in resources is detected (Table 4.1 to 4.4). Portage de l’Isle (1793 to 1795) and Fort Alexander (1795 to 1834) (HBCA B.166/a/1-3; HBCA B.4/a/1-7 and HBCA B.236/a/1) were posts located in the forest. Wild rice was one of the most common staples at these posts which was gathered and traded in August to October. Numerous beaver were traded from July to October as well as from March to April. A variety of fish were caught throughout the year while ducks and geese were traded mostly in the late summer to early fall (July to October). Bears were traded from April to June, and muskrats from March to September.

Despite these similarities there were also some differences in the animals traded at these posts. For example, sturgeon was not mentioned at Portage de l’Isle for the years studied whereas the post masters at Fort Alexander remark on the Natives’ “war upon sturgeon” (HBCA B.4/a/5, fo. 5) from May to July and again later from August to October. This discrepancy is somewhat confusing given the accounts of large numbers of sturgeon along the Winnipeg River close to Portage de l’Isle. For example, in early July 1857, John

Palliser (Spry 1968:81) remarks on the sturgeon caught near Rat Portage (present-day Kenora, Ontario),

sturgeon are caught in great number below the falls, principally by spearing, an operation which is performed with great dexterity by the Chippeway Indians. They stand on a projecting rock over some suitable eddy, until one of the large fish comes within reach, when they secure it by a skilful thrust with a barbed spear.

Perhaps the Cree groups located around Portage de l'Isle at the time concentrated their efforts of securing fur bearing trade animals rather than sturgeon, while the Ojibwa kept fishing; or perhaps, 1793 to 1795 were untypically bad years for sturgeon. There is mention of Natives going off to war May to July 1794 (i.e., the time of the densest runs of sturgeon), thus during these war years, it is possible that sturgeon season was missed (HBCA B.166/a/2).

Another notable difference is that, at Portage de l'Isle, venison was often traded from August to December, but was only specifically mentioned as a trade item at Fort Alexander once in October 1822; while moose was traded from September to November and March to April at Fort Alexander, it was only mentioned once at Portage de l'Isle. This difference could be due to the overtrapping of beaver (i.e., the number of beaver traded declined significantly after 1801 at Fort Alexander) which resulted in the exploitation other fur bearing animals. The decline in beaver numbers would make moose a more attractive meat resource despite the increased difficulty in hunting them. The lack of moose at Portage de l'Isle is also somewhat explained by Bishop (1974:91) who argues that by the 1820s moose had been "exterminated from northern Ontario" not to return until the 1890s.

The apparent differences in trade provisions recorded at Fort Alexander and Portage de l'Isle may be due to micro-regional variation in population densities of fauna, or

subsistence preferences. It has been demonstrated that while sturgeon were frequently brought into the Fort Alexander post, rarely were they mentioned at Portage de l'Isle although they were known to have been in the river there. Likewise, venison was the preferred staple at Portage de l'Isle, and moose at Fort Alexander. Unfortunately, due to the ambiguity of the journal references, these differences in the procurement of certain species over another cannot be attributed to specific Native groups without much confounding evidence. However, it should be remembered that these differences may arise from group preference rather than by availability.

| <b>Country Provisions</b>                         | <b>La Vérendrye and Sons<br/>(Rainy Lake/Wpg. R. Area)<br/>1729-37</b> | <b>Alexander Henry<br/>(Red River - Pembina)<br/>1800-05</b> | <b>Daniel Harmon<br/>(Winnipeg River)<br/>1800</b> |
|---|--|--|--|
| Wild Rice   | X  |  |  |
| Moose   | X  | X  | X  |
| Sturgeon  | X  | X  | X  |
| White Fish  | X  |  |  |
| Catfish   |  | X  |  |
| Ducks   |  | X  |  |
| Geese   |  | X  |  |
| Pigeon  | X  | X  | X  |
| Berries   | X  | X  | X  |
| Sugar   |  | X  |  |
| Deer  |  | X  | X  |
| Buffalo   | X  | X  |  |
| Dried Meat  | X  | X  |  |
| Sources: Burpee (1927); Gough (1988); Lamb (1957) |  |  |  |

| <b>Table 4.2</b>   |                            |                            |                              |                               |                                  |
|--|----------------------------|----------------------------|------------------------------|-------------------------------|----------------------------------|
| <b>Country Provisions Traded at Portage de l'Isle, Winnipeg Lake Post, Lac du Bonnet, and Rainy Lake</b> |                            |                            |                              |                               |                                  |
| <b>Country Provisions</b>  | <b>Portage<br/>1793-94</b> | <b>Portage<br/>1794-95</b> | <b>Wpg. Lake<br/>1796-97</b> | <b>Rainy Lake<br/>1804-05</b> | <b>Lac du Bonnet<br/>1807-08</b> |
| Wild Rice  | X                          | X                          | X                            |                               | X                                |
| Moose  |                            | X                          | X                            |                               |                                  |
| Sturgeon   |                            |                            |                              | X                             | X                                |
| White Fish   | X                          |                            |                              | X                             |                                  |
| Perch  | X                          | X                          |                              |                               |                                  |
| Jackfish   |                            | X                          | X                            |                               | X                                |
| Pickrel  |                            | X                          |                              |                               |                                  |
| Ducks  | X                          | X                          | X                            | X                             | X                                |
| Geese  | X                          | X                          | X                            |                               |                                  |
| Pigeon   |                            | X                          |                              |                               |                                  |
| Berries  |                            | X                          |                              |                               |                                  |
| Sugar  |                            |                            |                              | X                             |                                  |
| Bear   |                            |                            | X                            |                               |                                  |
| Beaver Flesh   | X                          |                            | X                            |                               | X                                |
| Rabbit   | X                          | X                          |                              |                               | X                                |
| Deer   | X                          | X                          |                              |                               |                                  |
| Pemmican   |                            |                            |                              |                               | X                                |
| Dried Meat   |                            |                            | X                            | X                             | X                                |

Sources: HBCA B.166/a/1-3; HBCA B.236/a/1; Gates (1965), "The Diary of Hugh Faries at Rainy Lake in 1804-05;" HBCA B.103/a/1

**Table 4.3**  
**Country Provisions Traded at Fort Alexander, 1795-1833**

| Country Provisions | 1795-96 | 1797-98 | 1798-99 | 1799-1800 | 1822-23 | 1833-34 |
|--------------------|---------|---------|---------|-----------|---------|---------|
| Wild Rice          | X       | X       | X       | X         | X       |         |
| Moose              | X       | X       | X       | X         | X       |         |
| Sturgeon           | X       | X       | X       | X         | X       | X       |
| White Fish         | X       | X       | X       | X         | X       | X       |
| Carp               |         | X       | X       |           |         |         |
| Jackfish           |         |         |         |           | X       | X       |
| Pickereel          |         |         |         |           | X       |         |
| Catfish            |         |         |         |           | X       |         |
| Ducks              |         |         | X       |           | X       | X       |
| Geese              |         | X       | X       |           |         | X       |
| Pigeon             |         |         |         |           | X       | X       |
| Berries            |         | X       |         |           |         |         |
| Bear               |         |         |         |           |         | X       |
| Rabbit             |         | X       | X       | X         |         | X       |
| Deer               |         |         |         |           | X       |         |
| Pemmican           |         |         |         |           | X       |         |
| Dried Meat         |         |         | X       |           | X       |         |

Sources: HBCA B.4/a/1-7

| Country Provisions       | 1793-94 | 1794-95 | 1795-96 | 1799-1800 |
|--------------------------|---------|---------|---------|-----------|
| Moose                    |         |         |         | X         |
| Sturgeon                 | X       |         |         |           |
| White Fish               |         | X       |         |           |
| Corn                     |         | X       |         |           |
| Sugar                    |         |         | X       |           |
| Berries                  |         | X       |         |           |
| Deer/Elk                 |         |         |         | X         |
| Buffalo                  | X       | X       | X       |           |
| Dried Meat               | X       | X       |         |           |
| Beaver Flesh             |         | X       |         |           |
| Sources: HBCA B.22/a/1-7 |         |         |         |           |

For the years 1793 to 1801, Brandon House (HBCA B.22/a/1-3 and 7) was a plains post where bison meat (i.e., green and dried) was traded all year; through the fall and winter (October to February) foxes and wolves were traded; maize was traded from February to May; and through the remainder of the year foxes, wolves and buffalo were randomly traded. Forest resources such as wild rice, sturgeon and beaver were rarely traded.

#### **4.4 European Influences on Native Diet**

It is obvious that once the European fur trade was firmly established in the Winnipeg River region, European contact was felt by local Natives in more ways than the simple trading of furs. European foods were initiated into Native diet just as Native dietary items

were included into the European diet. Although it is apparent that once the fur trade had directly infiltrated northwestern Ontario, Natives had more influence on the diets of Europeans than vice versa, there were a number of ways in which the Native diet was affected directly and indirectly by European exposure.

One of the earliest accounts of the interactions between Natives and Europeans west of Thunder Bay is that of LaVérendrye from 1729 to 1737. In 1733, LaVérendrye, in the company of a group of Cree, established Fort St. Charles on the west bank of Lake of the Woods where he put in a garden of corn (Burpee 1927:96). It is apparent from LaVérendrye's journal that the corn trade with the Mandan horticulturalists to the south probably had been established prior to the landing of Europeans in the North America.

It was through trade with the Ojibwa, Assiniboine and Cree that LaVérendrye was provided with the corn. Although these groups traded in corn, many did not partake of horticultural practices. Indeed, LaVérendrye initiated a few of the groups into horticulture in the Lake of the Woods area.

[The Great Chief of the Cree] told me that he would remain near the fort [St. Charles] all summer with the elders of the people to defend us, and that he was going to raise corn as we do. I urged him to raise as much as possible, and furnished him with seed (Burpee 1927:101-102).

Despite LaVérendrye's reliance on corn as a food source and as a seed crop, he remarks on the abundance of "wild oats" (i.e., wild rice) that enables him "to save the corn that was brought up last autumn" as well as a good quantity of fish and game in the area (Burpee 1927: 97). The fragility of this ecosystem (and those who depend on it) is demonstrated when the heavy rains of autumn 1733 wiped out the wild rice crops, and other food sources were

exploited more heavily as a result (Burpee 1927:141).

Native diet also was affected by the presence of European food products. LaVérendrye and other postmasters encouraged Natives to plant gardens of corn, potatoes, carrots and other roots crops. Frequently, European consumables such as, sugar, flour, potatoes, tobacco, and alcohol were traded. Some historians argue that certain groups became so dependent on posts for food that trapping and hunting were undertaken as the fundamental means of acquiring European consumables.

After 1821, the trapping of fur bearers cannot be considered a subsidiary activity in the lives of the Northern Ojibwa. Trapping became the basic subsistence pattern, for it was only through the acquisition of furs that the Ojibwa were able to obtain the materials from the post upon which they had come to depend for survival (Bishop 1974:196).

Alcohol became one of the most traded items of the European fur trade. During LaVérendrye's expeditions little mention is made of alcohol trade. Yet, by 1760, Alexander Henry the Elder (Henry 1969) had made a practice of offering alcohol as a gift and trade item, and by the 1790s, the rum trade had become firmly entrenched. John Macdonell, a fur trader of the North West Company around 1793, states that he "mixed nine gallons of Indian Rum it being customary for Bourgeois to wet the whistle of every Indian they met on the way" (Macdonell 1965:101-102).

Alcohol was the most preferred luxury items in the consumable trade. Typically the HBC traded whiskey while the NWC, the Canadians and the French traded rum. By the end of the 1790s, alcohol was watered down and used as wages (or bribes). Alexander Henry the Younger (Gough 1988:2), while near Portage la Prairie, writes that in order to convince

hunters to continue hunting during the harsh winter he had to pay “exorbitant rates including a 9 gallon keg of Saulteaux Liquor to each man to begin and an allowance of 2 gallons of liquor for every ten animals they might kill.”<sup>7</sup>

The alcohol trade dramatically increased during the years 1802 and 1803 as the competition between the XY, North West and Hudson’s Bay companies increased. In 1800 and 1801, the average annual consumption of rum and other spirits was 10,098 and 10,539 gallons, respectively. In 1802 and 1803 these averages jumped to 14,850 and 16,299 gallons, respectively, and immediately dropped to 12,168 in 1804 after the XY and North West companies merged (Gough 1988:139). In some areas, the alcohol trade resulted in such desperation that tobacco would be boiled and the juice drunk to continue a state of intoxication (Cameron 1960:248).

Although the trade of tobacco and alcohol was the norm, there were regional differences as to how and how much they were traded. As Lytwyn (1986:54), Ray (1974:71-93) and Tyrrell (1934:274) note, the climatic and ecological needs of each region had some input as to trade demands. For example, an HBC surveyor, named Philip Turnor, in 1780 noted the trade differences between a prairie post and a forest post. Cumberland House was located on the prairie where large game animals such as bison were a staple food and trade resource. The chief trade at such a prairie post was for brandy and, secondarily, hunting goods such as ammunition, knives, flints and steels. At posts within the woodlands (such as, Gloucester House), however, smaller fur bearing animals were usually traded for cloth,

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<sup>7</sup> "Saulteaux Liquor" is a mix of 8 or 9 quarts of "high wine" in a 9 gallon keg that is then filled to the top with water. High wine is redistilled (or double distilled) alcohol made from barley mash usually that, if aged, could become whiskey with 90% alcohol (Gough 1988:2).

blankets and then hunting equipment (Tyrrell 1934; Lytwyn 1986). Lytwyn (1986:54) also includes Turnor's observations of another way in which trade differed.

Turnor also remarked that since the Cumberland Indians could hunt the buffalo easily with bow and arrow, firearms were not necessary trade items (Tyrrell 1934: 274). In contrast, the Indians about Gloucester House depended upon the gun to hunt game such as moose, caribou, bear, and wildfowl. Cloth and blankets were also in demand because leather from large game was not easily or regularly available. The Gloucester Indians received a gift of liquor before the trading began, while the Cumberland Indians would trade for liquor as long as their supply of furs held out.

Therefore, in certain regions where the need for hunting and trapping paraphernalia were minimal, there was more disposable trade for luxury items, such as alcohol and tobacco.

Apart from the direct ways in which the fur trade affected Native diet, there were numerous indirect ways. For example, alcohol and tobacco affects diet by possibly inhibiting the desire for other food stuffs. This effect, however, cannot be estimated in any practical sense. Another way in which Europeans affected the diet of local Natives was by creating a market for regional food products that would drive up trade values and even create seasonal dearth in staples by overexploitation. Indeed, William McKay, a NWC trader around Lake Winnipeg, in an attempt to drive the HBC out of the area in 1801, bought up as much wild rice as possible (HBCA B.4/a/4, fo. 12). This tactic, of course, would also affect the wild rice stores for the regional bands making already difficult winters more difficult.

In a similar manner, the premium on specific fur bearing animals would entice over-exploitation for those animals (such as, beavers) and a decline in hunting of other, perhaps more traditional, food animals (such as, moose) that would not claim as high trade prices. The concentration on hunting, and fur preparation (i.e., often a family industry) could also

draw away from other important subsistence activities, such as plant gathering which was necessary for increasing food stores as well as providing a more nutritious and well rounded diet.

#### **4.5 Discussion**

One of the primary goals of this chapter was to determine whether the fur trade era in the Little North was an era of continuity in the subsistence strategies of Native groups, or discontinuity. In order to determine the continuity of subsistence of the groups inhabiting the Winnipeg River region, it was first necessary to understand who was in the Winnipeg River region throughout the historic period and how their territories had changed through time. Migration is generally believed to have a great impact on subsistence strategy. During the European fur trade period in the Winnipeg River region, there were three main groups (i.e., the Ojibwa, Cree and Assiniboine) who occupied the region for various periods of time.

Although there is some debate as to the “original” territories of the Cree and the Assiniboine prior to 1650, historic documents indicate that their eastern border was at least as far as Lake of the Woods from where they would travel further east to participate in the fur trade via Ojibwa middlemen. During this same period, the Ojibwa were slowly encroaching into Cree territory inhabiting the area around Rainy Lake. By 1821, the Ojibwa had migrated deeply into what had been Cree and Assiniboine territory past Lakes Winnipeg and Manitoba, and into east central Saskatchewan. The Cree were eventually pushed to either side of the Ojibwa front moving further north and west into central Alberta, while the Assiniboine primarily moved west virtually out of Manitoba and into southern Saskatchewan

to the Alberta border.

Vague references throughout the historic record indicate that the Ojibwa, while migrating from eastern Canada into northwestern Ontario, primarily retained the woodland subsistence strategy relying heavily upon fish, moose, wild rice and other plants. Indeed, the woodland roots of the Ojibwa were so strong that it leads historians to comment on their consistency even as they begin to venture further out of the parklands and onto the plains (i.e., for groups like the Bungi) in pursuit of bison, but all the while keeping to the wooded river valleys, and then returning to the parklands and forests (Peers 1994:28). This is evidenced in such reports by Alexander Henry the Younger (Gough 1988:119-125) during the winter of 1801 to 1802 who notes the presence of “Saulteaux” and “Lac la Pluie Indians” at Fort Pembina on their way to en derouine at the “upper part of the Two Rivers;” or by Donald McKay and Robert Goodwin at Brandon House from 1793 to 1795 who recorded that the “Lac la Pluie Indians” and “Saulties” were usually the ones who brought in the beaver, and wolf furs along with buffalo meat (HBCA B.22/a/1-3). During this time (from the late 17th century to the mid-19th century), the Ojibwa underwent many drastic changes — such as, severe population reduction, the amalgamations of “clans” into villages, and participation in the fur trade as middlemen — yet, they remained at a very fundamental level a woodland-parkland oriented people with, more or less, close and stable seasonal rounds. They would remain in the Winnipeg River region to the end of the study period.

The Cree, who are also believed to be a primarily woodland derived group (Mandelbaum 1940), did not demonstrate the subsistence continuity of the Ojibwa. Historically, the Cree fissioned into two main groups while still retaining their ties to each

other. By the mid-18th century, a “Plains Cree” group arose out of the need for bison provisioners, and the presence of the gun and the horse. Although the Plains Cree took advantage of the new market opportunity, they frequently entered into the parklands to exploit resources there (Ray 1974; Russell 1991). However, many Cree bands, much like the Ojibwa, remained primarily woodland-parkland subsistence strategists. The Woodland Cree kept, more or less, stable seasonal rounds and subsistence strategies, and stayed closer to “home.” Thus the woodland Cree, like the Ojibwa, continued to exploit the same resources and use the same subsistence strategy, while the Plains Cree diverted much of their efforts away from procuring forest resources and replaced them with bison and other plains foods. By 1822, however, few Cree resided in the Fort Alexander area.

The Assiniboine, much like the Cree, eventually became divided into two basic groups — one plains oriented and the other woodland oriented. In the case of the southern (i.e., plains) Assiniboine, they tended to relinquish even more of their woodland strategies than did the Plains Cree. The Assiniboine would typically trade exclusively in “meat” (i.e., bison meat), or “beat meat” at Brandon House (HBCA B.22/a/1-7). Due to the limited nature of the historic record involving the Assiniboine, specifically, within the Winnipeg River region, not much can be determined with regards to their consistency, or inconsistency of subsistence strategy. It can only be concluded that the Assiniboine not only migrated large distances through the historic era, but also underwent adaptations to new ecosystems and new occupations.

Overall, these groups, according to historic documents, demonstrate continuity in their subsistence strategies (i.e., continued to hunt, trap and gather the same foodstuffs)

despite their variability in migration distances until the mid-1750s when the horse and the gun became prevalent in Native trading practices. Even after the 1750s, some groups (typically woodland groups), as demonstrated in the individual trading patterns, subsisted in much the same way as they had prior to 1750. However, in the late 18th century, those groups oriented towards the prairie-parkland ecosystem began to exemplify a “plains behaviour” as buffalo hunters, pemmican provisioners and horse specialists.

From 1750 through 1821 (when the HBC gained the monopoly to the fur trade) until the mid-19th century, both plains and woodland peoples experienced subsistence continuity despite persistent hostilities. Undescribable changes again were to occur in subsistence patterns from 1850 to 1870 when the bison herds dwindled and reservations were created.

Another goal of this chapter was to determine if a “plains” diet could be distinguished from a “forest” diet, and the degree to which the food resources differed. Historically, judging by the transactions in the post journals, plains diets are easily distinguished from woodland diets. On the plains, bison were the primary food year round possibly supplemented by smaller game (perhaps deer, some fish and odd beavers) during the winter, and possibly maize. In the forests, spring and fall would be the seasons of plenty. In the fall, wild rice would be gathered, and venison, ducks and geese hunted. Moose were hunted, beaver trapped and sturgeon caught in the spring and fall. However, post journals from Fort Alexander and Portage de l’Isle indicate that traded foods (i.e., furs) were different even within a single econiche. Furthermore, parkland/forest groups, at times, relied on plains resources (i.e., specifically bison).

The question remains, therefore, whether these subsistence discrepancies can be

detected using stable isotope analysis. It is expected that “pure” plains diets would be relatively easy to distinguish from “pure” forest diets since stable isotopic signatures of freshwater and forest biota are significantly different than more xeric grassland biota (Katzenberg 1989; Schwarcz and Schoeninger 1991). I expect, however, that groups that exploit a wide range of biota from the forests, parklands and plains as described by the seasonal round in other studies, may have values that overlap these two extremes complicating interpretations.

The ease with which groups will be distinguished from one another will depend on the degree of their dietary resource diversity. The reconstruction of diets based on post journals in this study indicates that few groups actually experienced great dietary diversity (i.e., consumed equal proportions of foods from more than one econiche). Rather groups either primarily subsisted on food obtained on the plains, or foods obtained from within wooded areas. Few groups equally exploited resources from both regions. If this historic representation is correct and reflected in the diets of the individuals represented at the five study sites, isotopic analysis should be easily facilitated.

## **CHAPTER 5**

### **Dental Palaeopathological Evidence of Diet**

The analysis of dental pathology in human remains from archaeological sites has a long history in anthropology. This type of analysis helps reconstruct the health, nutritional status, and subsistence of past populations. This chapter covers the dental pathology of human burials from the Whaley Cairn, Slave Falls, Fort Alexander, Bjorklund and Whitemouth Falls sites, and the significance of these pathologies in reconstructing subsistence strategies. In particular, these data are used to determine if trends are present that indicate differences or similarities in the subsistence strategies between these groups.

Generally, only certain types of dental pathologies have been used in subsistence studies (eg. caries and tooth wear), however, a broader examination of pathologies can produce more reliable interpretations. Since such analysis encompasses numerous dental conditions and traits, this study will rely on the preliminary description and analysis of dental caries, specific antemortem tooth modifications, periodontal conditions and disease, alveolar abscesses, calculus, attrition and enamel hypoplasias in order to answer questions concerning health and diet. This chapter consists of three parts. The first section will describe the sample used in the dental analysis. The second section will consist of the methodology of scoring dentitions, and finally the results will be presented.

## 5.1 The Dental Sample

The sample analysed in this chapter is a slightly smaller sample than the “general” sample noted earlier.<sup>1</sup> As is typical of early river burials of this region, the human remains are few and their poor preservation often reflect the effect of a harsh environment. Therefore, not all age groups, nor complements of dentitions are equally represented in each site (Table 5.1).

The sample is comprised of sixteen (16) individuals ranging in age from children to older adults: five (5) from Whaley Cairn (2 females, 2 males and 1 of indeterminate sex); six (6) from Slave Falls (1 female, 2 males and 3 indeterminate); three (3) from Fort Alexander (1 female and 2 indeterminate); one (1) female from Bjorklund; and one (1) female from Whitemouth Falls.

Whaley Cairn is one of the best represented sites consisting of four (4) individuals (i.e., 1 old adult, 2 middle adults and 1 juvenile) with largely complete dentitions, and a mandibular dentition of middle adult. Slave Falls is fairly well represented in number and age group, but there are no complete dentitions — that is, portions of the maxilla and/or mandible are missing as well as postmortem missing teeth from the bone segments present. Of the six (6) individuals from Slave Falls, one juvenile and two middle adults have approximately three quarters of a full dentition, and a middle adult, an adolescent and a

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<sup>1</sup> Due to contextual problems, four of the seven individuals from Fort Alexander were excluded from the dental study. Three of the excluded remains were surface collected by Sagkeeng members from an unverified area on the reserve. The fourth individual was excluded due to curatorial problems. All four individuals demonstrate significant variation from the remaining dental sample. That they are different is not problematic in and of itself, but at least 2 of the individuals demonstrate “modern” (i.e., post-European settlement) characteristics (i.e., possible baby bottle syndrome and surgical extraction of wisdom teeth.)

**Table 5.1  
Dental Sample Summary**

| Site  | Individual | Age          | Sex | Max | No. Teeth Present |     | Mand | No. Teeth Present |     |
|---|------------|--------------|-----|-----|-------------------|-----|------|-------------------|-----|
|   |            |              |     |     | R                 | L   |      | R                 | L   |
|   |            |              |     |     |                   |     |      |                   |     |
| Whaley Cairn  | XU1I1      | Middle Adult | M   | 1   | 6/8               | 7/8 | 1    | 8/8               | 8/8 |
|   | XU1I2      | Middle Adult | F   | 1   | 7/8               | 8/8 | 1    | 6/8               | 7/8 |
|   | XU2F1I2    | Juvenile     | Ind | 1   | 7/7               | 4/6 | 1    | 7/7               | 6/7 |
|   | Whaley 1   | Old Adult    | M   | 1   | 3/7               | 4/6 | 1    | 7/8               | 4/8 |
|   | Whaley B   | Middle Adult | F   | 0   | 0                 | 0   | 1    | 4/8               | 5/8 |
| Slave Falls   | F1I1       | Middle Adult | M   | 0   | 0                 | 0   | ½    | 0                 | 5/7 |
|   | F1I2       | Adolescent   | Ind | ½   | 8/8               | 0   | 0    | 0                 | 0   |
|   | F1I3       | Juvenile     | Ind | ½   | 4/4               | 0   | 1    | 5/6               | 4/5 |
|   | F2I1       | Juvenile     | Ind | 0   | 0                 | 0   | ½    | 3/6               | 0   |
|   | F3I1       | Middle Adult | M   | ½   | 0/2               | 4/8 | ½+¼* | 2*/3              | 3/7 |
|   | F3I2       | Middle Adult | F   | ½   | 2/2               | 0   | 1    | 3/8               | 2/8 |
| Fort Alexander  | B1I1       | Adolescent   | F   | 1   | 6/7               | 7/7 | 1    | 8/8               | 7/8 |
|   | B2I1       | Child        | Ind | 1   | 5/5               | 5/5 | 1    | 5/5               | 5/5 |
|   | B2I2       | Child        | Ind | 1   | 3/5               | 3/4 | 1    | 5/5               | 4/5 |
| Bjorklund   | Z17        | Old Adult    | F   | 1   | 8/8               | 6/8 | 1    | 8/8               | 7/8 |
| Whitemouth Falls  | Z25        | Old Adult    | F   | 1   | 7/8               | 5/8 | 1    | 6/8               | 7/8 |
| <p>* Possible match. A portion of mandible found in the water of a eroding river bank burial at Slave Falls (Individual F3I1). This mandible section (and teeth) is morphologically very similar to another mandibular segment found in context, and therefore, is included in this study with this individual.</p> |            |              |     |     |                   |     |      |                   |     |

juvenile are only represented by one half, or less, of a full complement of teeth. Fort Alexander is represented by complete dentitions but the sample is small and skewed in age. It consists of one adolescent and two immature (i.e., children) dentitions. The remaining two sites, Whitemouth Falls and Bjorklund, have one individual each, however, these two “old”

adults are some of the best preserved of the sample. The dental sample represents seven individuals for the Archaic/Middle Plains Indian Period, six individuals for the Early to Middle Woodland Period and three for the Historic Period.

For the purposes of this study, the sample was divided into two components: dentally mature (n=195 teeth present; n=256 possible tooth numbers) and immature (n=75 teeth present; n=87 possible tooth numbers)(Table 5.2).<sup>2</sup> The adolescents were placed amongst the group with mature dentition since most of their permanent teeth were in place except for a few erupting second molars, and erupting and/or forming third molars. Since dental pathology is highly correlated with age, and some pathologies were found critical for distinguishing between the sites, the inclusion of the adolescents with the mature group greatly aids in the statistical analysis, and the reliability of the significance statements made in this paper.

A direct comparison of the “number of teeth present” demonstrates a wide discrepancy between sites — that is, the number of teeth present between sites varies greatly. For example, Slave Falls has the greatest number of individuals in this sample, but the number of teeth present for this site (n=29) is almost the same as the sites represented by a single mature dentition such as Fort Alexander (n=28), Bjorklund (n=29) and Whitemouth Falls (n=25). However, Slave Falls also has the lowest percentage of teeth present to the number of possible teeth (29 present/53 possible = 55%) compared to the other four sites all

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<sup>2</sup> “Possible teeth present” is defined here by the number of teeth that may have been present in the sample based on the bone structure available (e.g., a right mandible gonion angle broken at the canine would “possibly” support 2 premolars and 3 molars, therefore the possible teeth present n=5). Congenitally missing teeth were not included.

having percentages greater than 77%. This “differential” could have been compensated for by weighted means. However, these differences could be caused by factors other than preservation and recovery, such as, subsistence strategy and/or bio-social patterns.

| Site             | Immature Dentition |    |            |    | Total | Mature Dentition |    |            |    | Total |
|------------------|--------------------|----|------------|----|-------|------------------|----|------------|----|-------|
|                  | Maxillary          |    | Mandibular |    |       | Maxillary        |    | Mandibular |    |       |
|                  | R                  | L  | R          | L  |       | R                | L  | R          | L  |       |
| Whaley Cairn     | 7                  | 4  | 7          | 6  | 24    | 16               | 19 | 25         | 24 | 84    |
| Slave Falls      | 4                  | 0  | 8          | 4  | 16    | 10               | 4  | 5          | 10 | 29    |
| Fort Alexander   | 8                  | 8  | 10         | 9  | 35    | 6                | 7  | 8          | 7  | 28    |
| Bjorklund        | 0                  | 0  | 0          | 0  | 0     | 8                | 6  | 8          | 7  | 29    |
| Whitemouth Falls | 0                  | 0  | 0          | 0  | 0     | 7                | 5  | 6          | 7  | 25    |
| <b>Total</b>     | 19                 | 12 | 25         | 19 | 75    | 47               | 41 | 52         | 55 | 195   |

## 5.2 Method of Dental Scoring and Analysis

The methods used to score the dental pathologies in this study are found primarily in two sources: *Standards* by Buikstra and Ubelaker (1984); and Patterson’s (1984) dental palaeopathology study of Pre-Iroquois and Iroquois remains. A total of sixty-six (66) dental conditions and traits (not including six simple identification categories) were recorded for each available tooth (n=270 teeth), and another ten variables for some missing teeth. The recording and grading criteria are listed in Appendix VI. A photographic comparison of dentitions and traits are shown in Appendix XI. Of particular interest are the dental caries

(n=4 variables), calculus involvement (n=3 variables), various periodontal pathological conditions (n=7 variables), antemortem tooth modifications (n=3 variables), occlusal wear or attrition conditions (n=3 variables for premolars, canines and incisors, and n=6 variables for molars), alveolar abscesses (n=3 variables), and enamel hypoplasias (n=4 variables).

Caries were scored macroscopically. Patterson (1984:74) defines caries as “any macroscopic necrotic defect of tooth surface.” He tests for carious lesions using a dental explorer and records any explorer “catches,” but Buikstra and Ubelaker (1994:55, emphasis theirs) suggest that only lesions penetrating the enamel surface be recorded (increasing reporting reliability) and, if in doubt as to whether a lesion is present or not, “*do not* record the observation.” The *Standards* approach was taken using an explorer. Questionable lesions were recorded on score sheets, but not entered into the database. In order to score carious lesions I have used modified *Standards* [which would make it a modified “modified Moore and Corbett (1971)” technique] and Patterson (1984) methods.

For rating the “type” of caries, my methodology most resembles *Standards* (Buikstra and Ubelaker 1994: 54-55) which divides the crown into various surface types (i.e., occlusal surface, interproximal surfaces, smooth surfaces and cervical surfaces) and radicular surfaces as opposed to Patterson’s (1984:378) method which only designates crown and radicular caries, and a degree of caries development. Both Patterson (1984), and Buikstra and Ubelaker (1994) include in their “caries type” pulp exposure which I have kept as a separate condition since attrition or other conditions can obliterate the aetiology of the pulp exposure. The degree of caries development was scored according to Patterson’s (1984:378-379) “size of lesion,” and the caries surface includes cusps as well as typical directional designation.

The incidence of calculus was determined by examining the dentition with 10x magnification under a good source of light. It was scored by location as absent, or coronal, radicular or both (Patterson 1984:381), by amount of deposit [according to Dobney and Brothwell (1987) using calipers to determine the thickest depth in millimetres], and by directional surface involved (i.e., buccal/labial, distal, mesial, lingual). The Dobney and Brothwell (1987) method is more objective than either *Standards* or Patterson's method which is important when analysing sites where calculus is minimal, such as those in this study.

Five basic periodontal conditions were examined. These included periodontal fenestrations, dehiscence, infradental condition, blunting resorption and inflammation all of which were scored according to Patterson (1984:382-383). The first three of these conditions were scored on a presence, absence or indeterminate basis, although infradental depth was also measured using calipers. Blunting resorption and inflammation were scored as per degree of involvement.

Antemortem tooth modification often does not directly pertain to diet, however, since certain tough and abrasive foods can cause similar dental lesions, these types of dental lesions had to be eliminated, and therefore analysed. Macroscopic visual examination of teeth (using a dental explorer and 10x magnification under good light) was performed to determine antemortem modification.

To record antemortem tooth modification, Patterson's (1984:390) erosion and abrasion conditions were included into a modified Buikstra and Ubelaker (1994:58) designations. Although *Standards'* broad categories would account for most types of

modifications within a variety of populations, their exceedingly large category of “dental wear associated with artifact use or production” which includes all types of chipping, fracturing and abrasion is inadequate for analysis where chipping and fracturing (and even abrasion) could account for completely different bio-social processes. Therefore, in addition to the stated scores for filling, drilling, restorations and appliances, and tooth ablation (all of which are intentional modifications), allowance was made for less intentional modifications often caused as a by-product of some processes.

The dental wear category within antemortem tooth modification was solely used for location of specific abrasion conditions, such as those which would cause interproximal grooving. Erosion was added to the list to indicate other processes at work, such as acidic regurgitation breaking down the enamel of anterior teeth. The final classification of modification was left for all other possible (unintentional) traumatic effects which were further classified by specific type. Traumatic modification types are basically in keeping with Patterson (1984:391) with the addition of cracked teeth and other trauma. Surfaces were recorded for all types of modifications as were caries surfaces except for the inclusion of a mesial/distal and a buccal/lingual score to accommodate certain directionally cracked teeth.

Attrition was scored using the methodology described in *Standards* (Buikstra and Ubelaker 1994:51-53) based on Smith (1984:45-46) for premolars, canines and incisors, and Scott (1979b:214) for molars. The *Standards*-Smith wear-scoring methodology assesses the degree of wear for the whole occlusal surface of a tooth while Scott's (1979b) methodology assesses the degree of occlusal wear by quadrant on each molar. Although Patterson (1984:61) acknowledges Scott's (1979b) methodology for assessing molar wear

as a “major advance” producing “finer gradations,” he used Molnar’s (1971) methodology which uses the same scoring scale for all tooth types. Despite the advantage of scoring all teeth on the same scale, I have opted to use the dual system (see Appendix VI #4) since Scott’s (1979b) scores can be easily translated into Molnar scores (especially if quadrant scores are kept separate as I have done) while retrieving maximum information, and since attrition of molars and more anterior teeth are rarely effectively compared due to highly differential enamel depths, surface area and potential occlusal force.<sup>3</sup> Molnar’s (1971:175-179) and Patterson’s (1984:376-377) method for scoring direction and form of occlusal wear was also recorded per observable tooth. Attrition observations were performed on a macroscopic level (by the naked eye).

The methodology for recording alveolar abscesses follow Patterson (1984:71-81). Patterson (1984:77) and Bhaskar (1981:161-176) state, however, that the type of alveolar abscess (whether it is granulomatous, radicular or a periapical cyst) is difficult to determine absolutely (even using radiographs) without a histological examination. Fenestrations and dehiscences may in some cases mimic abscesses particularly if the tooth is lost. However, an attempt was made to distinguish types in the presence of the tooth if the abscess was large enough for an visual examination. Radiographs aided in the detection of otherwise unrevealed abscesses. The direction of the abscess channel if present was then noted. In a number of cases the aetiologies of the abscesses were difficult to determine either because the teeth were missing or because there were numerous possible sources. Patterson’s

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<sup>3</sup> Since these human remains are destined for repatriation in the near future, maximum information recording is of primary concern.

(1984:380) abscess aetiology was therefore expanded to include various combinations of possible sources (i.e., differential diagnosis) which often remedied the use of the “indeterminate” source.

Although observing enamel hypoplasias on a macroscopic scale (i.e., using a dental explorer and 10x magnification lenses) is not as accurate nor yields as much information as does thin sectioning and scanning electron microscopic examination, these options were not available at the time of analysis. The hypoplasias were recorded as to type, location and width of defect as best as possible according to the method described by Buikstra and Ubelaker (1994:56-58). The colour of hypocalcification was noted as suggested.

The computer database and statistical programme used for dental analysis in this study was “Winks 4.1c” (Kwikstat for Windows). Most of the data gathered and scored are categorical, or qualitative, in nature. The statistical analysis of the qualitative conditions and traits relied on frequencies, percentages, cross-tabulations/contingency tables, and  $\chi^2$  tables with calculated p-values and contingency coefficients.<sup>4</sup> Only a few variables were quantitative (i.e., enamel hypoplasia width, infradental and blunting resorption depth). Enamel hypoplasia location and width are typically used to determine age of onset and duration of stress. Recently there is some scepticism about the accuracy of macroscopic determination and measurement of hypoplasias. Because individuals (and their teeth) develop at different rates and because many other enamel defects resemble hypoplasias at a

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<sup>4</sup> It is important to note that the small sample size used in this study is unlikely to represent the true nature of the population variations. Any statistics beyond those of frequencies and percentages used in this chapter are meant only as guidelines for possible inference. Yate’s chi-square was used in contingency tables containing cells with values under 5.

macroscopic level, it is relatively easy to miss diagnosis the type of defect (or condition) and time of onset without a histological inspection (Dobney and Goodman 1991). However, for the sake of thoroughness, an attempt at diagnosing the age of onset was made. The qualitative categories of infradental and blunting resorption were utilised in the analysis of general periodontal condition of the sample. However, the associated measurements (i.e., quantitative data) were not considered in this study in favour of a more general dental analysis.

### **5.3 Results of Dental Analysis**

Frequently more than one pathology occurs within the oral cavity simultaneously, such as caries, attrition and tooth modification. The predominance of one dental condition over another, or a different combination of environmental factors, can favour one pathology over another (Lucas Powell 1985). For example, a fast rate of wear may hinder the development of caries by modifying tooth surfaces into less caries-prone smooth surfaces. However, in so doing, attrition can turn interproximal surfaces into food traps promoting periodontal problems. It is evident that pathological dental conditions must be examined individually as well as in association with each other in order to more accurately envision larger environmental, social and biological trends. In this section, caries, periodontal disease, attrition, antemortem tooth modification, enamel defects, abscesses and tooth lost, separately and in combination, will be presented with regards to subsistence strategy reconstruction for the study sample.

### 5.3.1 Caries

A certain oral environment is required for dental caries to be established. Some of the factors for creating a caries-prone environment are: dietary staples (eg., fermentable carbohydrates such as, maize), food texture (i.e., sticky as opposed to fibrous), tooth morphology (i.e., pitted as opposed to smooth exposed areas), saliva amount (i.e., less as opposed to more), poor oral hygiene, oral cavity pH and immunological status. Although many of these conditions cannot be determined from dental palaeopathology studies, some trends can be established which provide insight into subsistence strategies and bio-social practices. From the following caries data, certain trends can be established.

The incidence of caries for the five study sites is relatively low. There are only 10 carious lesions present in the 270 teeth present. The caries are limited to the mature permanent teeth (Table 5.3). Within the mature group 8 out of the 10 caries occur on mandibular posterior teeth (7 caries on molars and 1 on a premolar). The remaining two caries are on maxillary anterior teeth. Caries occur most frequently in pits and fissures of the occlusal surface, or on the distal surface in between teeth. The exception to this are 3 buccal caries in the Whaley Cairn sample where there is a high occurrence of lower molar protostylid buccal pits (i.e., an inheritable trait) in this group. Seven carious teeth co-occur with a slight amount of calculus, and one with a periapical abscess.

| <b>Surface Type</b> | <b>Whaley Cairn</b> | <b>Slave Falls</b> | <b>Fort Alexander</b> | <b>Bjorklund</b> | <b>Whitemouth Falls</b> | <b>Total</b> |
|---------------------|---------------------|--------------------|-----------------------|------------------|-------------------------|--------------|
| Upper Crown         | 3                   | 1                  | —                     | 1                | 2                       | 7            |
| Smooth              | 3                   | —                  | —                     | —                | —                       | 3            |
| <b>Total</b>        | <b>6</b>            | <b>1</b>           | <b>—</b>              | <b>1</b>         | <b>2</b>                | <b>10</b>    |

The Whaley Cairn site constitutes 60% of all the caries in the study; yet, these caries represent only 7% of the teeth within the site (i.e., 6 caries out of 84 teeth). By site, 8% of the Whitemouth Falls teeth are affected by caries, and 3% of Slave Falls and Bjorklund. Therefore, by site, Whitemouth Falls and Whaley Cairn have the highest percentage of caries. Fort Alexander has no caries, although individual FA3 Burial 1 Individual 1 has most of her dentition present (Table 5.4). Likewise, Whaley Cairn individual XU1 Individual 1 has no caries despite an almost complete dentition. This is in contrast to the remainder of the Whaley Cairn individuals which have 11% carious lesions with a potential for more since a number of their teeth are missing. In both of the FA3 and XU1 II cases, there may be other conditions present which obliterate the caries count such as, chipped and fractured teeth which will be discussed later in this chapter.

One would expect that this high occurrence of caries at one site would result in a statistical inference claiming a relationship between site and caries variables. However, the cross-tabulation of these two variables suggest an independence between caries and site variables — that is, the statistical evidence does not support a hypothesis of a correlation

between these two variables ( $\chi^2_{(8)}=6.169$ ;  $p\text{-value}=0.628$ ; contingency coefficient= $C=0.177$ ).<sup>5</sup>

| Surface Type | XU1/2 | Whaley 1 | Whaley B | F1/11 | Z17 | Z25 | Total |
|--------------|-------|----------|----------|-------|-----|-----|-------|
| Upper Crown  | 1     | 2        | —        | 1     | 1   | 2   | 7     |
| Smooth       | 2     | —        | 1        | —     | —   | —   | 3     |
| <b>Total</b> | 3     | 2        | 1        | 1     | 1   | 2   | 10    |

Slave Falls also has a potential for a greater number of caries given the number of missing teeth for that sample. Indeed, Feature 1 Individual 1 has 1 carious tooth although only represented by 5 mandibular teeth. The presence of this lesion in the mandible supports the occurrence of mandibular caries generally within this study, and accentuates the possibility of caries having a greater affect on the Slave Falls sample — for example, Feature 1 Individual 2 does not have a mandible, Feature 3 Individual 1 has only 9 of a possible 20

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<sup>5</sup> Unless otherwise stated, the hypothesis (or “null hypothesis”= $H_0$ ) for or against which cross-tabulations seek to establish statistical evidence is:

$H_0$  = There is no correlation between the variables. They are independent

The statistics often used in cross-tabulations to determine the rejection or acceptance of the null hypothesis is “chi-squared” value ( $\chi^2_{(df)}$ ) with a certain degree of freedom (df) based on the number of cells used in the cross-tabulation and the “p-value.” The chi-square value is the critical point at which the data is unlikely to support the independence of two variables. The p-value is a value at which a more extreme test statistic would be obtained by chance from that population. Typically a  $p\text{-value} \leq 0.05$  (or  $\leq 0.01$ ) is used to reject the null hypothesis. The  $\chi^2$  value and the p-value are only meaningful in analysis of numerous populations, when some measure of the degree of the association of the variables is made. The  $\chi^2$  adjustment measure used in this paper is the contingency coefficient which is a value between 0 and 1. The closer the contingency value is to zero, the weaker the support is for the  $\chi^2$  value.

teeth present, and Feature 3 Individual 2 also has less than half of her possible number of teeth present. If the twenty percent caries rate of Feature 1 Individual 1 were to hold for the rest of the site, this would be a considerable occurrence of caries within this population.

Numerous studies have focussed on the lack of caries in hunter-gatherer populations compared to those of agriculturalists/horticulturalists (Lucas Powell 1985; Larsen et al. 1991; Milner 1984; Schneider 1986; Turner 1979). For North American populations, these studies have generally concentrated on incipient maize horticulture. It has been fairly well-established that a population subsisting on a predominantly maize diet (i.e., high in sticky fermentable carbohydrate and low in protein) has a higher incidence of caries. Various caries rates have been determined for hunter-gatherer versus agricultural populations world-wide as well as for some North American Native populations. Turner (1979:624), after studying caries incidence world-wide, developed a range of caries incidence by a population's subsistence strategy: hunter-gatherer populations on average have an incidence of caries 0.0% to 5.3%; mixed subsistence populations have an incidence of 0.44% to 10.3%; and, agriculturalists 2.3% to 26.9%. In studies involving North American populations, Milner (1984) concluded that caries incidence for the hunter-gatherers of the Late Archaic to Middle Woodland periods was 0.4% to 7.8% while agriculturalists of the Late Woodland and Mississippian period experienced caries 4.5% to 43.4% of the time. In a diachronic study of Native populations in Georgia, Larsen et al. (1991) found the incidence of caries changed from 1.3% in the "pre-agricultural" period to 11.6% in the agricultural period. However, since the prevalence and degree of caries development depend on a number of variables (such as, age and tooth type), these rates are somewhat problematic.

In this study, some of the statistical results are in keeping with the above studies. According to the ranges for caries frequencies stated by Larsen et al. (1991), Milner (1984) and Turner (1979), Fort Alexander, Bjorklund and Whitemouth Falls (i.e., 0%, 3% and 8% caries frequencies, respectively) would be characteristic of pre-agricultural hunter-gatherer populations of the Late Archaic to Middle Woodland period. Whaley Cairn and Slave Falls are somewhat more problematic.

The rate of caries at the Whaley Cairn site overall is 7%. This is quite a conservative estimate, however, since two of the individuals are missing a number of teeth, and since the individuals that do have carious lesions experience caries at a rate of 11% each. Therefore, the conservative estimate of their caries would be considered of mid-range or mixed subsistence strategy by Larsen (1991) and Turner (1979), and on the upper limit of the range for hunter-gatherers by Milner's (1984) estimates. The more extreme estimate of an 11% caries rate would put Whaley Cairn into the range of agricultural groups. Slave Falls also can be attributed a conservative (i.e., 3%) and a more extreme (0-20%) caries rate. The conservative estimate would also place Slave Falls within the hunter-gatherer group, but the higher figure would place this sample well into the agricultural group.

If the associations between these sites and subsistence strategies based on caries rates are to be believed, Slave Falls (i.e., an Archaic sample) and Whaley Cairn (i.e., a possible early Plains Woodland sample) could be characteristic of horticultural groups. Although this association would support Whaley Cairn individuals as being associated with a horticultural Laurel culture, it is highly problematic for the Slave Falls sample. However, Whaley Cairn and Slave Falls sites are located further into the boreal forest in close proximity to each other

as well as an abundance of wild rice. Wild rice as a dietary staple would explain the higher occurrence of caries within these two samples. Wild rice is a “sticky” carbohydrate (i.e., fermentable) plant on which both groups probably relied; therefore, Slave Falls and Whaley Cairn individuals would have similarities with maize horticulturalists. The sample size of this study is too small to test this hypothesis; further data are required.

It is germane to note that dietary sources are not the only explanation for the higher occurrence of caries at these sites. In this study sample, seven out of ten caries occur in pit and fissure or protostylid pits. This may indicate an association with tooth morphology more than it would subsistence strategy. However, this conclusion would also be premature since only two (2) caries occurred in the absence of calculus (i.e., a dental pathology that requires a similar oral environment as to that of caries).

There are other factors than food sources and texture, and tooth morphology to be considered when determining the cause of caries within a population. Schneider (1986) argues that corn horticulturalists exposed themselves to a more caries-prone environment in two ways: a high carbohydrate diet as well as a high nickel intake from maize. Schneider (1986:101) found that a diet high in nickel changed the dental enamel composition making teeth more susceptible to bacteria. Similarly, Lucas Powell (1985:315) concluded while some minerals are cariogenic (i.e., selenium, magnesium, lead, cadmium and silicon), others are cariostatic (i.e., calcium and fluoride). She (1985:315) argues that, “Trace mineral levels in soils and waters may vary considerably from one region to the next, even within relatively small geographic areas, and may markedly affect the cariogenicity of foods produced on them.” Mineral levels at these sites could have contributed to caries as well as the fairly high

levels of magnesium found in wild rice.

Generally the low rate of caries for this sample indicates a typical hunter-gatherer subsistence strategy. The comparatively higher rates of caries amongst the Slave Falls and Whaley Cairn individuals could be due to tooth morphology as well as a high reliance on wild rice. It seems fairly obvious that data from other dental conditions should be examined to substantiate any conclusions.

### 5.3.2 Calculus

Other conditions of dental palaeopathology such as calculus, periodontal disease and alveolar abscesses have not been applied to population subsistence studies with the same intensity as caries and attrition. Rare studies in calculus formation and presence in the oral cavity have demonstrated that there is a relationship between diet and calculus (Stanton 1969; Dobney and Brothwell 1987). Indeed, there is a relationship between salivary calculus and a high carbohydrate diet (Stanton 1969) — that is, one of the same dietary sources which promote caries.

The location of the calculus is sometimes indicative of the type of calculus. Salivary calculus is usually on the lingual surface of the lower anterior teeth and the buccal surface of the upper molars (i.e., near salivary ducts), and subgingival calculus is located below the gingiva (i.e., radicular surfaces) but to no specific area in the mouth (Patterson 1984). The presence of calculus is instrumental in the development of some periodontal disease (Hillson 1996:254-263). Specifically, subgingival calculus can cause irritation to the gingiva causing inflammation of the periodontal tissues. Periodontal disease is often the cause of tooth loss.

Calculus analysis, therefore, is important in diet and subsistence strategy analysis, and individual and group nutrition and health studies.

Calculus formation on teeth is a natural process, therefore, it is not surprising that calculus is present at each site of this study in both the mature and immature samples. It is important to note, however, that the frequencies of calculus at these sites are variable. All of the individuals from these sites that experience some degree of calculus formation have only a slight build up, and, most importantly, radicular involvement is low. Indeed, in the mature group, coronal calculus accounts for 78 out of 95 cases (82%) of calculus formation on teeth present, 16% of calculus is present on coronal as well as radicular surfaces, and 2% is solely radicular calculus.

The immature dentitions demonstrate very little calculus involvement. Only two individuals, Slave Falls F1/I3 and Fort Alexander B2/I2, have a “slight” amount of calculus. For these individuals calculus occurs on the buccal surface of maxillary molar crowns. This type of calculus is typical salivary calculus and may be associated with diet. Since the immature dentitions have only marginal involvement, the remainder of the section will deal with calculus in mature dentitions.

A comparison of the percentages of calculus by site, and the frequency of calculus per teeth present and per possible tooth numbers within sites, create an interesting scenario (Table 5.5). If one were just to examine the frequency of calculus per site, it would appear that Whaley Cairn has the highest rate of calculus amongst the study sites. However, calculus frequencies per tooth present indicate that Whaley Cairn is ranked fourth out of the five sites. Yet, this ranking does not tell the whole story. When analysing calculus involvement within

and between sites, it is important to examine the calculus count with respect to the possible number of teeth present within a site. Many conditions related to the presence of calculus (i.e., periodontal disease and caries) could account for missing teeth, and therefore, factor heavily into the frequencies of calculus estimation.

| <b>Site</b>      | <b>Calculus by Site</b> | <b>Calculus per Teeth Present</b> | <b>Calculus per Possible Tooth Present</b> |
|------------------|-------------------------|-----------------------------------|--|
| Whaley Cairn     | 27/92 (29%)             | 27/84 (32%)                       | 27/109 (25%)                               |
| Slave Falls      | 14/92 (15%)             | 14/29 (48%)                       | 14/53 (26%)                                |
| Fort Alexander   | 4/92 (4%)               | 4/28 (15%)                        | 4/30 (13%)                                 |
| Bjorklund        | 24/92 (27%)             | 24/29 (83%)                       | 24/32 (75%)                                |
| Whitemouth Falls | 23/92 (25%)             | 23/25 (92%)                       | 23/32 (72%)                                |

On reexamination of the calculus data using frequencies based on possible tooth numbers present, it is evident that there are three levels of calculus involvement: Bjorklund and Whitemouth Falls sites rank as the highest calculus frequency (75% and 72%, respectively), Whaley Cairn and Slave Falls rank second (25% and 26%, respectively), and Fort Alexander ranks the lowest (13%). These statistics vary considerably from the percentages of overall calculus involvement per site. Some of this variation can be explained by the fact that 3 individuals, Whaley Cairn XU1/I1, Bjorklund Z17 and Whitemouth Falls Z25, constitute 69% of all the calculus in the sample, and also reflects on the rather low calculus involvement throughout the rest of the sample. That the latter two individuals are “old adults” is significant. In fact, there is a correlation between calculus occurrence and age

( $\chi^2_{(4)}=25.859$ ; p-value=0.000; C=0.348).

One calculus statistic that is not as dependent on missing tooth information is calculus location by dental arch section. As expected, calculus is present more often on molars (57%) than premolars (26%) and anterior teeth (17%). In cross-tabulations between tooth type and calculus, there is a correlation ( $\chi^2_{(6)}=40.582$ ; p-value=0.000; C=0.421). In the two cases of radicular calculus, only premolars are involved. Those teeth having both radicular and coronal calculus are usually molars (followed by premolars). Calculus in these cases typically are either on buccal surfaces or in between teeth. Coronal calculus is found in all sections of the dental arch on all surfaces of maxillary and mandibular teeth. The above characteristics of calculus for this sample demonstrate both salivary and subgingival calculus.

It is interesting to note that the individuals with the highest counts of radicular, and/or radicular and coronal, calculus have very few teeth lost antemortem. Whaley Cairn XU1/I1 has 1 count of radicular and 6 counts of radicular-coronal calculus but is only missing 2 teeth antemortem; the Bjorklund individual has 1 and 3, respectively, and is missing 3 teeth (1 molar and 2 incisors); the Whitemouth Falls individual has 1 count of radicular-coronal calculus and is missing 4 teeth (includes 3 incisors); and Slave Falls F3/I1 has 3 counts of radicular-coronal calculus and 2 teeth lost antemortem. However, one individual, Slave Falls F3/I2 has only 1 count of radicular-coronal calculus but 9 molars and premolars missing. It should be noted that the first three of these individuals also have the highest calculus counts overall, but very low counts of caries.

Despite the fact that there has been a correlation found between certain food types and calculus and that calculus develops in the oral cavity under the same conditions as caries,

there is no apparent correlation between calculus and caries for this sample ( $\chi^2_{(6)}=5.566$ ; p-value=0.475; C=0.170). Hillson (1996:260) also notes the interesting relationship between calculus and caries,

Dental caries involves progressive local demineralization of tooth surfaces, whereas calculus involves mineralization and the two conditions should therefore be mutually exclusive . . . . But both conditions are frequently seen on the same tooth, where arrested carious lesions in crown fissures are often covered with calculus . . . , and active caries may be seen in cement or dentine underneath calculus deposits . . . . At a population level there may however be a slight inverse relationship between caries and calculus frequencies.

This sample, therefore, supports the mutually exclusive nature of these conditions. However, a larger sample size could provide evidence against this conclusion.

The rather moderate amount of calculus for the sample is expected in a healthy population. The older individuals experience greater amounts of calculus build up, but that too is normal for hunting and gathering peoples. In general, the calculus evidence supports the caries data that these groups relied on hunting and gathering food resources.

### **5.3.3 Periodontal Conditions**

In order to fairly assess the periodontal condition of this sample, this study focusses on five conditions which demonstrate varying degrees of periodontal disease. These are periodontal dehiscence, fenestrations, interproximal septa inflammation, and blunting and intradental resorption. To better observe and compare the degree of each variable to overall periodontal condition a summary of the frequencies and cross-tabulation analyses follows (Table 5.6).

In four out of five of the periodontal conditions, cross-tabulations indicate that there is evidence of association between the site and the variables in question to reject the null hypothesis. The cross-tabulation of the remaining variable (i.e., infradental resorption) could be affected by the zeros in some of the cells of the Chi-square test. However, based on the other four conditions (i.e., periodontal dehiscence and fenestrations, blunting resorption and interproximal septa inflammation) there is clearly certain sites that have a greater tendency towards periodontal disease than others.

| Condition              | Whaley<br>Cairn | Slave<br>Falls | FA3 | Bjork-<br>lund | White-<br>mouth | $\chi^2_{(df)}$ ; p-value; C |
|------------------------|-----------------|----------------|-----|----------------|-----------------|------------------------------|
| Dehiscence             | 21              | 12             | 2   | 0              | 2               | (4)15.372; 0.004; 0.256      |
| Resorption             | 66              | 22             | 2   | 19             | 12              | (16)58.582; 0.000; 0.456     |
| Inflammation           | 67              | 10             | 4   | 7              | 2               | (12)72.215; 0.000; 0.494     |
| Fenestrations          | 11              | 1              | 0   | 0              | 0               | (4)11.842; 0.019; 0.226      |
| Infradental Resorption | 3               | 1              | 0   | 0              | 0               | (8)4.459; 0.813; 0.144       |

Whaley Cairn demonstrates the greatest number of affected dental sites for each periodontal condition. The periodontal disease is so prevalent at the Whaley Cairn site that some of the missing teeth may have been lost due to periodontal disease from this site. Twelve (12) teeth present had over half of their roots exposed due to alveolar bone loss. At Slave Falls, nine (9) teeth had over half of their roots exposed, and a number of teeth were missing. The question remains, what caused the periodontal disease in this sample — diet or some other factor. Age is a key dependent variable in the progress of periodontitis as is

calculus (Hillson 1996). Fenestrations, however, are often independent of age. The two old adults from Bjorklund and Whitemouth Falls sites, however, do not demonstrate conditions as severe as other old adults. Therefore, age, in this study, is not the cause of periodontal disease, but a contributing factor.

Typically, the predominant cause of periodontal disease is calculus. The amount of calculus involvement and its location is significant in diagnosing the type of periodontal condition present (Bhaskar 1981:177-216). For this sample, fenestrations and dehiscence were almost twice as likely to occur on anterior teeth while calculus occurred mostly on molars followed by premolars. Inflammation and resorption, although more evenly distributed through the dental arch, still have a slight tendency to occur more around the anterior teeth. This evidence is contrary to calculus being the cause of periodontal disease here. Caries, also, were found more likely to occur in the posterior teeth. Other causes must be at work in this sample.

Some indication of cause is found in the fact that certain periodontal conditions (i.e., fenestrations and dehiscence) were more likely to occur in males than females ( $\chi^2_{(2)}=7.059$ ; p-value=0.030; C=0.176 and  $\chi^2_{(2)}=13.838$ ; p-value=0.001; C=0.244) while resorption and inflammation seemed to occur in both sexes rather evenly. Therefore, men either ate different foods, performed different tasks, or were more susceptible due to some other biosocial function than women. The low occurrence of caries and the moderate amount of calculus in this sample does not aid in drawing conclusions in this respect. Antemortem modifications also frequently demonstrate sex biased trends, and, therefore, may indicate a possible solution to this problem.

### 5.3.4 Antemortem Modifications

Antemortem modifications are one of the most prevalent dental conditions for this sample. There are a total of 114 antemortem dental modifications in the mature sample of which 28 occur on already modified teeth (i.e., at times, 2 or more modifications per tooth). There are no antemortem modifications in the immature sample. The most prevalent of the modifications amongst the mature group are of a traumatic nature (i.e., 101/114, or 88%) to which Whaley Cairn contributes more than half (n=57, or 54%). It is possibly due to Whaley Cairns high percentage of trauma that there is an association between site and modification variables ( $\chi^2_{(16)}=42.405$ , p-value=0.001, C=0.437) (Table 5.7). In a distant second place, comes abrasion accounting for 10% of all modifications. The most commonly modified surfaces by abrasion and trauma are the mesial, distal and buccal surfaces (74%).

| <b>Modification Type</b> | <b>Whaley Cairn</b> | <b>Slave Falls</b> | <b>Fort Alexander</b> | <b>Bjorklund</b> | <b>Whitemouth Falls</b> | <b>Total</b> |
|--------------------------|---------------------|--------------------|-----------------------|------------------|-------------------------|--------------|
| Abrasive Wear            | 1                   | 3                  | 1                     | 3                | 3                       | 11           |
| Erosion                  | —                   | —                  | —                     | 2                | —                       | 2            |
| Trauma                   | 57                  | 11                 | 5                     | 6                | 22                      | 101          |
| <b>Total</b>             | <b>58</b>           | <b>14</b>          | <b>6</b>              | <b>11</b>        | <b>25</b>               | <b>114</b>   |

Of the 101 total traumatic modifications on mature dentition, 52 (51%) are chipped teeth, 31 (31%) are fractured teeth, and 18 (18%) are cracked teeth. Once again Whaley Cairn scores the highest in all types of trauma (i.e., 40%, 50% and 94%, respectively) which is supported statistically with an association between traumatic modification type and site

( $\chi^2_{(12)}=38.134$ ,  $p\text{-value}=0.000$ ,  $C=0.425$ ). Also one would expect more trauma to be evident in older individuals than younger individuals, and, since Whaley Cairn has the largest older demographic, this, in part, would account for its relatively higher numbers (Table 5.8). The correlation between age and trauma also is supported statistically ( $\chi^2_{(6)}=16.879$ ,  $p\text{-value}=0.011$ ,  $C=0.298$ ). Indeed, the old adults have 44 traumatic lesions on the 73 teeth present (60%), the middle adults have 51 out of 87 teeth present (58%), and the adolescent individuals have 6 traumatic lesions out of 37 teeth present (16%). However, it must be remembered when dealing with these types of modifications (i.e., traumatic) the greatest unknown is the number of modifications that were on missing teeth.

| Individual            | Sex | Age        | Chipped | Fractured | Cracked | Total Age | Total Sex       |
|-----------------------|-----|------------|---------|-----------|---------|-----------|-----------------|
| B1/I1 <sup>1</sup>    | F   | Adolescent | 5       | —         | —       | 5         | 46 <sup>6</sup> |
| F1/I2 <sup>2</sup>    | Ind | Adolescent | 1       | —         | —       |           |                 |
| F3/I2 <sup>2</sup>    | F   | Mid-Adult  | —       | —         | —       | 13        |                 |
| Whaley B <sup>3</sup> | F   | Mid-Adult  | 1       | 1         | 4       |           |                 |
| XU1/I2 <sup>3</sup>   | F   | Mid-Adult  | 7       | —         | —       |           |                 |
| Z17 <sup>4</sup>      | F   | Old Adult  | 1       | 4         | 1       | 28        |                 |
| Z25 <sup>5</sup>      | F   | Old Adult  | 15      | 7         | —       |           |                 |
| F1/I1 <sup>2</sup>    | M   | Mid-Adult  | 4       | 1         | —       | 38        | 54              |
| F3/I1 <sup>2</sup>    | M   | Mid-Adult  | 5       | —         | —       |           |                 |
| XU1/I1 <sup>3</sup>   | M   | Mid-Adult  | 10      | 12        | 6       |           |                 |
| Whaley 1 <sup>3</sup> | M   | Old Adult  | 3       | 6         | 7       | 16        |                 |

1=Fort Alexander; 2=Slave Falls; 3=Whaley Cairn; 4=Bjorklund; 5=Whitemouth Falls;  
6=Minus the "indeterminate" sex individual

For the total sample, the old adults have 73 teeth present out of a possible 93 (78%) while the middle adults have 51 teeth present out of a possible 125 teeth (41%). Since the middle adults are represented by a smaller percentage of teeth present, they could have even more traumatic modifications on missing teeth than the older group. But antemortem tooth trauma is often sex biased as it is for this sample ( $\chi^2_{(6)}=31.019$ , p-value=0.000, C=0.390). When the sample is divided into female and male sub-samples, the increase of dental trauma (for teeth present and possible teeth) from middle adults to old adults generally holds. For the female sub-sample, the middle adult age category has 30% traumatic lesions by teeth present and 20% by possible teeth; the old adult age category has 52% and 44%, respectively. For the male sub-sample, the middle adult age category has 78% traumatic lesions by teeth present while the old adult has 89%. The one exception to this trend is between the possible teeth frequency by traumatic lesion of middle male adult (64%) category and the old individual (55%). However, old adult males are represented by a single individual who has 62% of his dentition present and the middle adults males are represented by 3 individuals with 80% of their dentitions present. Therefore, the older individual would probably have more traumatic lesions on his missing teeth. Unfortunately, many processes can account for the sex and age trend. The location of dental lesions can help in this regard.

Antemortem tooth modifications, in general, and traumatic lesions, specifically, are fairly evenly distributed throughout the dental arch with the premolars suffering the least damage (26% and 29%, respectively). Chipped teeth occur twice as much on the anterior teeth and molars than on the premolars; dental fractures occur rather evenly throughout the mouth; cracks in teeth were more prevalent in premolars and molars; and abrasions were

more likely to occur on anterior teeth. Other trends are evident when modifications by sex are examined within and between sites. Unfortunately, there are no males in the Fort Alexander, Bjorklund and Whitemouth sites. At Whaley Cairn and Slave Falls sites, females and males may use their teeth differently.

In the Slave Falls sample, females have anterior teeth and molar abrasions, and only a single chipped tooth whereas the males have no abrasions but chipped molars. In the Whaley Cairn sample, females have chipped and cracked teeth throughout their mouths as do the males, however the males also have a high incidence of fractured (mostly anterior and premolar) teeth. Comparing the modifications by sex between Whaley Cairn and Slave Falls also demonstrates different trends in teeth use. At Whaley Cairn, males have almost equal occurrence of chipped, fractured and cracked teeth, but at Slave Falls males have no cracked teeth, only one fracture and a few chips. The females at Whaley Cairn have no tooth abrasions and a number of chipped and cracked teeth compared to Slave Falls females who have a number of abrasions but few other modifications (i.e., one chip).

The differences of tooth modification between females and males between and within sites are unlikely to be explained by diet but are likely to be explained by tooth use as tools. The anterior teeth for both sexes, generally, suffer from chips, abrasions and fractures. The use of anterior teeth in hide curing, trap setting and sinew preparation could all result in such trauma. Since various methods may be used to procure and prepare foods, however, subsistence strategy is still a possible factor.

### 5.3.5 Occlusal Attrition

One of the most interesting variables in this study is that of attrition, or tooth wear. The amount of wear on a tooth is usually age related, therefore the best comparative indicator of attrition between populations is the rate of wear. Attrition and attrition rates are often the focus of studies examining the subsistence strategy and diet of populations. This focus on rates would assume a measurable, or quantitative methodology for rating attrition. Yet, the most predominantly used methods (i.e., Scott 1979b and Molnar 1971) are actually founded on qualitative scoring schemes. Scott's (1979b) methodology is especially interesting in this regard. This method is based on an ordinal system (i.e., applying a number to a certain degree of wear of a molar quadrant). However, these quadrant numbers are summed to give the molar a value. The molar value, therefore, is an interval measurement allowing for many quantitative statistical analyses, such as, summary statistics, correlation, regression, comparisons of variance, and principle axis analysis.

Correlation for adjacent molar pairs have been used as an indicator of rates of wear (Smith 1972). However, it has been concluded that correlation only indicates that there is a difference in rates but not the degree or direction of that difference. A better indicator of the rate of wear is the slope of the regression equation derived from molar pairs. The molar pairs subset is derived using five criteria (Scott 1979a:205). Firstly, only one side of the maxillary or mandibular data should be analysed at a time. This wear rate analysis is based on the attritional scores of adjacent molar pairs (i.e., M1-M2, M2-M3 or M1-M3 pairs) and the same molar pair should be used when comparing study groups. Attritional scores over 36 should be dropped from the subset, since the teeth represented by this interval would have

dentine or root wear that would differ considerably from teeth with more enamel. Teeth within a pair that erupt before the paired molar and that have a lower wear score than the second erupting molar should also be dropped from the subset. The final criterion is, as with all statistical analyses relying on statistical means, the elimination of outliers that influence the mean.

In a preliminary study using a larger sample size of twenty individuals (i.e., a sample that included the excluded individuals of this study), the only criterion used to derive the adjacent molar pair subset was finding existing adjacent molar pairs regardless of side for each site. This eliminated three out of the five study sites from analysis. Correlation and regression analysis was performed on the remaining two sites (i.e., Whaley Cairn and Slave Falls). The resulting regression equations (based on the remaining three molar pairs) were:

$$\text{Whaley Cairn:} \quad \text{Tooth 2 Wear} = 3.27 + 0.62(\text{Tooth 1 Wear})$$

$$\text{Slave Falls:} \quad \text{Tooth 2 Wear} = 0.43 + 0.74(\text{Tooth 1 Wear})$$

It was concluded (based upon the unqualified molar pairs) that there was no significant difference in slope (i.e., wear rates) between these two sites. The y-intercept, however, is indicative of wear on the first molar prior to the eruption of the second molar (Patterson 1984:112). Thus, the Slave Falls y-intercept (0, -0.58) indicates that wear on the first molar before the eruption of the second is not as great as that on the first molar at Whaley Cairn (0, -5.26). It should be noted that, since these regression equations are based on data that only meet one (with modification) out of five criteria for this type of analysis, these results should not be viewed as reliable. Furthermore, principle axis analysis of molar pairs is even more reliable than simple regression due to the inherent error in measuring the

regressor variable (Patterson 1984:112-116). However, due to the small sample size, regression and principle axis analysis were not performed on the dental sample.

The comparison of rates of molar occlusal wear between sites is not the only attrition statistic relevant to palaeodietary analysis. Indeed, other trends in attrition data have been found to be indicative of certain subsistence strategies. As Hillson (1996:292) notes,

At a macroscopic level, tooth wear shows some characteristic patterns. Hunter-gatherer groups, in particular, seem to have a distinctive distribution and angle of wear, different to that of early agricultural groups. Most notably in North America, a change in wear pattern is matched by evidence from caries rates and stable isotopes for an increasing reliance on maize agriculture. Even simply recorded with the naked eye, therefore, tooth wear has an important place in the reconstruction of past human subsistence.

For the above reasons, trends in occlusal attrition for the study sites were examined for differences and similarities of attrition angle and form, and any characteristics that would distinguish one group from another.

Since the attrition of anterior teeth were scored using categorical criteria (unlike the molar and premolar data), statistical analysis was limited to qualitative correlations between variables. As expected, a correlation between age and anterior tooth wear was determined ( $\chi^2_{(16)}=82.814$ , p-value=0.000, C=0.741). There is also a significant correlation between anterior tooth wear and sex ( $\chi^2_{(16)}=63.188$ , p-value=0.000, C=0.694). Females appear to have suffered the heaviest attrition over all and are represented in the categories of extreme wear ( $x \geq 8$ , or extreme crown loss) whereas males demonstrate more moderate anterior tooth wear ( $5 \leq x \leq 7$ , or dentine exposure to full dentin exposure) (Appendix VI). By site, Whaley Cairn individuals demonstrate the most severe attrition of the canines and incisors than any other

site. The cross-tabulation between anterior tooth wear and site verifies that there is a correlation between these two variables ( $\chi^2_{(32)}=86.498$ ,  $p\text{-value}=0.000$ ,  $C=0.748$ ).

In order to analyse molar and premolar occlusal attrition, the left side of the dental arch was used and the maxillary dentition was analysed separately from the mandibular dentition. For the left maxillary premolar subset, the right upper premolars from Slave Falls were used since this site would have been otherwise excluded due to missing teeth. Even with this modification, Slave Falls was only represented by a single adolescent female.

The distribution of the left maxillary premolar subset is approximately normal with a mean of 3.73 and a standard deviation of 1.95. It is a bimodal distribution with a gap at the mean between 3.5 and 4.5 degrees of wear. By site, Whaley Cairn demonstrates more extreme wear than the other sites, but is also a generally older sample. The Bjorklund and Whitemouth Falls sample has moderate wear where two large dentine areas are evident (wear degree = 5). Slave Falls is at the lower end of the range of attrition where there is only moderate blunting of the cusp (wear = 2). As will be demonstrated by molar attrition, this moderate wear is quite “uncharacteristic” for the Slave Falls sample, and is explained by representation by a single adolescent female. In fact, for the maxillary and mandibular premolar attrition analyses, the Slave Falls sample very much resembles Fort Alexander which is also represented by a single adolescent female.<sup>6</sup> The wear in the adolescent category, in general, is so slight as to be of limited value in this study. Although statistically attrition is independent of sex, all of the females’ teeth have occlusal wear equal to or less than 5

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<sup>6</sup> This problem is somewhat rectified for the molar attrition sample where Slave Falls is represented by the full complement of individuals.

whereas the males' occlusal wear is 6 or greater.

It has been argued that the direction in which teeth wear and the form that that wear takes are indicative of cultural variability (Molnar 1971). Occlusal wear direction is scored noting the highest part of the tooth crown first (eg. "buccal-lingual" direction refers to a higher buccal crown that angles down toward the lingual surface). Occlusal wear form refers to the shape of the plane of wear whether it be flat, cupped or rounded. For the left maxillary premolar sample, no great differentials between sites were noted for occlusal attrition direction or form. The sample is fairly evenly distributed in angles between buccal-lingual, distal-mesial, horizontal and mesiodistal rounded, and in form between natural, flat, cupped, notched and rounded. In this sample, those teeth with horizontal, distal-mesial, and rounded distal-mesial wear angles had heavier degrees of attrition than those buccal-lingually worn teeth which had moderate wear.

In many respects, the left mandibular premolar sample is like the maxillary sample. Its distribution is approximately normal with a mean of  $4.78 \pm 2.00$ . It is unimodal but has two outliers in the extreme wear range. Once again Whaley Cairn has the greatest extent of wear ranging from teeth with two dentine exposures to severe loss of crown height. The Bjorklund and Whitemouth Falls samples have moderate, or less, occlusal wear. Females suffer generally less wear (wear  $\leq 5$ ) than males (wear  $\geq 5$ ). In direction of wear, 43% of the Whaley Cairn teeth have horizontal wear patterns and another 29% have buccal-lingual angles. Bjorklund does not have any buccal or lingual orientations. Overall, horizontal and mesial-distal directions are most prominent, but buccal-lingual, lingual-buccal or horizontal directions demonstrate heavier wear. Most sites have flat occlusal forms except for Whaley

Cairn which has flat or cupped forms.

The Whaley Cairn premolar sample appears remarkable only by the extreme degree of wear compared to other sites. However, since age has a close correlation with wear, the lack of young, middle and old adults at Fort Alexander and Slave Falls samples probably affects the distribution rather drastically. Some of these affects can be demonstrated by the analysis of the molar sample.

Both the left maxillary and mandibular molar wear distributions approximate normal. The left maxillary molar sample is unimodal with 3 outliers in the extreme wear range. The mean of the distribution is  $20.06 \pm 10.95$ . The mean of the distribution is influenced by the outliers. By excluding the outliers the central tendency would be a 15.5 degree of wear which is moderate, however, since these outliers (i.e., cases of excessive wear) are indicative of the process of attrition within this sample, they have been included. The left mandibular molar distribution is bimodal with a gap (between 28.5 and 33.5 degree wear) between the more moderate modal distribution and the more extreme mode. The mean of the mandibular sample is  $24.32 \pm 10.69$ , but the central tendencies for each mode is 18.5 and 39.0 degrees of wear. In either case, mandibular molar wear is more extreme than for the maxillary molars.

It is interesting to note that, despite the fact that age and occlusal attrition are usually correlated, this sample does not demonstrate that trend. However, the small sample size in this study abrogates this evidence as conclusive. In fact, the extreme cases of wear in the mandibular and maxillary samples consist mostly of middle adult males. The old adults (one male and one female) show extreme wear only in the mandibular sample. Neither was a

correlation between sex and molar wear apparent; yet, 8 out of 10 maxillary molars of the female subset have wear lower than the mean of the total sample, and 5 out of 7 upper molars of the male subset have wear is greater than the mean. This situation, however, does not hold true for the mandibular sample in which female molar wear are ranked on either side of the range (i.e., either more moderate or extreme) and males molar wear straddles either side of the mean.

Site as a variable, also, is not correlated with molar attrition although certain characteristics of each site might be gleaned. The Whaley Cairn mandibular molars have moderate to high moderate wear in all but natural or horizontal directions. The maxillary molars are rather evenly distributed in degree of wear from low moderate to extreme wear with 43% worn in a mesial-distal direction. The old adult female from the Bjorklund site exhibits wear under the mean for mandibular and maxillary molar samples yet are in the high moderate range (17 to 21, and 15 to 20, respectively). The maxillary and mandibular wear directions are appropriate for occlusion with the maxillary teeth having a buccal-lingual, mesial-distal or flat direction and the mandibular teeth having lingual-buccal or mesial-distal direction. The other old adult female of the Whitemouth Falls site has extreme mandibular molar wear primarily in the lingual-buccal direction, and high moderate wear (21 to 28) maxillary molar wear in either a buccal-lingual or mesial-distal direction. Slave Falls is most remarkable in degree, direction and form of wear. The degree of wear for this site ranges from moderate to extreme (i.e., 19 to 39) lingual-buccal wear for mandibular teeth and high moderate to extreme (i.e., 27 to 39) buccal-lingual wear for maxillary molars.

The form of wear for both upper and lower molars tend to be flat or half cupped for

all sites except for the Slave Falls sample where the upper molars are notched or flat and the lower molars are notched, fully cupped or flat. For the whole sample, the molars with buccal-lingual and corresponding lingual-buccal wear directions typically exhibit the most wear.

A number of palaeodietary and palaeodemographic studies have been based on occlusal wear, direction, form and degree (Molnar 1971; Scott 1979; Smith 1984). From these, and other studies, various correlations between age, sex, subsistence strategy and occlusal attrition have been suggested, but most are population specific. One correlation that appears to be maintained across populations is that of certain subsistence strategies and occlusal attrition. As Hillson (1996:237) notes, "Attrition gradients vary between populations and hunter-gatherers show rapid wear, with heavy anterior tooth attrition, when compared with agriculturalists." For this sample, correlations between age, sex, site and occlusal wear were only supported by the anterior teeth. The heavy anterior wear of the Whaley Cairn sample would indicate that this was a typical hunter-gatherer group. The attrition of the anterior teeth of the Bjorklund, Whitemouth Falls and Slave Falls sample, although less than Whaley Cairn, still is in the high moderate range possibly indicating a hunter-gatherer subsistence strategy for these sites. A study by Smith (1984) uses the direction and degree of angle of molar occlusal wear to distinguish agricultural groups from hunter-gatherers.

Smith (1984) examined various populations from different regions of the world (e.g., western Europe, Britain, Australia, Canada, United States), and from different time periods (i.e., Middle Palaeolithic to 1675 AD). She concluded that agricultural populations had a more restricted and oblique pattern of occlusal wear (i.e., buccal-lingual wear angled 10° more extreme) than the horticultural populations who have flatter wear patterns. She (Smith

1984:54) attributes the agriculturalists' more extreme wear pattern to "a reduction in food toughness or fibrousness that is associated with the appearance of intensive collection of grains and intensive use of grinding stones and pottery in food preparation."

Smith's conclusions are somewhat problematic for this sample since the direction of wear that is prevalent at these sites is buccal-lingual or lingual buccal, but the wear angle is rarely over 10°. Only three molars from three individuals (XU1/I1, Whaley 1 and Z25) from two sites (Whaley Cairn and Whitemouth Falls) have angles greater than 10° (15°, 17° and 30°, respectively).

A combinative examination of direction and angle of wear, and antemortem tooth modifications aids in this regard. Relative to other dental pathologies at these sites, tooth trauma has very high frequencies. Some of these traumas can easily explain the tendency for oblique wear patterns. The tooth type that indicates the highest frequency of trauma is the molars (40% of all trauma). Trauma to molars occurred more frequently to whole cusps rather than simple surfaces. Therefore once a cusp is lost exposing dentine, wear will occur faster in that area than in an area with enamel still in place. Eventually mastication will result in an oblique wear pattern.

Whaley Cairn, besides having the highest frequency of traumatic modifications, also contains the oldest individuals of the sample. Since age is related to trauma frequencies, it could account for tooth trauma and oblique wear as opposed to subsistence strategy. Furthermore, the concentration of studies on occlusal attrition of horticultural versus hunter-gatherer subsistence strategies is overlooking the fact that the study groups are all probably hunter-gatherers to some degree.

Given the region of the study area (i.e., the prairie-forest transition zone) and the time periods involved (i.e., Archaic to Historic) only some of these groups might be questionably either horticulturally-based, or influenced by other horticultural groups. A more relevant examination of the dental attrition data would be discriminatory of the differences between the hunter-gatherer groups that might be represented at these sites. This is a cumbersome task that is significantly hindered by a small sample size. There are further complications due to the obvious confounding data involved with occlusal attrition that indicates that bio-social processes (along with diet) are possibly involved in the attrition patterns. In order to come to some conclusions with regards to the dietary practices of the populations represented in this study, all of the dental data must be considered.

### 5.3.6 Alveolar Abscesses

Abscesses are usually concomitant of the interaction of the extrinsic pathologies although they also may develop from a haematogenous origin with no damage to the crown. Since they can result from numerous processes, it is germane to deduce which process actually caused the abscess. The determination of cause is not as straight forward as it may first appear. Abscesses may be caused by multiple dental pathologies as well as general systemic pathologies. In the analysis of abscesses each dental pathology was considered separately to determine possible cause. Only a few of the statistical tests performed resulted in correlations with other variables.

One of the more important cross-tabulations in which the null hypothesis is rejected is alveolar abscesses by site ( $\chi^2_{(20)}=33.940$ ; p-value=0.030; C=0.359) indicating that a site

is somehow important to the presence of an abscess. Table 5.9 summarises the abscesses by type occurring in mature dentitions. By studying the frequencies of abscesses per site, it was established that Whaley Cairn averages 6.75 abscesses per mature individual. Every individual from the Whaley Cairn sample has at least one abscess, and 3 out of 4 individuals have greater than 5. Whitemouth Falls has the second highest frequency (4/individual), then Bjorklund and Slave Falls (1/individual at each site), and finally Fort Alexander has no abscesses. Only one child, Fort Alexander B2/I1, amongst the immature sample has any abscesses (n=2). Whaley Cairn and Whitemouth Falls are the only sites with greater than 1 abscess per individual.

| Type               | Whaley Cairn | Slave Falls | FA3 | Bjorklund | Whitemouth |
|--------------------|--------------|-------------|-----|-----------|------------|
| Periapical         | 11           | 0           | 0   | 0         | 2          |
| Diffuse Periapical | 2            | 1           | 0   | 0         | 2          |
| Apical             | 6            | 0           | 0   | 1         | 0          |
| Radicular Cyst     | 1            | 0           | 0   | 0         | 0          |
| Apical Thinning    | 8            | 0           | 0   | 0         | 0          |
| Total              | 28           | 1           | 0   | 1         | 4          |

In an attempt to analyse the aetiology of the abscesses, cross-tabulations were performed for each dental condition. No correlation was found for abscesses and caries, attrition, calculus, nor antemortem tooth modification. Intrinsic factors were not considered. Correlations were determined for most of the periodontal conditions: fenestrations ( $\chi^2_{(5)}=30.306$ ; p-value=0.000; C=0.352), dehiscence ( $\chi^2_{(5)}=24.077$ ; p-value=0.000; C=0.319),

blunting resorption ( $\chi^2_{(20)}=109.095$ ; p-value=0.000; C=0.583) and inflammation ( $\chi^2_{(15)}=45.942$ ; p-value=0.000; C=0.418).

This evidence provides little information about the aetiology of abscesses since periodontal disease “is multi-factorial in origin and involves inheritance, environment, diet and hygiene” (Hillson 1996:269). Since calculus was demonstrated not to have caused the periodontal conditions in the sample, other variables were cross-tabulated (i.e., age, sex and individual). Despite the increase in abscesses with age, age was apparently not a factor in the occurrence of abscesses ( $\chi^2_{(10)}=10.690$ ; p-value=0.385; C=0.211). Both sex and individual variables had correlations with abscesses. Unfortunately, with qualitative variables it is not possible to establish which of these variables is the dependent variable, or the magnitude of influence of one variable over another.

### **5.3.7 Enamel Hypoplasia**

Dental enamel defects (DDEs), or enamel hypoplasias, are the enamel deficiencies caused by “stress” during crown development in crypts. DDEs are formed due to stress, however, the source of stress can be highly variable. To date known sources of stress that can cause hypoplasias are diseases such as measles and smallpox, environmental causes such as trauma and radiation as well as dietary stresses such as weaning, scurvy and rickets (Hillson 1996:165-171; Ortner and Putschar 1981:444-446; White 1991:354). Hypoplasias come in many forms: linear grooves (LEH), pits and hypocalcifications. Unfortunately, the sources of stress have not been directly related to specific manifestations of DDEs. Rough age estimates can, however, be made.

Certain stages of crown development are known to occur within a specific age range. The demarcation of a DDE at a specific location on the crown, therefore, is sometimes used to determine the age of onset of the stress that created the DDE. Since DDEs are a developmental condition, analysis is limited to permanent versus deciduous teeth rather than mature versus immature individuals. In total there are 36 incidences of enamel hypoplasia in this sample — 8 occur on deciduous teeth and 28 occur on permanent teeth.

For this sample, the 8 DDEs on the deciduous teeth are limited hypocalcifications. For the permanent dentition, all but diffuse hypocalcification occur. The most prevalent form of DDE in the permanent dentition are linear horizontal grooves (n=17). Six of the horizontal grooves occur on already affected teeth which indicate repeated periods of stress. The next most prevalent form is non-linearly arranged pits (n=4) followed by linear pits (n=3). There are 2 discrete hypocalcifications, 1 single pit and 1 vertical linear groove.

By site and individual, the deciduous teeth all of the DDEs occur in the children of the Fort Alexander sample. Of the 8 hypocalcifications, 2 are discrete and 6 are diffuse. It is not known what processes make some opacities diffuse and others discrete although it could be a matter of degree and duration of stress. All four upper deciduous incisors of individual B2/I1 are affected by diffuse opacities close to the occlusal part of the crown while the two lower central incisors have discrete opacities also close to the occlusal edge. Only the two maxillary first molars of individual B2/I2 have DDEs (diffuse hypocalcifications) close to the occlusal edge, but this individual is also missing 3 maxillary incisors and 1 canine, and 1 lower incisor. The deciduous teeth of Slave Falls individual F1/I3 are not affected at all.

Most of the DDEs on the permanent dentitions are from Whaley Cairn (53%).

Although the greatest portion of these are LEHs (63%), all other types of hypoplasias are expressed except hypocalcifications. The individual with the most DDEs is XU1/I2 who has 2 LEHs, and 6 linear, non-linear and single pits. Slave Falls is the second most affected site with a total of 6 LEHs. Two discrete hypocalcifications occur in the Fort Alexander sample; two LEHs in the Bjorklund sample; and, two non-linear pits occur in the Whitemouth Falls sample. All of the mature individuals, except for two (Slave Falls F3/I1 and F3/I2), have at least one to four enamel hypoplasias. The most affected tooth type are the canines.

Age ranges were established for the onset of stress creating enamel hypoplasias using the Goodman and Armelagos (1980) chronology methodology. Two periods of stress were noted using this method: 1.5 to 3.5 years of age, and 3.5 to 5 years of age. In the Whaley Cairn sample, all four individuals experienced some stress during the earlier period of life, and only three of the four experienced stress that resulted in hypoplasias during the second period. All three of the Slave Falls individuals that have DDEs exhibit enamel hypoplasias for both periods. The Bjorklund hypoplasias were in the individuals first to second years of life while the Whitemouth individual's DDEs occurred during her third to fourth years.

It is not known whether this distribution is an inherent problem with the sample size, or if two periods of stress occur at the five sites over time. The earlier onset of stress (i.e., 1.5-3.5 years) is consistent with other studies which contribute the stress to the "increased infection and nutritional stress in the postweaning period" (Huss-Ashmore (1982:448). The later period of stress for this sample is unknown, however, since teeth which develop later are unaffected in this sample, it is apparent that the stress is restricted to early childhood years.

## 5.4 Discussion

The frequencies of dental caries, and the types and degrees of occlusal attrition have frequently been used to reconstruct the subsistence strategies of archaeological populations. More recently, approaches to dietary reconstructions using dental palaeopathology have become more holistic examining numerous dental conditions within a population. The focus of many of these studies is the determination of the different patterns of dental conditions between horticultural and hunter-gatherer populations.

The dental criteria frequently used to differentiate hunting-fishing-gathering groups from horticulturalists are moderate to extreme occlusal attrition, “pronounced” periodontal pathologies, moderate to high rates of abscesses, “substantial” antemortem tooth trauma, low antemortem tooth loss, anterior tooth wear and low rates of caries (Hillson 1996; Patterson 1986). By and large, the individuals from the Whaley Cairn, Slave Falls, Fort Alexander, Bjorklund and Whitemouth Falls burial sites exhibit the characteristics of hunting-fishing-gathering subsistence oriented groups.

Generally, the individuals of this study demonstrate high occlusal wear (especially males), high anterior tooth wear (especially females), moderate to high periodontal pathologies, low rates of caries, moderate to high rates of abscesses, and high rates of antemortem tooth chipping as well as other dental traumas. However, they share some characteristics typical of the dentitions of horticulturalists. Although it is not usually stated what is meant by “low” rates of antemortem tooth loss, the 18% rate in this study sample is considered high for a hunting-fishing-gathering group. The high anterior tooth chipping usually associated with horticultural groups is also present in this sample.

The above statements, however, only apply to the sample as a whole. They are not site specific. Indeed, the individuals of Whaley Cairn have high prevalence of caries and lower (16%) antemortem tooth loss. Slave Falls has a low rate of abscesses (2%), and an even lower rate of antemortem tooth loss (13%) than the Whaley Cairn sample. The individual of Bjorklund shows moderate occlusal wear, a low rate of periodontal disease (but a high frequency of calculus) and a low rate of abscesses (3%). Lastly, the individual of the Whitemouth Falls burial has a moderate rate of periodontal disease with prevalent (but slight) degree of calculus and a low rate of antemortem tooth loss (14%). Although these sites all share most dental characteristics with hunter-gatherers, it is evident that they also have traits which vary from group to group.

If it is assumed that the individuals from these sites do represent different hunting-gathering-fishing groups, then the emphasis should not be placed on whether they demonstrate horticultural or hunter-gatherer characteristics, but how these hunter-gatherers differ from one another — that is, if they do at all. Since the sample size of this study is small, one of the best ways of observing subtle differences in dental trends between groups is to examine individuals from different sites that are of similar age.

There are 3 individuals within the “old adult” age category varying in age between 40 to 60: Whaley 1, Z25 of Whitemouth Falls, and Z17 of Bjorklund. In a side by side comparison of the frequencies of dental conditions of these individuals, it was found that Whitemouth Falls and Bjorklund shares the greatest number of dental conditions (Table

5.10).<sup>7</sup> The frequencies of calculus for these individuals is high for this study whereas it is low in the Whaley Cairn individual. However, cracked teeth, and periodontal and hypoplastic disturbances for the former individuals are low, but are high for Whaley 1. Finally, the frequency of abrasion is moderate for the first group but low for the Whaley Cairn individual. The Whitemouth Falls individual shares only two commonalities with the Whaley individual — that is, moderate caries rates and high rates in fractures. The Bjorklund and Whaley Cairn individuals have no frequencies of dental conditions in common.

| <b>Condition</b> | <b>Whaley 1</b> | <b>Z25</b> | <b>Z17</b> |
|------------------|-----------------|------------|------------|
| Caries           | 2               | 2          | 1          |
| Calculus         | Low             | High       | High       |
| Cracked Teeth    | 7               | --         | 1          |
| Fractured Teeth  | 6               | 7          | 4          |
| Periodontal      | High            | Low        | Low        |

A number of interesting points can be made about the comparison of the old adults individuals. Firstly, three of the periodontal conditions (four, including calculus) remained clustered together in the pairing of Whitemouth Falls and Bjorklund. This would perhaps imply a similarity in dietary sources. Secondly, the antemortem modifications were split by types between groups — that is, low frequency cracked teeth and moderate abrasion for the

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<sup>7</sup> Although dependent upon the condition (i.e., more frequent occurrences of calculus can be tolerated than abscesses), rates were generally evaluated as: low (1-7%), moderate (6-20%), or high (20+).

Whitemouth Falls-Bjorklund grouping, and a high frequency of fractures for the Whitemouth-Whaley group. There were no shared tendencies for antemortem tooth loss nor frequencies of abscesses. This fact might imply that the tooth loss and abscesses for these groups could be attributed to antemortem tooth modification. The following question is raised: Was it a dietary difference, a subsistence strategy difference, or some other bio-social process that brought about these similarities and differences in the individuals of these sites? Further comparisons are needed in order to answer this question.

The “middle adult” individuals were divided into “older” middle adults (i.e., Whaley Cairn XU1/I1, Slave Falls F3/I1 and F3/I2) and “younger” middle adults (i.e., Whaley Cairn XU1/I2, Whaley B and Slave Falls F1/I1). In the older individuals, as expected, the Slave Falls individuals (one male and one female) shared the most dental traits: low fenestration, high blunting resorption and high dehiscence rates, low rates of fractured and cracked teeth, and a high rate of antemortem tooth loss. Depending on the dental condition, the Whaley Cairn individual (a male) shared one trait (i.e., high rates of posterior chipped teeth) with the Slave Falls male (F3/I1), one trait (i.e., low rates of enamel hypoplasias) with Slave Falls female (F3/I2), and some traits (i.e., low caries and abrasion rates) with both Slave Falls individuals.

Once again, the periodontal conditions remain grouped together within one paired group of sites, the antemortem modifications are split by type between paired sites, and abscess rates are shared by no two groups. Calculus rates also vary between individuals. The only variables considered in this study that may account for the high rates of tooth loss for both Slave Falls individuals, in this comparison, are the high rates of fenestrations and

dehiscence in the group. This scenario also is supported by the old adult comparisons. That two of these individuals are from the same site, yet do not have similar frequencies for all dental conditions, supports the argument of sex differentials for certain traits. One of the ways that the Slave Falls male differs significantly from the Slave Falls female is by the frequency of chipped teeth. Slave Falls individual F3/I1 exhibits a high frequency of 45% chipped teeth while the Slave Falls female does not have any chipped teeth.

The younger middle adult group is comprised of Whaley Cairn XU1/I2, Whaley B and Slave Falls F1/I1. For the younger middle adults, the frequencies of the dental conditions overall are lower than those of the older middle adults, ranging from low to moderate for most conditions. The exceptions to this are the high frequencies of caries, calculus, hypoplasias and chipped teeth all in one individual, F1/I1 who is the only male in the grouping. In this comparison, the two Whaley Cairn females have similar rates for caries (moderate), calculus (moderate) and fractured teeth (low). Most rates of dental conditions are common to the Whaley Cairn female (XU1/I2) and the Slave Falls male. They both have low frequencies of periodontal conditions (i.e., fenestrations, dehiscence and resorption), cracked teeth and abscesses, moderate antemortem tooth loss, and high frequencies of chipped teeth. All three individuals have common frequencies for abrasions (low) and enamel hypoplasias (high). It should be noted that the frequencies of fenestrations and dehiscence are actually fairly similar to all three individuals of this grouping.

Although all the individuals demonstrate fairly typical hunter-gatherer dental pathological trends, there are significant differences between sites, and, in some cases, between sexes. Based on this admittedly scant evidence, I argue that three types of hunting-

fishing-gathering subsistence strategies and/or labour practices are represented by the individuals of the five study sites. Whaley Cairn (for which there is a reasonable sample size) characterises one strategy. It is hypothesised that the foods eaten by this group results in moderate rates of caries, calculus and periodontal conditions. The sex-biased fractures are possibly produced by food but are more likely to be resultant of some type of gender-divided labour. The high fracture rates result in higher tooth losses and abscesses.

The second, but similar, type of hunting-fishing-gathering subsistence strategy is characterised by the individuals of Slave Falls (another reasonably sized sample). These people ate foods that produced high frequencies of calculus which resulted in higher rates of periodontal conditions. It is speculated that the sex-biased antemortem tooth chips also result from gender divisions in labour as opposed to dietary properties. Since Slave Falls teeth tend to be chipped rather than fractured, there are fewer abscesses and tooth losses in this group. The Fort Alexander group is only represented by one adolescent female. She is assumed to have had a similar lifeway to the Slave Falls group based upon her already prevalent periodontal conditions and tendency toward antemortem tooth chips. Although the Whaley Cairn and Slave Falls sites are in close proximity to each other and further into the boreal forest than the other sites, I suggest that their labour, if not, subsistence strategies varied somewhat to produce these dental patterns. Whaley Cairn and Slave Falls share some traits (i.e., caries, calculus and periodontal disease) but sometimes vary in degree, and differ in another (i.e., modification types).

Both the Whitemouth Falls and Bjorklund individuals characterise the third type of hunter-gatherer group. Both individuals, despite their advanced age, exhibit caries and

periodontal rates that range from low to moderate. They have moderate to high rates of antemortem tooth fractures, and moderate frequencies of abrasion and antemortem tooth loss. They have high frequencies of calculus like Slave Falls but low periodontal conditions like Whaley Cairn. They exhibit fractures similar to Whaley Cairn but chipped and cracked teeth like Slave Falls.

It is hypothesised that low rates of periodontal conditions and high rates of fractures are somehow related to a plains-parkland-oriented subsistence strategy that does not rely as heavily on high carbohydrate foods (such as wild rice) but rather on coarser prairie vegetation and more sinewy terrestrial foods (such as bison and moose). The tougher dietary sources and the need to procure and prepare larger and tougher hides may contribute to the higher rates of antemortem fractured teeth.

On the other hand, it is argued that the higher frequencies of calculus indicates a heavier reliance on starchier foods, such as, wild rice, that would be found in a more woodland-oriented subsistence strategy. The preparation of fishing weirs and trapping sinews result in the abrasions, chipped and cracked teeth that are more prevalent in the Whaley Cairn, Slave Falls and Fort Alexander individuals. Furthermore, a subdivision using dental pathologies may distinguish between those groups who rely more on less tougher woodland foods (such as, fish) and others who tend to exploit tougher woodland food sources (such as, terrestrial animals).

The similarities in dental pathologies among the Whaley Cairn, Slave Falls and Fort Alexander individuals, and among the Whitemouth Falls and Bjorklund individuals might have been anticipated because of the geographical proximity. It is expected that people would

rely more heavily on the resources closer at hand. It is interesting to note that dental palaeopathological analysis may detect slight differences between similar subsistence strategists such as hunting-gathering-fishing groups of Whaley Cairn and Slave Falls. However, the dental sample in this study is small and may not accurately represent these populations.

## **CHAPTER 6**

### **Stable Carbon and Nitrogen Isotope Analysis of the Winnipeg River System**

This study has focussed on the dietary reconstruction of individuals from five sites along the Winnipeg River system using a variety of approaches or methods. The archaeological, historical, and palaeopathological evidence provide some clues as to the possible subsistence strategies that may have been used in this region from circa 5000 BC to 1800 AD, but many questions are left unanswered by these approaches. Stable carbon and nitrogen isotope analyses provide another approach to test these questions.

Analysis of stable carbon and nitrogen isotopic composition of human tissues is now a common approach to trace the food sources from which those tissues were derived. This analytic technique is quantitative in nature, unlike ethnohistoric, archaeological or many standard physical anthropological methodologies, and allows the researcher to compile more definitive evidence for palaeodietary reconstruction. Stable isotope analysis also aids in palaeodietary analysis by facilitating palaeoenvironmental reconstructions, since the environment plays a major role in determining local subsistence strategies.

The study region has a rich fur trade history that provides some insights into Native diet. According to the historic record, the Native groups that inhabited the Winnipeg River region appear, at first glance, to have been great travellers who were highly adaptable to new territories, technologies, trade and social networks during different times of the year. This historic evidence of the dietary diversity offered by seasonal rounds, however, raises

questions of how diverse diets were prior to European contact, and to what degree the fur trade changed subsistence strategies. Stable isotope analysis should be able to determine if the seasonal round evident in the historical record was part of these peoples' earlier history.

The archaeological record indicates that some groups had diversified diets while other groups were highly specialised. The burial sites studied, however, provide few, if any, diagnostic artifacts to indicate the archaeological cultures to which these individuals belong, and, thus, it is difficult to determine the various subsistence strategies that they may represent. Two of the study groups (Fort Alexander and Bjorklund) may have had access to horticultural products, particularly maize; Whaley Cairn individuals are likely to have relied on fish as a main staple since many fish remains were included in the cairn; the Whitemouth Falls individual may have relied heavily on bison since a bison skull was placed over the remains, but all this evidence is circumstantial. Stable isotope analysis should be able to detect the presence of maize in a diet, and the differences between a primarily fish-based diet versus a plains mammal-based (such as, bison) diet.

According to the dental pathologies observed amongst these individuals, the Whaley Cairn and Slave Falls individuals appear to have many similar characteristics which indicate a reliance on softer and possibly more cariogenic foods. The Whitemouth Falls and Bjorklund individuals also share certain dental pathologies that indicate a reliance on possibly tougher foods, or different biosocial practices from the Whaley Cairn and Slave Falls individuals which result in a different pattern of pathologies. Although the differences in biosocial practices are not detectable through stable carbon and nitrogen isotope analysis, basic dietary similarities and differences between groups of individuals can be assessed.

Given data summarised in the earlier chapters in this thesis and the questions raised above, I hypothesise that three different subsistence strategies may have been used in the Winnipeg River region prior to European contact. Although a dietary dichotomy between plains and boreal groups is assumed, I posit that the seasonal round may have been an historic phenomenon, and that the people inhabiting the boreal forest relied either on aquatic resources (i.e., fish), or boreal terrestrial resources (i.e., boreal mammals), but rarely both. This hypothesis will also be tested using stable isotope analysis.

### **6.1 Stable Carbon and Nitrogen Isotope Theory**

The dietary reconstruction of past peoples using stable isotope analysis is a comparatively recent technique. Although stable isotope analysis had been used as early as 1967 to differentiate between specific plant types and their animal consumers that ate them, it had not been used specifically as a human dietary reconstruction technique until the latter part of the 1970s (DeNiro and Epstein 1978a; van der Merwe and Vogel 1978). Stable isotope analysis is now the prominent methodology in palaeodietary studies.

The basic premise of stable isotope theory is that the atoms of the foods eaten become incorporated into the consumer's tissues (Ambrose 1993; DeNiro and Epstein 1978a, 1981a; Katzenberg and Schwarcz 1986; Schwarcz 1969; Smith and Epstein 1971). All animals rely on plants for survival, whether directly or indirectly. Starting at the lowest level in the food chain, plants obtain carbon and nitrogen from the environment. The conditions of that environment and the way the plants metabolise carbon and nitrogen result in a specific "isotopic signature" of those elements (see Appendix VII for carbon and nitrogen metabolism

and stable isotope theory). These isotopic signatures are altered (or fractionated) as they are passed from the plant to the consumer. Stable carbon and nitrogen isotope analysis uses this information to reconstruct the diets of people and animals by identifying the isotopic signatures and concentrations of the atoms that form the tissues of their bodies.

The isotopic signature is a ratio of heavier isotopes to lighter isotopes. The isotope ratio of a sample is measured in reference to a standard material — that is, carbon samples are measured against Peedee *Belemnitella americana* (PDB), and nitrogen samples are measured against atmospheric nitrogen (N<sub>2</sub> AIR). The equation for measuring the appropriate ratio results in a “delta” value for the element of the sample as follows:

$$\delta^I E\text{‰} = \left[ \frac{{}^I E / E_{(\text{sample})}}{{}^I E / E_{(\text{standard})}} \right] - 1 \times 10^3$$

Where E = element

I = heavier isotope

i = lighter isotope

$\delta^I E$  = “delta value” = isotope signature of the sample

‰ = parts per mil

Since PDB tends to have relatively more <sup>13</sup>C than biological tissues and food sources, the  $\delta^{13}\text{C}$  values of samples are generally negative. Whereas,  $\delta^{15}\text{N}$  values tend to be positive since  $\delta^{15}\text{N}_{\text{AIR}}$  is comparatively lower than sample materials (Ambrose 1993:65).

Plants are classified into three groups according to the way in which they metabolise carbon and the resultant isotopic signature. The two categories most commonly referred to in North American studies are C<sub>3</sub> plants which are characteristic of temperate zones, such as, Canada, and C<sub>4</sub> plants which are found in warmer climates.

The rise of horticulture is often the focus of North American dietary studies since

maize is a  $C_4$  plant that can be isotopically detected as a dietary food source. Other subsistence models for  $C_3$  environments, however, have been little examined since there is considerable overlap of carbon isotope values which prevents clear definition of different dietary resources. Due to the overlap of  $\delta^{13}C$  values in a  $C_3$  environment and the paucity of research for these areas, comparatively little is known about Canada's isotopic makeup. However, it is apparent that there are micro-regional differences in stable isotope values that could play a major role in subsistence interpretation.

## 6.2 Stable Isotopic Samples and Quality

This stable isotope study includes twenty (20) human bone collagen samples, thirteen (13) animal bone collagen samples and eleven (11) plant portions. Collagen is the preferred material for stable isotope analysis because it is a structurally strong protein that maintains its isotopic integrity: that is, it is known to reflect long term dietary intake in light of diagenetic factors, its chemistry is well-known, and its composition is fairly constant among species facilitating comparison of  $\delta^{13}C$  and  $\delta^{15}N$  values (Bender et al. 1981; DeNiro and Epstein 1978a, 1981a; Schoeninger and DeNiro 1984; Sealy 1986). As Ambrose (1993:72) argues,

Collagen is the preferred biochemical fraction for isotopic analysis because it comprises approximately 20% of bone and tooth dentin by weight. . . . it does not significantly vary in its structure and amino acid composition among vertebrate classes. . . . Bone collagen can survive for thousands of years after burial, particularly in cool and stable environments, and is extremely resistant to post-mortem diagenetic alteration of stable isotope ratios.

There are three tests for collagen integrity (Ambrose and Norr 1992). The one most

frequently used is the atomic ratio of carbon to nitrogen atoms (i.e., C:N) usually found in the amino acids in collagen.<sup>1</sup> Typically the C:N ratio of a collagen sample should be similar to that of in vivo bone falling between 2.9 to 3.6 and optimally be 3.205 (Ambrose 1993:76; Keegan and DeNiro 1988:329). Variation of this ratio can be indicative of the type of contamination. For example, C:N ratios of 3.4 or higher may indicate carbon rich contaminants (i.e., biogenic contaminants such as, lipids and carbonates, or humic acid), and a ratio between 3.4 to 3.6 indicates a probable humic acid (organic soil acids) contamination (Ambrose 1993:75). All samples bearing C:N values below 2.9 should be rejected as being non-collagenous. However, even a C:N ratio that falls between 2.9 and 3.6 should still be treated as suspect.

A further test of collagen integrity is the percentage of collagen yield from the bone sample, and the percentages of carbon and nitrogen yield from the collagen sample should also be tested (Ambrose and Norr 1992). An acceptable percentage of collagen yield by weight from bone is 5% or greater. Carbon and nitrogen yields by weight from collagen of 6.6 (optimally 43%) and 1.9 (optimally 16%) or greater, respectively, indicate sufficiently good collagen integrity for the sample.

All collagen samples in this study had acceptable C:N ratios except one beaver bone sample. Unfortunately, not all the data needed for the remaining tests are available as

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<sup>1</sup> Glycine is the amino acid with the greatest concentration in collagen (30%). It contributes largely to the low C:N ratio since it is atypical among amino acids having only two carbon atoms to one nitrogen as opposed to most amino acids having four or more carbon atoms to every nitrogen. The 30% presence of glycine and the presence of hydroxyproline (only found in collagen) are characteristic of collagen (Schwarcz and Shoeninger 1991:292).

Tables 6.1 and 6.2 demonstrate. But for the beaver sample, all collagen samples received are satisfactory according to the remaining tests.

| <b>Table 6.1<br/>Human Bone Collagen Integrity Tests</b> |                    |                |                  |               |               |                   |
|--|--------------------|----------------|------------------|---------------|---------------|-------------------|
| <b>Site</b>  | <b>Feature/Ind</b> | <b>Rand. #</b> | <b>%Wt. Col.</b> | <b>%Wt. C</b> | <b>%Wt. N</b> | <b>Atomic C:N</b> |
| Whaley Cairn   | XU1/I1             | DE - 23        |                  |               |               | 3.15              |
| Whaley Cairn   | XU1/I2             | DE - 11        | 20               |               |               | 3.03              |
| Whaley Cairn   | XU2F1/I1           | DE - 15        | 22               | 41.69         | 14.61         | 3.32              |
| Whaley Cairn   | XU2F1/I2           | DE - 16        | 13               | 36.9          | 12.77         | 3.37              |
| Whaley Cairn   | XU2F1/I3           | DE - 18        | 16               | 39.32         | 13.72         | 3.34              |
| Whaley Cairn   | XU2F1/I4           | DE - 19        | 7                |               |               | 3.20              |
| Whaley Cairn   | XU2F1/I5           | DE - 26        |                  | 43.35         | 17.15         | 2.92              |
| Fort Alexander   | B1I1               | DE - 12        | 8                | 17.56         | 6.25          | 3.28              |
| Fort Alexander   | B1I2               | DE - 27        | 13               | 22.81         | 7.86          | 3.38              |
| Fort Alexander   | B2I1               | DE - 13        | 8                | 25.58         | 8.86          | 3.37              |
| Fort Alexander   | B2I2               | DE - 25        | 8                | 28.01         | 9.81          | 3.32              |
| Slave Falls  | F1I1               | DE - 24        | 17               |               |               | 3.03              |
| Slave Falls  | F1I2               | DE - 14        |                  |               |               | 3.16              |
| Slave Falls  | F1I3               | DE - 6         | 19               | 43.27         | 15.10         | 3.34              |
| Slave Falls  | F2I1               | DE - 7         |                  |               |               | 3.00              |
| Slave Falls  | F3I1               | DE - 9         |                  |               |               | 3.09              |
| Slave Falls  | F3I2               | DE - 1         | 11               | 36.56         | 12.63         | 3.37              |
| Slave Falls  | F3I3               | DE - 20        |                  |               |               | 3.23              |
| Whitemouth   | Z25                | DE - 4         | 14               | 39.77         | 13.92         | 3.37              |
| Bjorklund  | Z17                | DE - 8         | 13               | 39.13         | 13.72         | 3.34              |

| <b>Table 6.2<br/>Animal Bone Collagen Integrity Tests</b> |                             |                  |               |               |                   |
|---|-----------------------------|------------------|---------------|---------------|-------------------|
| <b>Common Name</b>  | <b>Genus Species</b>        | <b>%Wt. Col.</b> | <b>%Wt. C</b> | <b>%Wt. N</b> | <b>Atomic C:N</b> |
| Beaver  | <i>Castor canadensis</i>    | 11               | 5.76          | 2.3           | 2.92              |
| Beaver  | <i>Castor canadensis</i>    | 6                | 7.42          | 3.05          | 2.83              |
| Bison   | <i>Bison bison</i>          | 13               | 24.07         | 8.3           | 3.38              |
| Bison   | <i>Bison bison</i>          | 12               | 8.65          | 3.24          | 3.11              |
| Moose   | <i>Alces alces</i>          | 16               | 22.61         | 7.84          | 3.41              |
| Channel Catfish   | <i>Ictalurus punctatus</i>  | 9                | 29.84         | 10.38         | 3.35              |
| Pike  | <i>Esox lucius</i>          | 14               | 28.36         | 9.61          | 3.44              |
| Pike  | <i>Esox lucius</i>          | 8                | 20.47         | 7.08          | 3.37              |
| Sturgeon  | <i>Acipenser fulvescens</i> | 13               | 30.71         | 10.68         | 3.27              |
| Sturgeon  | <i>Acipenser fulvescens</i> | 5                | 24.98         | 8.87          | 3.29              |
| Walleye   | <i>Stizostedion sp.</i>     | 17               | 31.86         | 10.8          | 3.44              |
| Walleye   | <i>Stizostedion sp.</i>     | 12               | 30.9          | 10.71         | 3.36              |
| Walleye   | <i>Stizostedion sp.</i>     | 20               | 34.11         | 11.6          | 3.43              |

### 6.3 Laboratory Methodologies

Three stable isotope laboratories were used to process the samples for this study.<sup>2</sup>

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<sup>2</sup> The three stable isotope laboratories used were University of Florida, Departments of Anthropology and Geology under the direction of Dr. Norr and Dr. Summers, respectively (laboratory instruction by Theresa Schober); McMaster University, Department of Geology under the direction of Dr. Schwarcz and Martin Knyf (sample preparation by Scott Fairgrievies); and, University of Colorado, Institute of Arctic and Alpine Research under the direction of Dr. Stafford. I would like to restate my gratitude to these people for aiding in my research.

To ensure that isotope values were comparable between the laboratories, a sample from seven individuals were sent to two different laboratories, and the results compared. The mean differences between carbon and nitrogen values between institutions (i.e., 0.30‰ and 0.97‰, respectively) are less than  $1\sigma$  for the study population in total and by site. Since the errors of the isotope ratio mass spectrometers (IRMS) are  $\pm 0.1\%$  for carbon and  $\pm 0.4\%$  for nitrogen, the difference between laboratories is not significant. Processing methodologies did differ and are described in Appendix VIII.

## 6.4 Results

The basic premise of stable isotope analysis as a subsistence reconstruction technique is that the isotopic signature of plants at the base of the food chain are similar to, or are reflected in, the isotopic compositions of their consumers. In turn, the isotope values of the humans reflect the proportion of food classes ingested (i.e., plant and animal values). Interpretation of the stable isotope data must be first made at the base level (i.e., plants) for any significant distinction between food classes to be made further up the food chain (Keegan and DeNiro 1988:329).<sup>3</sup>

### 6.4.1 Plant Data

Eleven (11) plant samples from the Winnipeg River region, both terrestrial and

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<sup>3</sup> Due to financial constraints, the number of regional biotic samples tested is small, and is not statistically significant. The results and conclusions drawn from this data are used to propose a subsistence model for the Winnipeg River region which needs to be further tested once more isotope data for the region is available.

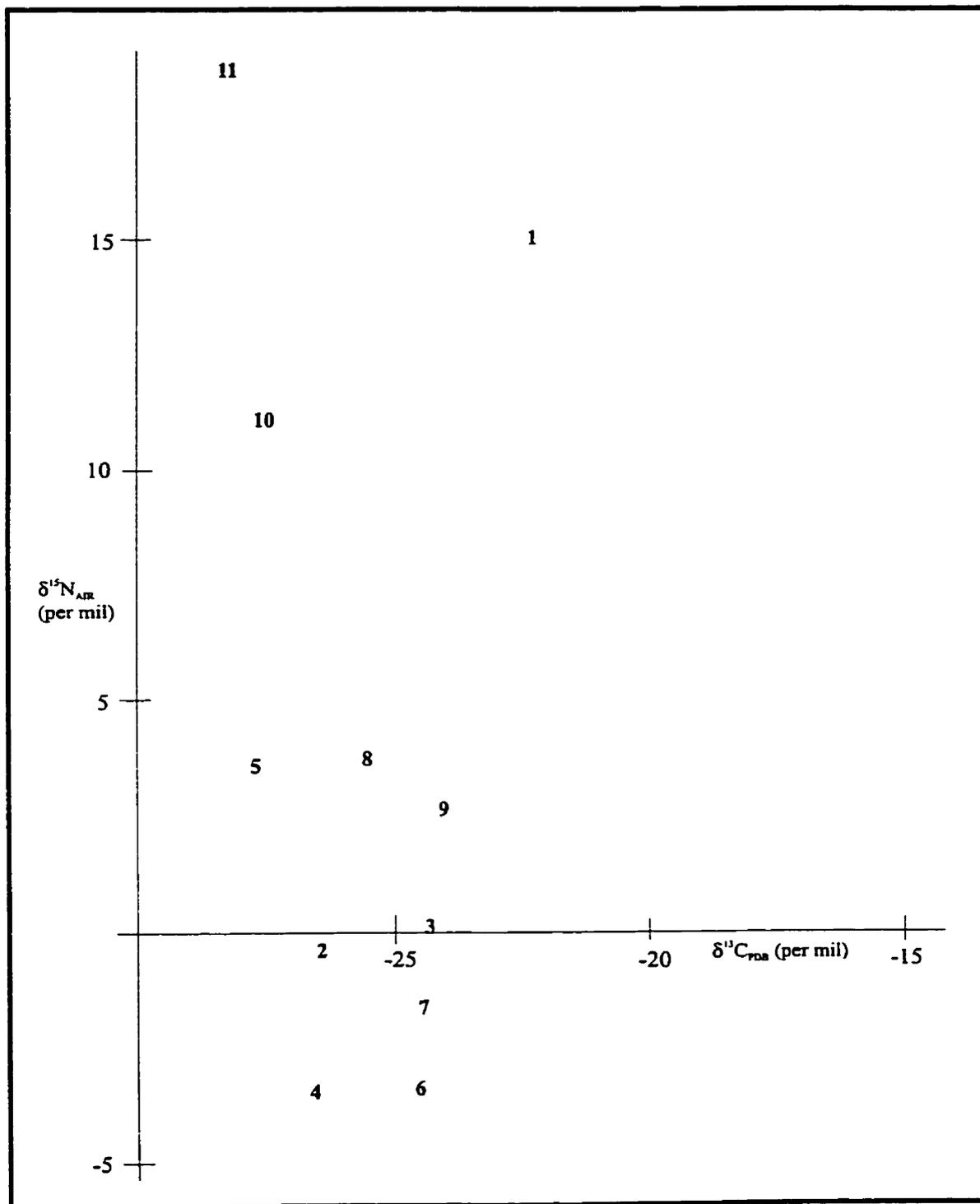
freshwater, were isotopically analysed in this study (Table 6.3). These plant portions consisted of three (3) types of fruits, four (4) samples of seeds, two (2) root portions, one (1) fungus and one (1) tree sap sample. Most of the samples are modern except for a sample of charred archaeological wild rice (*Zizania aquatica*) from the Wanipigow site just north of the Winnipeg River system.

| <b>Common Name</b>             | <b>Genus Species</b>         | <b>Sample #</b> | <b>Locale</b>      | <b>C:N</b> | <b><math>\delta^{13}\text{C}</math></b> | <b><math>\delta^{15}\text{N}</math></b> |
|--------------------------------|------------------------------|-----------------|--------------------|------------|---|---|
| Manitoba Maple Sap             | <i>Acer negundo</i>          | DP-1            | St. Pierre Jolie   | n/a        | -22.75                                  | 14.99                                   |
| Saskatoon Fruit                | <i>Amelanchier alnifolia</i> | DP-2            | Lac du Bonnet      | 55.56      | -26.43                                  | -0.44                                   |
| Chokecherry Fruit              | <i>Prunus virginianus</i>    | DP-3            | Cypress River      | 46.34      | -24.39                                  | 0.08                                    |
| Blueberry Fruit                | <i>Vaccinium vacillans</i>   | DP-4            | Lac du Bonnet      | 101.81     | -26.51                                  | -3.41                                   |
| Dock Seeds                     | <i>Rumex sp.</i>             | DP-5            | Lac du Bonnet      | 58.43      | -27.7                                   | 3.61                                    |
| Prairie Turnip Root            | <i>Psoralea esculenta</i>    | DP-6            | Cypress River      | 30.76      | -24.52                                  | -3.44                                   |
| Posagon                        | <i>Inonotus obliquus</i>     | DP-7            | Churchill          | 134.53     | -24.41                                  | -1.66                                   |
| Wild Rice Seeds                | <i>Zizania aquatica</i>      | DP-8            | Wanipigow (arch.)  | 19.1       | -25.57                                  | 3.69                                    |
| Wild Rice Seeds                | <i>Zizania aquatica</i>      | DP-9            | Wanipigow (modern) | 24.65      | -24.09                                  | 2.66                                    |
| Bulrush Root                   | <i>Scirpus validus</i>       | DP-10           | Delta Marsh        | 54.37      | -27.56                                  | 11.04                                   |
| Lamb's Quarter Goosefoot Seeds | <i>Chenopodium album</i>     | DP-11           | Lockport           | 59.67      | -28.29                                  | 18.65                                   |

All of the  $\delta^{13}\text{C}$  values reflect a typical  $\text{C}_3$  environment. The range of  $\delta^{13}\text{C}$  values is

between -27.7 to -22.75‰ with a mean of -25.66‰ and a variation of 4.95‰. However, it is important to test as many plants as possible from a region since many ecoclimatic factors can change a plants isotopic signature. For example, the genus *Chenopodium* has been shown to produce typical C<sub>4</sub> signatures (i.e., -16‰ or greater) as well as C<sub>3</sub> signatures (Smith 1972:228). The *Chenopodium* species (*album*) studied here produced the lowest C<sub>3</sub> value ( $\delta^{13}\text{C}=-28.29\text{‰}$ ) of this project, even though this sample was taken from one of the most southern (i.e., warmest) locales. This value, however, is slightly lower than the C<sub>3</sub> values from a region more geographically south than Manitoba (i.e., southern Ontario) for species *hybridum* (-26.7) and *glaucum* (-28.2) which is expected (Schwarcz et al. 1985:197).

The small variation between plants in a C<sub>3</sub> environment hinders dietary interpretations, and deters many from studying such a region due to lack of discriminatory criteria. However, when  $\delta^{13}\text{C}$  values are used in combination with  $\delta^{15}\text{N}$  data, certain distinctions can be made. Figure 6.1 demonstrates the small range in the  $\delta^{13}\text{C}$  plant values compared to the wider range of their  $\delta^{15}\text{N}$  values. For example, the berries produced  $\delta^{15}\text{N}$  values ranging from -3.41 to 0.08‰ with a mean of -1.26‰. These low values are interesting for a number of reasons. Stable nitrogen isotope studies usually categorise plants in two groups — that is, “nitrogen-fixers” known as legumes (eg. peas, beans, clover, etc.), and non-legumes (Rigaud 1981). Legumes typically have low  $\delta^{15}\text{N}$  values around 0.0‰ while the other group of the plants have higher values (DeNiro 1987; Katzenberg and Schwarcz 1986; Schwarcz et al. 1985; Schwarcz and Schoeninger 1991). Few studies have tested the nitrogen values for berries (i.e., a non-legumes) yet they produce low (i.e., legume-like)  $\delta^{15}\text{N}$  values. Given the number of herbivores that eat a significant number of berries,



**Figure 6.1 -  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  Values for Plant Portions. [Numbers indicate sample numbers (DP)]**

this information would affect isotopic interpretation.

The wild rice and dock seeds have similar  $\delta^{15}\text{N}$  values although one is an aquatic plant and the other terrestrial. The goosefoot seeds, however, have an extremely high  $\delta^{15}\text{N}$  value (18.65‰). The difference in values between the first two seed types and the latter may be due to exposure of the latter plant to fertilisers since the Lockport area has a greater modern agricultural base. Indeed, stable isotope researchers who use modern plants sometimes compensate for modern contaminants, such as, industrial carbon emissions and fertilisers (nitrogen-based) that decrease  $\delta^{13}\text{C}$  and increase  $\delta^{15}\text{N}$  values, with a correction factor (Ambrose 1993; van der Merwe 1989). A comparison of the archaeological and modern wild rice from the Wanipigow area provides some evidence of this phenomenon. In this case, there is a  $^{15}\text{N}$  enrichment and a  $^{13}\text{C}$  depletion over time. Although the differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values may be due to modern contaminants, there may be differences due to variation within, or between, species, or some environmental significance. Unfortunately, the sample size is too small to speculate as to cause.

#### **6.4.2 Animal Data**

The bone collagen from thirteen animals (5 mammals and 8 fish) were processed for stable carbon and nitrogen isotope analysis. All of the animals samples were taken from archaeological contexts from the Whitemouth Falls, Bjorklund, Whaley Cairn, Lockport and Mullet (southwestern Manitoba) sites. These samples were in proximity to previously radiocarbon dated material providing an additional variable of time (Appendix IX). The use of archaeological bone eliminates the need to speculate on the effects of modern

contaminants, and provides direct evidence for palaeodietary and palaeoenvironmental reconstructions.

Most of the  $\delta^{13}\text{C}$  values for the animals are typical for a  $\text{C}_3$  environment having a range of  $-19.12$  to  $-22.61\text{‰}$  and a variance of  $3.49\text{‰}$ ; however, two samples (i.e., the bison samples) have higher values more typical of  $\text{C}_4$  areas. Unlike the  $\delta^{15}\text{N}$  values for the plants, the animals have a narrower range of values ( $3.50$  to  $10.92\text{‰}$ ). The  $\delta^{15}\text{N}$  values, however, separate the animals into three categories: 1) forest herbivores; 2) plains grazers; and, 3) aquatic carnivores (Table 6.4).

| <b>Common Name</b> | <b>Genus Species</b>        | <b>Sample #</b> | <b>Locale</b> | <b><math>\delta^{13}\text{C}</math></b> | <b><math>\delta^{15}\text{N}</math></b> |
|--------------------|-----------------------------|-----------------|---------------|---|---|
| Bison              | <i>Bison bison</i>          | DA-1            | Whitemouth    | -16.28                                  | 5.52                                    |
| Bison              | <i>Bison bison</i>          | DA-2            | Mullet        | -17.7                                   | 6.53                                    |
| Moose              | <i>Alces alces</i>          | DA-3            | Bjorklund     | -20.67                                  | 3.50                                    |
| Beaver             | <i>Castor canadensis</i>    | DA-5            | Whitemouth    | -19.97                                  | 3.92                                    |
| Sturgeon           | <i>Acipenser fulvescens</i> | DA-6            | Whitemouth    | -21.31                                  | 9.63                                    |
| Sturgeon           | <i>Acipenser fulvescens</i> | DA-7            | Whitemouth    | -22.61                                  | 9.97                                    |
| Pike               | <i>Esox lucius</i>          | DA-8            | Whaley        | -21.19                                  | 9.67                                    |
| Walleye            | <i>Stizostedion sp.</i>     | DA-9            | Whaley        | -20.28                                  | 10.73                                   |
| Channel Catfish    | <i>Ictalurus punctatus</i>  | DA-10           | Lockport      | -21.51                                  | 9.18                                    |
| Walleye            | <i>Stizostedion sp.</i>     | DA-11           | Whaley        | -21.24                                  | 10.92                                   |
| Pike               | <i>Esox lucius</i>          | DA-12           | Whaley        | -19.12                                  | 9.43                                    |
| Walleye            | <i>Stizostedion sp.</i>     | DA-13           | Whaley        | -19.57                                  | 9.63                                    |

The  $\delta^{15}\text{N}$  values separate the animals into groups as expected.  $\delta^{15}\text{N}$  values have been shown to be discriminatory between levels in the food chain — that is, herbivores can be distinguished from carnivores, and usually omnivores. Isotopic values are changed dependent upon the animal's position in the food chain. Generally, these isotopic changes are regular, and therefore, predictive, so that an animal's trophic level can be determined from its isotopic value. This is known as the trophic effect (Minagawa and Wada 1984:1140; Schoeninger and DeNiro 1984:625).

Schoeninger and DeNiro (1984) describe  $\delta^{15}\text{N}$  trophic level enrichments in both marine and terrestrial environments. For terrestrial and marine animals, the  $\delta^{15}\text{N}$  enrichment value of bone collagen between herbivores and carnivores was found to be 2.7‰ and 3.3‰, respectively.<sup>4</sup> This enrichment value, however, must be considered only within each system — that is, trophic levels within marine or terrestrial systems where nitrogen sources are believed the same, and therefore, comparable (Minagawa and Wada 1984:1137; Schwarcz and Schoeninger 1991:299).

The  $\delta^{15}\text{N}$  means of the forest and the plains mammals in this study are separated by 2.32‰. This difference should be noted since both groups are herbivores, and are expected to have similar  $\delta^{15}\text{N}$  values (Appendix I). However, Ambrose and DeNiro (1986) argue that short-term water stress creates an  $^{15}\text{N}$  enrichment for animals in more xeric conditions. To explain this phenomenon Schoeninger and DeNiro (1984:635) hypothesise that “restricted or delayed nitrogen excretion,” that minimizes water loss, allows for greater incorporation

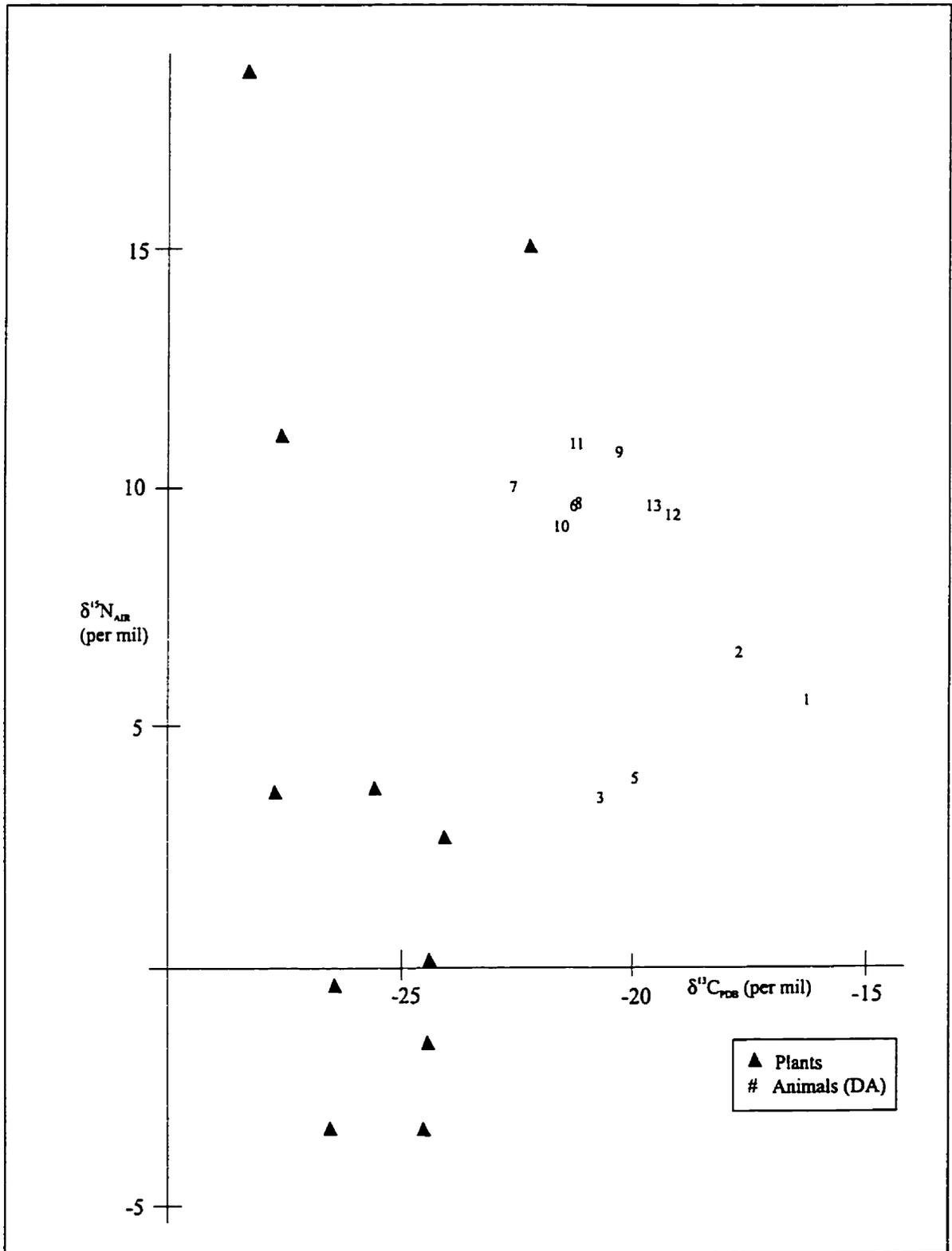
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<sup>4</sup> The exception to this was reef fish, migratory birds and anadromous fish which span terrestrial and marine isotopic values.

of  $^{15}\text{N}$  into bone collagen. However, as Schwarcz and Schoeninger (1991:300) state, "it is far from clear what role water intake, protein levels, and gastrointestinal bacteria play in determining the final  $\delta^{15}\text{N}$  values of an animal's tissues." The drier conditions of the plains, therefore, could explain the  $^{15}\text{N}$  enriched values. Other ecoclimatic phenomenon can be gleaned from examining the stable isotope values of the mammals (Figure 6.2).

Each of the four mammals represent a different period of time. In chronological order, the bison (DA-2) sample taken from the Mullet site is approximately dated to 1200 years Before Present (BP), the moose (DA-3) from Bjorklund is ca. 3100 BP, the bison (DA-1) from Whitemouth Falls is ca. 3400 BP, and the oldest sample is the beaver (DA-5) from the Whitemouth Falls site ca. 5000 BP. According to palaeoclimatic models, the latter specimen should be representative of the Winnipeg River region during the close of the Atlantic episode (i.e., the end of a global warming trend)(Bell and Walker 1992). If this model is correct, as temperatures became cooler and precipitation increased, there should be a decrease in  $\delta^{15}\text{N}$  values over time, due to less water-stress, and a decrease in  $\delta^{13}\text{C}$  values as  $\text{C}_3$  plants began to replace  $\text{C}_4$  plants in the more temperate climate. Assuming that the food sources of the beaver and the moose are relatively the same (see Appendix I), the decrease in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values between these animals over a 2000 year period are consistent with the climatic paradigm. The  $\delta^{13}\text{C}$  values for the bison also demonstrate the expected  $^{13}\text{C}$  depletion over time.

Bison are primarily grass consumers. There are three types of grasslands in North America (see Figure 2.5): short-grass xeric regions consisting of Blue Grama (*Bouteloua gracilis*), Buffalo grass (*Buchloe dactyloides*), Needle and Thread grass (*Stipa comata*),



**Figure 6.2** -  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  Values for Plants and Animal Bone Collagen. [Numbers indicate sample numbers (DA)]

Western wheatgrass (*Agropyron smithii*) and Green Needle grass (*Stipa vividula*); tall-grass prairie consisting of Big, Little and Sand Bluestem (*Andropogan gerardi*, *A. scoparius* and *A. halii*, respectively), Switchgrass (*Panicum virgatum*), Needle grass (*Stipa spartea*), Indian grass (*Sorghastrum nutans*), Hairy and Side-Oats Grama (*Bouteloua hirsuta* and *curtipendula*, respectively), Western wheatgrass, and Needle and Thread Grass; and mixed-grass prairie (Buchner 1979:13 and Scott 1995). At least four of these grasses (*B. gracilis*, *B. curtipendula*, *A. gerardi* and *A. scoparius*) are known to have C<sub>4</sub> members (Downton 1971; Downton 1975; and Adams per. com.). Southeastern Manitoba prairies, historically, had been characterised as having both mixed-grass and tall-grass prairie grasses.

Bison have variable grass preferences depending on the season. Huebner and Boutton (n.d.:2) note,

Studies of fistulated bison on [Texas] shortgrass plains have shown that they consume roughly 80% C<sub>4</sub> grasses. These ruminants prefer C<sub>4</sub> grasses in all seasons except spring, when C<sub>3</sub> grasses are growing actively and the C<sub>4</sub> species are not . . . . Bison also have a narrow niche breadth, with only three grass species accounting for 65-75% of dietary intake in the shortgrass prairie.

Since bison have an affinity for C<sub>4</sub> grasses, it is possible to estimate the percentage of C<sub>4</sub> plants in its resource region by calculating the percentage of C<sub>4</sub> plants in a bison diet, and thereby, speculating on ecoclimatic changes within that region over time. Schwarcz et al. (1985) provide the following equation in order to calculate the percentage of C<sub>4</sub> food in the consumer's diet:

$$C_4\% = \frac{(\delta_{\text{collagen}} - \delta_3 + \Delta_{dc})}{\delta_4 - \delta_3} \times 100$$

$\delta_3$  is the mean  $\delta^{13}\text{C}$  value of a C<sub>3</sub> plants (-26.5‰),  $\delta_4$  is the mean  $\delta^{13}\text{C}$  value of a C<sub>4</sub> plants (-12.5‰), and  $\Delta_{dc}$  is the  $\delta^{13}\text{C}$  fractionation factor between an animal's diet and its collagen

(-5‰).

The calculated percentage of C<sub>4</sub> plants in the diet of the bison from the Whitemouth Falls site is 37% and for the Mullet site bison 27%. These percentages represent the maximum percentage of C<sub>4</sub> grasses that are likely to be in these areas since the bison would have generally discriminated against C<sub>3</sub> varieties in favour of C<sub>4</sub> grasses. The mixed-grass and tall-grass prairie of the recent past stretched from Manitoba to north-central Texas (Scott 1995:143-149). However, the calculated Manitoba C<sub>4</sub> bison diet are considerably lower than those determined by Huebner and Boutton (n.d.) for archaeological bison samples (80±8% C<sub>4</sub> diet) found in Texas sites where 68% of grass species are C<sub>4</sub>. This indicates that there are significant regional variations in vegetation even within a single vegetation zone.

A comparison of the  $\delta^{13}\text{C}$  values and the percentage of C<sub>4</sub> plants in the diets of the Mullet and Whitemouth Falls bison further exemplifies the need to study micro-regional variation isotopically. The  $\delta^{13}\text{C}$  bison data of this study indicates at least three non-exclusive ecoclimatic scenarios: 1) there was an ecoclimatic change over a 2000 year period (ca. 3400 BP to 1200 BP) indicating a shift from a warmer to a cooler climates; 2) there was micro-regional variation of C<sub>4</sub> plant densities; and/or 3) there was a shift in dietary preference of bison from C<sub>4</sub> to C<sub>3</sub> grasses. The first scenario is in agreement with the palaeoclimatic model of the cooling trend from the Atlantic to the Sub-Boreal episode and is supported by the stable isotope evidence of the moose and beaver data. The micro-regional variation in C<sub>4</sub> plant density is evidenced by the difference in  $\delta^{13}\text{C}$  values for the two study bison. These data indicate that there were probably more C<sub>4</sub> grasses in the Whitemouth site region ca. 3400 BP than there were further west at the Mullet site 2000 years later as expected during a period

of global cooling. It, however, does refute other arguments such as those made by Stafford (1984), who argues that there was a trend of increased  $C_4$  grazing between 13000 to 200 BP, and Huebner and Boutton (n.d.) who state,

The main point is that chronic grazing of almost any intensity has the potential to change plant communities and produce  $C_3/C_4$  shifts, which could produce the variation in bison diet seen in this and other studies.

These studies argue for an increase in  $C_4$  values over time rather than the decrease that is noted in this study. This trend towards increased  $C_4$  values than may apply to more southerly climates than southern Manitoba.

The larger sample size of those studies renders the conclusions more acceptable. The other possible explanation for the discrepancy between those studies and this study is the third scenario — that is, a change in dietary preference of bison in favour of  $C_3$  grasses. The cooling trend of the Boreal episode and the resulting replacement of  $C_4$  grasses by  $C_3$  grasses, and the increased competition for grazing pastures as the bison population increased are all factors that promote the rise of a bison subspecies that would exploit a slightly different econiche along the northern prairie fringe. Indeed, the “wood bison” (*B. bison athabascae*) existed alongside *B. bison bison*, yet remained closer to the prairie fringe (Baenzinger 1990; Gordon 1979; Hind 1969). The Mullet bison, therefore, could represent a wood bison species. It is apparent that stable isotope analysis of plants as well as animals is important in order to establish regional and micro-regional norms.

The stable isotope data for fish also support micro-regional variation. There is an apparent differential between the  $\delta^{13}C$  means of the fish from the Whaley Cairn site

(-20.43‰) and the Whitemouth Falls site (-21.93‰) even though these sites are on the same river system. In comparing the fish data from Garvie's (1993) stable carbon isotope study of the Lockport site, the  $\delta^{13}\text{C}$  means of the Winnipeg River and those of the Red River differs by 2.24‰. Further north of Lake Winnipeg at the Kame Hills site, the biota residues found in ceramic pots demonstrate an even greater  $^{13}\text{C}$  depletion than the biota of either the Red River or Winnipeg River systems (Sherriff et al. 1995). It is apparent that northern regions have lower  $\delta^{13}\text{C}$  values.

Further dietary gradients in stable isotope values for aquatic environments have been studied. Katzenberg (1989:327) speculates that a 5-6‰  $\delta^{15}\text{N}$  differential for freshwater fish may be used to distinguish between bottom-feeding fishes and those more piscivorous. This is a trophic phenomenon whereby piscivorous fish have a higher  $\delta^{15}\text{N}$  value than others eating more vegetation. The diet of a fish, however, generally changes through its life. Younger fish of most species eat vegetation and various larvae, but once a large body size is achieved fish eat foods higher up the food chain. Therefore, the age of a fish must be considered before this factor can be applied. The fish of this study were not aged, but neither did they demonstrate  $\delta^{15}\text{N}$  differences amongst feeding types. They did, however, demonstrate higher  $\delta^{15}\text{N}$  values than most terrestrial animals as did fish from the Great Lakes (Katzenberg 1989). Generally, higher  $\delta^{15}\text{N}$  values and lower  $\delta^{13}\text{C}$  values are expected for fish and fish consumers than for terrestrial mammals and those eating terrestrial mammals.

### 6.4.3 Human Data

Twenty (20) samples of human bone collagen were analysed. These samples were processed under blind random numbers in order to reduce bias during analysis (Table 6.5).

The analysis using the blind numbers will be presented first.

| <b>Site</b>      | <b>Feature/Ind</b> | <b>Rand. #</b> | <b>Sex</b> | <b>Age Category</b> | <b>d<sup>13</sup>C (‰)</b> | <b>d<sup>15</sup>N (‰)</b> |
|------------------|--------------------|----------------|------------|---------------------|----------------------------|----------------------------|
| Whaley Cairn     | XU1/I1             | DE - 23        | M          | Middle Adult        | -20.51                     | 10.44                      |
| Whaley Cairn     | XU1/I2             | DE - 11        | F          | Middle Adult        | -19.20                     | 13.82                      |
| Whaley Cairn     | XU2F1/I1           | DE - 15        | M          | Middle Adult        | -18.98                     | 12.39                      |
| Whaley Cairn     | XU2F1/I2           | DE - 16        | Ind        | Juvenile            | -19.82                     | 11.54                      |
| Whaley Cairn     | XU2F1/I3           | DE - 18        | Ind        | Young Adult         | -19.71                     | 10.56                      |
| Whaley Cairn     | XU2F1/I4           | DE - 19        | F          | Young Adult         | -19.73                     | 13.26                      |
| Whaley Cairn     | XU2F1/I5           | DE - 26        | F          | Middle Adult        | -19.80                     | 11.95                      |
| Fort Alexander   | B1I1               | DE - 12        | F          | Adolescent          | -20.41                     | 11.50                      |
| Fort Alexander   | B1I2               | DE - 27        | Ind        | Perinate            | -21.40                     | 12.77                      |
| Fort Alexander   | B2I1               | DE - 13        | Ind        | Child               | -21.59                     | 14.21                      |
| Fort Alexander   | B2I2               | DE - 25        | Ind        | Child               | -21.29                     | 12.43                      |
| Slave Falls      | F1I1               | DE - 24        | M          | Middle Adult        | -19.07                     | 13.49                      |
| Slave Falls      | F1I2               | DE - 14        | Ind        | Adolescent          | -19.70                     | 12.97                      |
| Slave Falls      | F1I3               | DE - 6         | Ind        | Juvenile            | -18.76                     | 12.72                      |
| Slave Falls      | F2I1               | DE - 7         | Ind        | Juvenile            | -19.43                     | 14.23                      |
| Slave Falls      | F3I1               | DE - 9         | M          | Middle Adult        | -20.51                     | 12.43                      |
| Slave Falls      | F3I2               | DE - 1         | F          | Middle Adult        | -19.09                     | 13.01                      |
| Slave Falls      | F3I3               | DE - 20        | Ind        | Young Adult         | -19.00                     | 13.34                      |
| Whitemouth Falls | Z25                | DE - 4         | F          | Old Adult           | -18.81                     | 12.01                      |
| Bjorklund        | Z17                | DE - 8         | F          | Old Adult           | -17.48                     | 10.41                      |

It is expected that people eating similar foods will have similar stable carbon and nitrogen values. DeNiro and Schoeninger (1983) have shown that  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of bone collagen for populations with the same diet usually fall within 1‰ of the population average. Therefore, if the study groups have isotopically-significant different diets, the diets represented by the human bone collagen should demonstrate this difference. Cluster analysis was used to detect distinctions between the groups.

Cluster analysis is a multivariate statistical procedure that classifies data into homogenous groups. Two methods of cluster analysis were used on the stable isotope values derived from the randomly numbered human bone collagen using “Microsoft xlSTAT 2.5.” Both the centroids and Ward’s ascendant hierarchical cluster analysis produced three clusters (Figure 6.3). One individual (DE-8) fell outside the  $1\sigma$  range for both the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values for the total sample. This individual, although included within “Cluster II” in xlSTAT, was separated out as an outlier from analysis, and new mean for Cluster II calculated. The calculated  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  means for each of the clusters are: Cluster I (-21.20‰ and 12.92‰, respectively), Cluster II (-19.18‰ and 12.92‰, respectively), and Cluster III (-20.05‰ and 11.20‰). It was found that the centroid means of Clusters I and III were significantly different from Cluster II by the  $\delta^{15}\text{N}$  value, and that the means of Cluster II and III were significantly different from Cluster I by the  $\delta^{13}\text{C}$  value. Since the “outlier” individual probably represented a different diet, possibly four distinct subsistence strategies were represented by the individuals used in this study: two groups relying more heavily on boreal aquatic food resources (Cluster I and II), another that incorporates more boreal mammal foods (Cluster III), and an individual who relies more heavily on terrestrial mammals.

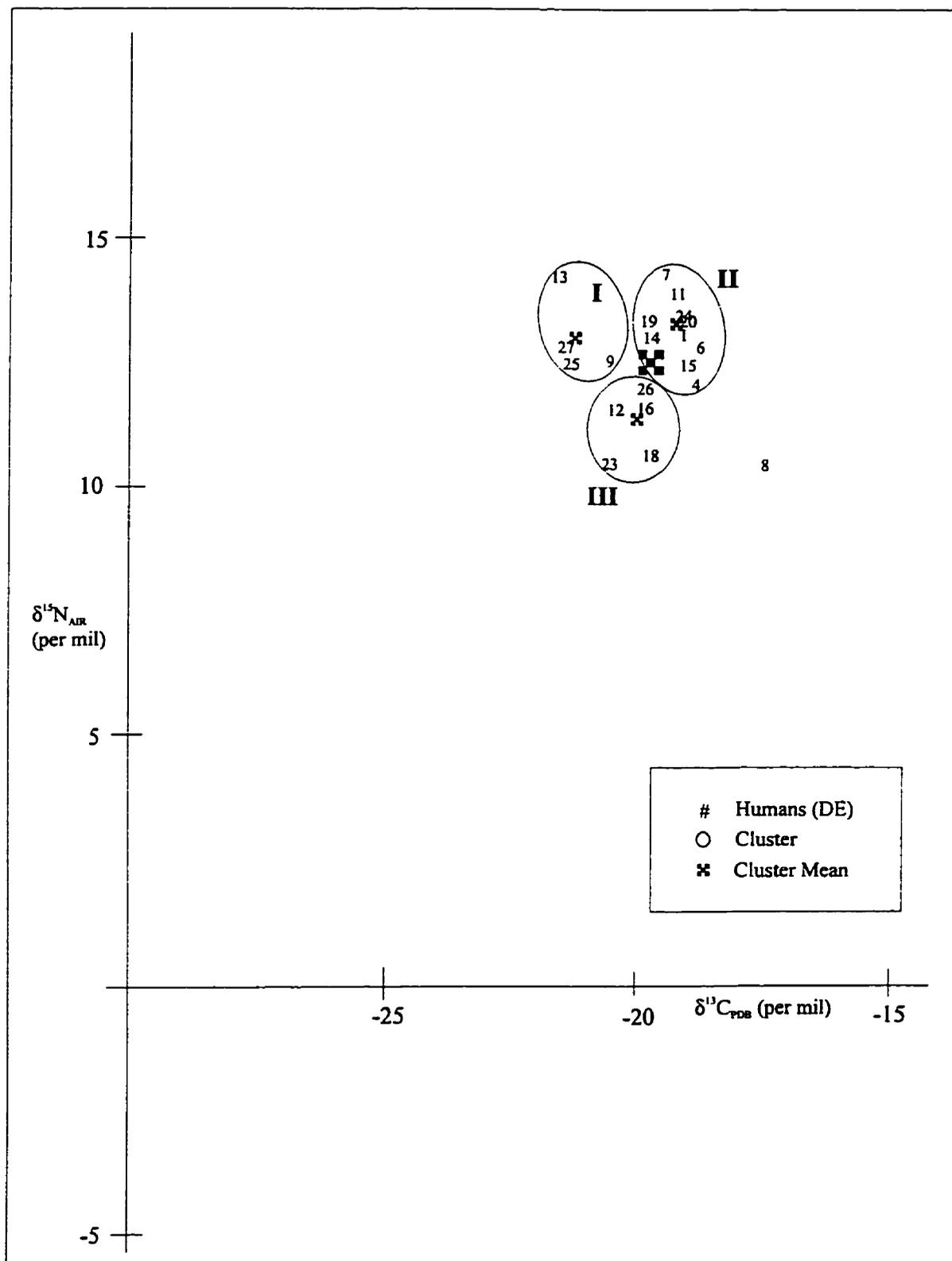


Figure 6.3 -  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  Values, and Clusters for Human Bone Collagen

Schoeninger (1989) and Ambrose (1993) argue that fairly precise dietary reconstruction using of stable isotopic data is achieved by calculating weighted delta values for specific food sources. As Ambrose (1993:84) states,

. . . the relative proportions of proteins to carbohydrates and fats is low in plants and high in meat. In a diet with 80% plant and 20% meat most of the nitrogen in collagen will thus come from meat. The appropriate measure is thus the % in the dietary resource. Carbon in collagen may come from meat, carbohydrates and fats. Therefore, for carbon the relevant variable is the number of calories in the resource. If the specific food items in a particular diet can be identified by floral and faunal analysis, then their proportional contribution to the diet can be determined by finding the sum of the weighted food  $\delta$  values that equals the tissue  $\delta$  values.

They conclude that the sum of the weighted food proportions that yields  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values similar to those of the human collagen, therefore, are probably a good indication of actual diet.<sup>5</sup> However, very little is known with regards to the variable absorption of food components (i.e., proteins, lipids, carbohydrates, etc.) into various tissues and their resulting fractionation. Although summed weighted values may be a fairly good indication of dietary reconstructions, physiological and metabolic processes probably affect fractionation and, therefore, isotopic values. Hypothetical dietary reconstructions using summed weighted delta values follow under the assumption that  $\delta^{15}\text{N}$  represents percentage of protein absorbed into

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<sup>5</sup> Weighted  $\delta$  values are calculated as follows (Schoeninger 1989:46-47):

$$\text{Weighted } \delta^{13}\text{C}_{\text{collagen consumer}} = \% \text{ calories in food} \times (\delta^{13}\text{C}_{\text{food}} + \Delta^{13}\text{C}_{\text{DC}}),$$

$$\text{where } \Delta^{13}\text{C}_{\text{Diet-Collagen}} = 5\text{‰} \text{ (van der Merwe 1982)}$$

$$\text{Weighted } \delta^{15}\text{N}_{\text{collagen consumer}} = \% \text{ protein in food} \times (\delta^{15}\text{N}_{\text{food}} + \Delta^{15}\text{N}_{\text{DC}}),$$

$$\text{where } \Delta^{15}\text{N}_{\text{Diet-Collagen}} = 3\text{‰} \text{ (DeNiro and Epstein 1981).}$$

See Appendix X for calculated weighted resources for this study.

bone collagen and  $\delta^{13}\text{C}$  represents the percentage of calories.

Although the biotic samples analysed, here, for the Winnipeg River region are far from complete, the application of weighted values for the foods tested provide evidence of possible proportions of general food categories eaten (Appendix X).<sup>6</sup> I would like to emphasise that, until further isotope studies have been performed determining the fractionation of specific compounds, and more floral and faunal samples from this region, the following dietary reconstructions using weighted isotopic values are highly speculative. According to the weighted  $\delta$  values for the foods tested, the diet of the Cluster I individuals may have consisted of approximately 50-60% high caloric (“C”), low fat (“f”) and high protein (“P”) plants (i.e., fairly high for a plant, such as, wild rice), approximately 20% moderate caloric (“C”), low fat and high protein fish (such as, pike or walleye), 10% moderate caloric, moderate fat (“F”) and moderate protein (“P”) fish (such as, sturgeon or catfish), and approximately 15% high caloric, high fat (“F”) and high protein mammal (such as, beaver).<sup>7</sup> This type of diet would account for the low  $\delta^{13}\text{C}$  and high  $\delta^{15}\text{N}$  values consistent with a primarily boreal aquatic subsistence strategy.

The Cluster II diet also has a high  $\delta^{15}\text{N}$  mean, but a slightly higher  $\delta^{13}\text{C}$  value that indicates that the primary protein resource probably consists of fewer calories (i.e.,

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<sup>6</sup> The following discussion refers to foods by their caloric, fat and protein contents whether they be high (capitalised), moderate (capitalised italics) or low (lower case). For example, wild rice would be a high caloric (C), low fat (f), high protein (P) plant resource; berries would be “cfp” plants; bison meat is CfP; moose is CFP meat; beaver is CFP meat; pike and pickerel are CfP fish; and, sturgeon are CFP fish.

<sup>7</sup> Some sort of waterfowl may replace the mammal portion of this diet, but no identifiable waterfowl remains were found to be tested.

characteristic of an aquatic-based diet). Indeed, a possible dietary reconstruction for this group consists of fish as their primary source of protein — that is, 60% C<sub>1</sub>P plants and 40% C<sub>1</sub>P fish.

The dietary reconstruction of Cluster III is a little more difficult since the  $\delta^{13}\text{C}$  and the  $\delta^{15}\text{N}$  values are indicative of a boreal forest subsistence strategy, but are moderate values for a C<sub>3</sub> environment proffering a few dietary alternatives. One possible dietary reconstruction consists of C<sub>1</sub>P fish constituting one half of the source of dietary protein. The protein sources in this hypothetical diet consists of approximately 20% C<sub>1</sub>P fish flesh “tempered” by 5% C<sub>1</sub>P (such as, moose), 5% C<sub>1</sub>P (such as, beaver) and 10% C<sub>1</sub>P mammal (such as, bison) flesh, and 60% C<sub>1</sub>P plants.

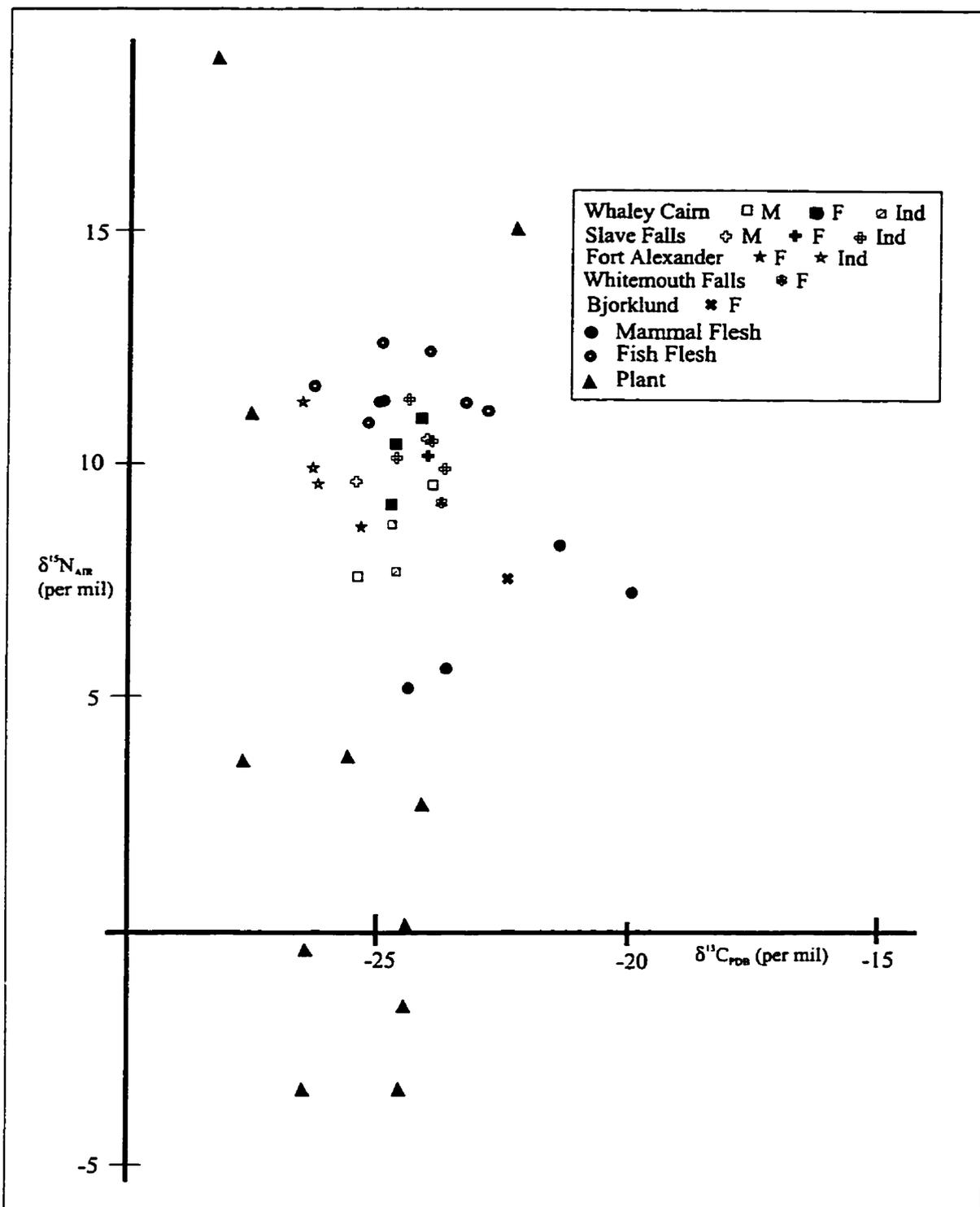
The fourth major subsistence strategy (represented by the outlier individual) is primarily based on terrestrial mammals; approximately 20% of this individual’s diet probably consisted of C<sub>1</sub>P mammal flesh and 20% of C<sub>1</sub>P mammal flesh. The remainder of the diet consisted of approximately 5% C<sub>1</sub>P aquatic protein, and 40% c<sub>1</sub>p and 15% C<sub>1</sub>P plants.

These dietary reconstruction estimates based on weighted portions of dietary resources provides evidence for four different subsistence strategies as does cluster analysis: two consisting of primarily aquatic protein resources; a third consisting of equal portions of terrestrial and aquatic protein resources; and the fourth consisting of primarily terrestrial protein resources. However, some questions are raised once the site, sex and age information is applied to these individuals (Figure 6.4).

It is important to note that three out of four individuals in Cluster I are sub-adults from the Fort Alexander site — that is, two children possibly not yet weaned and one foetus.

There is a separation in values between the mother (DE-12) and the foetus (DE-27) of 0.99‰  $\delta^{13}\text{C}$  and 1.27‰  $\delta^{15}\text{N}$ . This difference is probably attributable to mother-foetus fractionation. The stable isotope values for the DE-25 child falls within 1‰ from the older DE-12 female (i.e., within common population variation). Steele and Daniel (1978) have found there is a 1.5-2.0‰ increase in  $\delta^{15}\text{N}$  in milk and for breast-fed children. The  $\text{N}^{15}$  enrichment of 0.93‰ also would be expected if this child had not yet been completely weaned. The last Fort Alexander child, DE-13, has stable isotope values quite different from the older female, DE-12 (i.e., a difference of 1.18‰  $\delta^{13}\text{C}$  and 2.71‰  $\delta^{15}\text{N}$ ). Although the  $\delta^{13}\text{C}$  value could be due to population variation, the  $\delta^{15}\text{N}$  difference cannot be explained solely by either weaning enrichment nor population variation.

This child does have certain pathologies that may account for the difference in values. White and Armelagos (1997) found that osteopenic Nubian females had significantly higher  $\delta^{15}\text{N}$  values probably attributed to excessive calcium and phosphorus excretion. This child demonstrates Harris lines as well as sclerotic lesions on some metaphyses and ribs which may be due to growth remodelling of bone. It is uncertain what pathological conditions may affect stable isotope values. If this child suffered from an illness that resulted in the excess excretion of calcium and phosphorus, it could affect the isotope values, but such an illness cannot be determined at this time. However, the pathologies found on this child resemble, but are not as severe as, those found on the other Fort Alexander child (DE-25) that has stable isotope values closer to the older Fort Alexander individual. Therefore, if the pathology were the same for both children, both children should demonstrate  $^{15}\text{N}$  enrichment. This is not the case, and the high  $\delta^{15}\text{N}$  value for the DE-25 child remains an enigma.



**Figure 6.4 - Human Dietary Values by Site and Food Portions.**

[Human collagen converted into dietary values (i.e.,  $\Delta_{\text{DC}} = 5\text{‰}\delta^{13}\text{C}$  and  $3\text{‰}\delta^{15}\text{N}$ ) (DeNiro and Epstein 1978; van der Merwe 1982); Mammal and fish collagen values converted into flesh values (i.e.,  $\Delta_{\text{CF}} = -3.7\text{‰}\delta^{13}\text{C}$  and  $+1.7\text{‰}\delta^{15}\text{N}$ ) (DeNiro and Epstein 1978; 1981)]

The diet of the Fort Alexander population probably is better represented by the DE-12 individual since the stable isotope values for the sub-adults found in Cluster I may be explained by population variation, weaning, tissue fractionation and/or pathologic phenomena. Under this assumption, Cluster I is subsumed by the other clusters resulting in three subsistence strategies. This hypothesis once again can be tested using weighted isotope food values.

The stable isotope values for the Fort Alexander individual DE-12 are  $-20.41\text{‰}$   $\delta^{13}\text{C}$  and  $11.5\text{‰}$   $\delta^{15}\text{N}$ . A hypothetical long-term diet for this individual is approximately 60% CfP plant foods (eg. wild rice), 20% CfP fish (eg. pike or walleye), and 10% CFP, 5% CFP and 5% CfP mammal flesh (eg. beaver, moose, bison, respectively). The burials recovered from Fort Alexander are historic and closely associated with a nearby trading fort. The mixed diet of boreal aquatic and terrestrial, and non-boreal meats for people inhabiting this prairie fringe region is expected, and noted in historic documents. (See Chapter 4.) In this area, fish were abundant, and trade would offer higher yields of plains resources, such as, bison, contributing to the moderately low  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values in this  $\text{C}_3$  region. The isotopic “buffering” effect that terrestrial resources can have on a typically  $\text{C}_3$  aquatic-oriented diet is evident in a comparison of the dietary reconstructions of the Fort Alexander individual and the Slave Falls group.

The Slave Falls group has the lowest stable isotope variation of all the study sites. Only two out of seven individuals fall outside the population mean ( $\delta^{13}\text{C} = -19.36\text{‰}$ ;  $\delta^{15}\text{N} = 13.17\text{‰}$ ) by slightly more than 1‰. A dietary reconstruction of possible proportions of food types using weighted  $\delta$  values estimates 50% of the diet consisted of CfP and 5% cfp

plants, and 25% CfP and 20% CFP fish. A near total reliance on fish as the protein source results in a moderately high  $\delta^{13}\text{C}$  value, and a very high  $\delta^{15}\text{N}$  value. Comparatively, a high terrestrial protein diet results in higher  $\delta^{13}\text{C}$  values, but low  $\delta^{15}\text{N}$  values, as is found in the Bjorklund individual (-17.48‰ and 10.41‰, respectively). The reconstructed diet of this individual possibly consisted of 40% cfp plants (eg. berries), 15% CfP plants (eg. wild rice), 20% CfP (eg. bison) and 20% CFP (eg. beaver) mammal flesh, and 5% CFP fish (eg. sturgeon). All of these resources were readily available along the prairie fringe especially in the region of the Bjorklund site.

A change in one or more resources changes the summed weighted stable isotope values considerably. For example, the population mean of the Whaley Cairn (i.e.,  $\delta^{13}\text{C} = -19.68\text{‰}$ ;  $\delta^{15}\text{N} = 11.99\text{‰}$ ) differs significantly from the Slave Falls mean (13.17‰) only in the  $\delta^{15}\text{N}$  value. The difference between the estimated diets of these two groups consists of slight changes of proportions of plants and fish, and a small addition of mammal flesh. Where the estimated Slave Falls diet consists of nearly 100% fish protein, the Whaley Cairn diet consists of approximately 60% CfP plants, 30-40% CfP fish and 2-3% CFP mammal flesh (i.e., 93% of dietary protein obtained from CfP fish and 7% from CFP mammal flesh). A small addition of mammal protein significantly changes the resulting stable nitrogen signature.

Similarly, a shift from terrestrial “boreal” mammal flesh (eg. beaver and moose) to terrestrial plains mammal flesh (eg. bison) affects both the  $\delta^{13}\text{C}$  and the  $\delta^{15}\text{N}$  values as demonstrated in a comparison between the Bjorklund and Whitemouth individuals. The Whitemouth individual has  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of -18.81‰ and 12.01‰, respectively.

The estimated diet of this individual consisted of 10% cfp and 40% Cfp plants, and 40% Cfp and 10% CFP mammal flesh. Although the diet still consists of boreal and plains protein resources, the Whitemouth Falls individual had a greater reliance on “plains” resources for protein (i.e., a greater percentage of bison meat in the diet).

## 6.5 Discussion

The attempt to use summed weighted  $\delta$  values for regional resources is critical for dietary reconstruction — at least as a monitoring mechanism. It is a fairly common practice to apply simpler stable isotope reconstruction calculations but this may lead to erroneous conclusions. The most commonly used stable isotope calculation is to establish a percentage of  $C_4$  foods in diet. The equation is:

$$C_4\% = \frac{(\delta_{\text{collagen}} - \delta_3 + \Delta_{dc})}{\delta_4 - \delta_3} \times 100$$

The  $\delta_3$  and  $\delta_4$  values frequently used approximate -26.5‰ and -12.5‰, respectively. These values represent averages of  $C_3$  and  $C_4$  plants established by general studies such as, Tieszen (1991) and Smith (1972). Some studies do allow for regional modifications, however, due to the enormous amount of work needed to establish regional baseline data (and even more difficult for archaeological biota), it is often necessary to rely on the estimated values from the general studies. If dietary reconstructions rely solely on estimating  $C_4$  foods in this fashion, and cursory evaluations of where human collagen values lie in respect to food values, conclusions could prove misleading without an attempt to verify results using summed weighted  $\delta$  values.

A simple calculation for the Bjorklund individual's diet results in a 29% C<sub>4</sub> diet (i.e., the highest percentage of C<sub>4</sub> foods for an individual in this study). This result is visually apparent in Figures 6.3 and 6.4 since this individual has a  $\delta^{13}\text{C}$  value most closely approaching C<sub>4</sub> values (i.e., -16‰ or higher). Often common C<sub>4</sub> foods, such as maize, are explanatory of such values. However, by summing weighted values for regional resources, the "C<sub>4</sub>" values most likely are obtained from bison. That bison is a source of C<sub>4</sub> food is not problematic, but it is problematic that the Bjorklund individual appears to have had a higher percentage of C<sub>4</sub> foods than the Whitemouth Falls individual (19% C<sub>4</sub>). The Whitemouth Falls individual probably ate more (perhaps twice as much) bison than did the Bjorklund individual. This observation is based on a dietary reconstruction using summed weighted resource values, and archaeological context.<sup>8</sup> This inconsistency is further complicated since the Whitemouth Falls bison (ca. 3400 BP) is more likely to have had a higher C<sub>4</sub> diet than the Bjorklund bison (ca. 1600 BP) due to cooling temperatures during the close of the Altantic episode. Furthermore, using the group mean for the Slave Falls individuals whose diet most likely consisted of fish protein and boreal C<sub>3</sub> plants, a 15% C<sub>4</sub> diet was estimated with the above equation. This indicates that particular diets, which in no way consist of C<sub>4</sub> foods, can appear to consist of a certain percentage of C<sub>4</sub> foods because the commonly used  $\delta_3$  and  $\delta_4$  averages are not accurate for the region, and foods contribute disproportionately to the stable isotope signature in bone collagen.

An estimation of percentage of C<sub>4</sub> foods in diet is of little value for this study. The

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<sup>8</sup> Although little archaeological animal bone was found with either the Bjorklund individual or the Whitemouth Falls individual, the Whitemouth Falls individual had a ritualistically placed bison cranium over the remains.

dietary reconstructions using summed weighted  $\delta$  values, however, do provide better insights into the possible subsistence strategies used in the prairie fringe along the Winnipeg River system. The post-contact Fort Alexander diet is interesting in that it verifies historical observations of seasonal rounds that exploited boreal, plains, terrestrial and aquatic resources. It cannot be determined if this subsistence strategy pre-dates the influences of the fur trade, or if it is the result of those influences. However, prior to European contact, three other subsistence strategies are indicated: one consisting almost totally of boreal aquatic resources (i.e., Slave Falls and Whaley Cairn sites), another of both plains and boreal terrestrial resources (i.e., Bjorklund site), and a third consisting of mostly terrestrial plains resources (i.e., Whitemouth Falls site). Based on the restricted diets of the latter four sites, I argue that the diverse diet of the Fort Alexander individual is likely a result of the fur trade influences.

It is possible to apply stable isotope results to issues other than those directly associated with diet. For example, a frequently debated issue amongst archaeologists is that of cultural continuity in the region — that is, whether one or two Archaic groups maintained control over southeastern Manitoba throughout time, or whether resident groups were replaced by other groups. Typically the question of regional “cultural” continuity is studied using lithic and ceramic analysis. Stable isotope dietary reconstruction provides a new avenue for further exploring this issue.

The most obvious method of assessing changes in diet, and thus changes of groups of people over time, is to examine the changes in stable isotope values. An examination of the group means over time indicates that there is a decrease in  $\delta^{13}\text{C}$  values over time with the

exception of the Bjorklund site (Figures 6.5 and 6.6). At first this observation appears significant; however, it is coincidental that the chronological arrangement of sites also places them in latitudinal order — that is, south to north except for the Bjorklund site which is a more southerly site. The geographical position of the sites is more explanatory of the decrease in  $\delta^{13}\text{C}$  than is a change over time. Thus the further north the site, the lower the  $\delta^{13}\text{C}$  value which infers colder temperatures produce lower  $\delta^{13}\text{C}$  values, and demonstrates the need for region-specific isotopic baseline data. The  $\delta^{15}\text{N}$  values demonstrate no secular trends.

Although no secular trends are relevant to the discussion of regional cultural continuity, there appears to be a dichotomy of subsistence strategies for the region that are more or less maintained from the Archaic period to the pre-contact era — that is, one relying mainly on fish as the principle source of protein, and the other relying on mammal flesh. The Slave Falls (ca. 4000 BP) and the Whaley Cairns (ca. 1760 BP) sites are located further into the boreal forest. Both groups relied heavily on fish as their primary source of protein. The earlier group (Slave Falls individuals) probably ate more fish than the later group (Whaley Cairn individuals) who incorporated a few boreal mammals into their diet. Similarly, closer to the plains, the earlier Whitemouth Falls individuals (ca. 6090) relied mostly on bison; whereas, the later Bjorklund individuals (ca. 1570) incorporated a more diverse range of terrestrial mammals into their diet (i.e., boreal and plains in fairly equal proportions).

The earlier groups, in both cases, were probably more specialised in their subsistence strategies relying heavily on only a few resources. The reliance on a limited number of resources is a riskier strategy than one with greater diversity, since periods of decline within species would mean hardships for groups that relied on that resource. I suggest it is possible

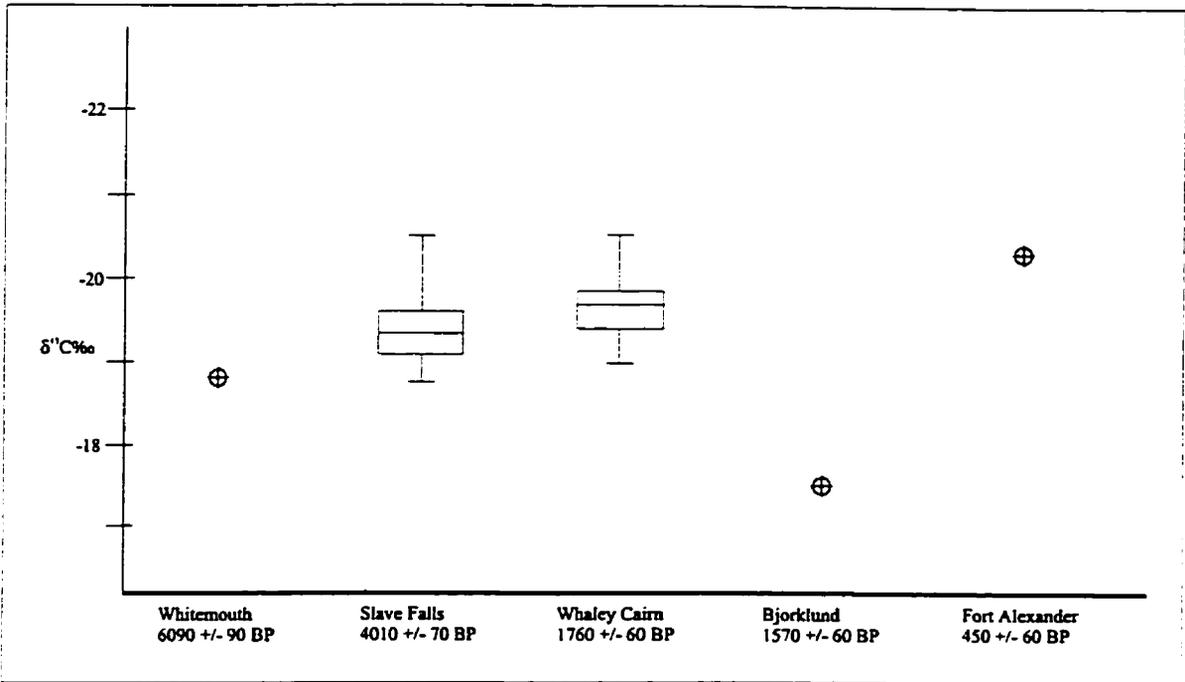


Figure 6.5 -  $\delta^{13}\text{C}$  Values by Site Arranged Chronologically

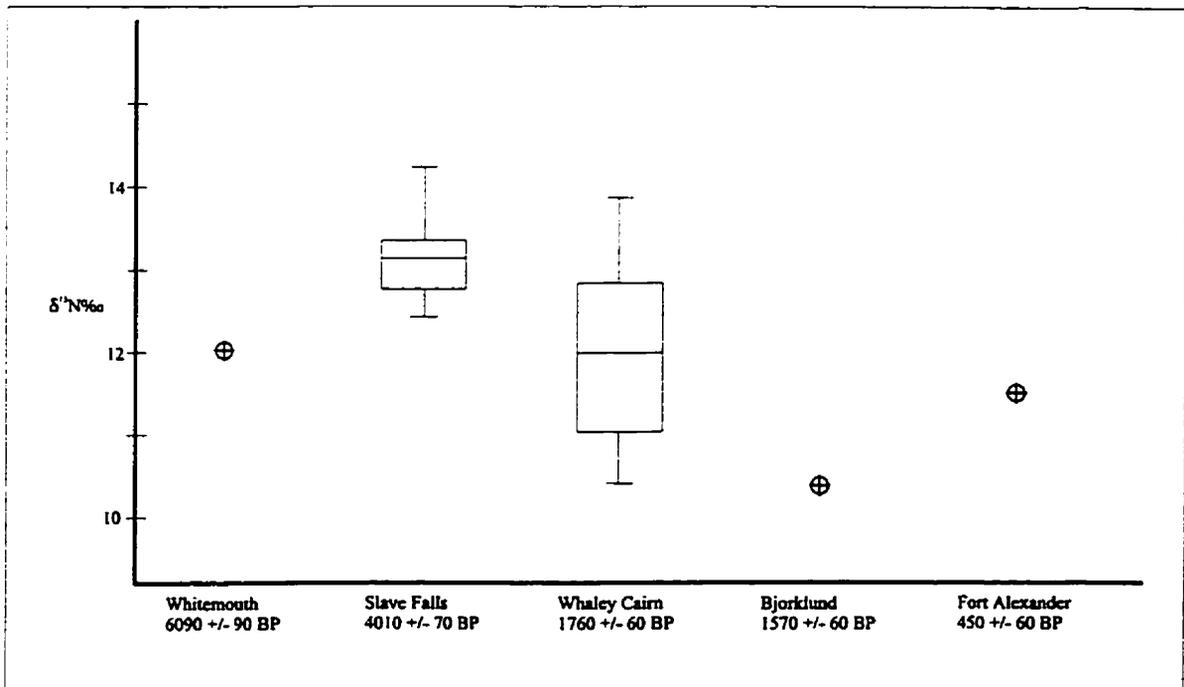


Figure 6.6 -  $\delta^{15}\text{N}$  Values by Site Arranged Chronologically

that the later, less specialised groups, adapted from the earlier groups. The slight changes to their subsistence strategies reduced risk while still utilising the same technology. Therefore, three basic subsistence strategies seem to be used in the prairie fringe of southeastern Manitoba: a boreal aquatic strategy, a plains and/or boreal terrestrial resource strategy, and a mixed aquatic-terrestrial strategy. The latter represents a historic, fur trade-influenced strategy.

A major focus in this chapter was intra-regional variation and paleoenvironmental reconstruction using stable nitrogen and carbon data. From the isotopic data it is apparent that ecosystem diversity in the study region is considerable. It is my opinion that this reflects subsistence variation. The Winnipeg River region is a fairly small yet diverse ecoclimatic region. The variety of resources in the region offers numerous subsistence strategies. The differences between these strategies can be detected isotopically only when the micro-regional variation and climatic changes over time are appreciated. Unfortunately, the tested biotic sample size was too small (and had too many modern members) to establish micro-regional  $\delta_3$  and  $\delta_4$  averages and ranges. However, sufficient data were collected to produce weighted  $\delta$  values for a fair range of resource categories. The use of summed weighted  $\delta$  values for the available data provides evidence that the dietary resources of the prairie fringe of southeastern Manitoba were used selectively. It appears that the major split in subsistence strategy in the Winnipeg River region occurred between boreal forest oriented groups who relied primarily on fish as their source of protein, and those groups who relied primarily on terrestrial mammals. There is evidence that truly mixed subsistence strategy exploiting aquatic, terrestrial, boreal and plains resources may be the result of European post-contact

influences.

Furthermore, this study has demonstrated the possibility that  $\delta^{13}\text{C}$  values that indicate some  $\text{C}_4$  enrichment in a diet may not contain any  $\text{C}_4$  foods at all. Indeed, since higher caloric foods contribute more of their  $\delta^{13}\text{C}$  signature to the overall diet and, thus, the isotope values in bone collagen, they tend to skew carbon values possibly producing results that are more  $\text{C}_4$ -like than would otherwise be expected. It is important, therefore, to attempt to reconstruct diets using weighted food isotope values in order to test the calculated percentages of  $\text{C}_4$  foods in diets.

## **CHAPTER 7**

### **Conclusion**

The prairie fringe of southeastern Manitoba, as defined in this study, consists of the tall grass prairie, aspen parkland and mixed deciduous and coniferous forest ecoclimatic zones. This is a region of considerable biotic diversity. Each zone has its own particular biotic makeup, yet, there is considerable overlap of resources between the zones. The resource diversity of the region can support multifarious subsistence strategies. The archaeological record attests to the numerous populations that have inhabited this region, and the range of their exploitation strategies. Subsistence strategies have ranged from predominantly plains-oriented strategies exploiting bison to very unspecialised strategies exploiting a myriad of animals.

Although there has been archaeological research in the Winnipeg River region aimed at reconstructing the subsistence strategies of various archaeological complexes, there are significant gaps in the data that require the use of assumptions and analogies. One historical analogy frequently applied in archaeological contexts is the “seasonal round” in which groups of people move to one location at a particular time of year to exploit a particular resource then move to another location another part of the year to exploit a different resource (Syms 1977). However, seasonal rounds can vary between groups depending on the familiarity of the group with the resources and the required technology.

In this study, I attempted to test the degree of variability in the diets of the people

represented at five sites in the prairie fringe of southeastern Manitoba. Fort Alexander, Slave Falls, Whaley Cairn, Bjorklund and Whitemouth Falls are the five burial sites located along the Winnipeg River that basically coincides with the prairie fringe in southeastern Manitoba. The general hypothesis tested is that subsistence strategies were more restricted than has often been assumed by the seasonal round analogy. Rather, groups may be differentiated into boreal aquatic-oriented groups, boreal terrestrial-oriented groups, or plains-oriented groups. Although the sample size in this study is too limited to draw firm conclusions, this hypothesis has been, more or less, confirmed.

The methodology used to reconstruct the palaeodiets in this study was multidisciplinary. The most conclusive evidence was derived from stable carbon and nitrogen isotope data, and dental palaeopathological analysis, however, historical and archaeological information also were used. Reference to other archaeological dietary studies is rare since the burials sites in this study (except for Fort Alexander) did not have diagnostic artifacts with which to identify the archaeological associations; thus, comparisons with archaeological studies of specific archaeological phases were not useful. The empirical and interpretative aspects inherent in my model are summarised below.

Based primarily on stable isotope analysis, the subsistence strategies represented by the human remains from the five Winnipeg River sites, generally, do appear to be quite restricted, but the orientations of the groups are different than originally hypothesised. The greatest division between subsistence strategies appears to be between aquatic resource exploiters (i.e., fishers) and terrestrial resource exploiters (i.e., hunters). The terrestrial resource exploiters are further subdivided between boreal-parkland-oriented hunters and

plains-oriented hunters. This tripartite model for the southeastern Manitoba region, however, must be further tested for confirmation.

The historic record is frequently used for historic and proto-historic evidence of socio-economic behaviour of First Nations cultures. Historic documents were examined in this study basically for two reasons: one site (Fort Alexander) is historic and documents are available that provide certain dietary information directly associated with that region; and, general trends with regards to trading, travelling and diet in the Winnipeg River region can be gleaned from these sources.

The documents show that early in the historic record the Ojibwa, Assiniboine and Cree were known to travel great distances. They were highly receptive to new environs, technologies, trade alliances and dietary sources. This receptiveness during the post-European contact era infers that Native groups prior to contact probably were equally flexible. Indeed, many historians comment on the adaptability of many Native groups (Friesen 1984; Lytwyn 1986; Ray 1974).

Despite claims for general diversification, it is germane to re-emphasise that not all groups behave in the same manner even if part of the “same” cultural group. Some populations may maintain much of their subsistence strategies over time while others diversify their subsistence pursuits. For example, at Brandon House during the 1790s the predominant trade item was bison, yet the Rainy River Ojibwa were singly renown for bringing in beaver and wolf furs, as well as bison, in keeping with their forest-oriented subsistence strategy (HBCA B.22/a/1-3). Conversely, there are a number of cases where plains, or plains/parkland-oriented groups (eg., Plains Cree, Assiniboine and the Bungi/Plains

Ojibwa) relying heavily on bison were initially forest-oriented groups (eg., Woodland Cree, Assiniboine and Ojibwa) who relied heavily on fish and moose.

Intra-regional ecozone exploitation differences also seem to play a role in subsistence strategy variation. There are instances of groups with very similar subsistence strategies inhabiting a similar econiche, but exploiting slightly different resources (whether for reason of micro-regional variation or dietary preference). For example, according to post journals, Fort Alexander did not exploit deer while further upstream at Portage de l'Isle deer were one of the primarily dietary resources.

For Fort Alexander specifically, post journals indicate that some local groups with the addition of European trade goods from the post had a very small territory for seasonal rounds. Within a fairly confined area, the inhabitants of the Fort Alexander area could exploit fish year round, beaver and moose seasonally (although beaver seemed to be preferable), ducks and geese, bears, muskrats, sturgeon and harvest wild rice.

The archaeological record can counter discrepancies found in the historic documentation, but it requires sound archaeological proveniences. The burials from this study lack the diagnostic artifacts to identify the appropriate archaeological cultures to which they belong. However, burials are specialised sites that may yield cultural information using methods other than relative associations based on diagnostic artifacts.

Possible archaeological associations for each burial site were tenuously based on AMS radiocarbon dates. Although AMS dates are not the preferred method of establishing associations, there was other evidence at each site that supported the AMS dates. The Whitemouth Falls site may be associated with an Oxbow or Mummy Cave-Oxbow transition

phase based on an association of an Oxbow point in or near the lining of the burial. According to the AMS date and the stratigraphy of the burials, the Slave Falls site may be an Old Copper, Oxbow or a McKean component; however, the locale of the Slave Falls site and the burial type favours an Old Copper phase association. The Whaley Cairn burial is noteworthy in that the cairn structure is similar to Besant or Pelican Lake phase cairns, but the area was predominated by Laurel groups and many fish (i.e., a predominant faunal remain at Laurel sites) were contained within the burial. Thus, the Whaley Cairn burials may represent a transitional subsistence strategy phase, where the Besant are moving into Laurel (forest) territory and learning to exploit fish as a staple, or where the Laurel are demonstrating the influences of encroaching plains/parkland (Besant) culture. In either case, the cairn structure may have served as a boundary marker as well as a burial structure. Based on the presence of many Laurel components at the site, the Bjorklund site probably represents a Laurel burial although a Besant association cannot be ruled out. The most recent site is the Fort Alexander site representing a Cree or Ojibwa historic burial. The only other archaeological evidence with regards to identification of archaeological associations or subsistence strategy from the above burial sites was extracted from a comparison of the mortuary customs demonstrated at the sites.

The comparison of mortuary customs between sites is somewhat reminiscent of Lowie's (1988:133) concept of cultural "survivals" whereby a cultural trait persists from one cultural generation to another. Thus, tenuous links may be made between sites that use common traits. For example, there may be a cultural link between the historic Cree/Ojibwa burials at Fort Alexander and the Middle Woodland/Plains Woodland (i.e., Laurel or Besant)

burial at Bjorklund based upon the placement of a lithic or gunflint at the elbow of the deceased. However, this tenuous connection is only based on a single mortuary custom.

After considering a number of mortuary traits simultaneously, connections between Fort Alexander, Slave Falls and Bjorklund sites may also be made. These sites all contained ochred primary extended burials with the head oriented to the west. The Whitemouth Falls burial shared the fewest mortuary traits although it shares certain traits with the Whaley Cairn and Bjorklund burials (i.e., ochred primary flexed skeletons with head orientation in directions other than west). The inclusion of the Bjorklund site in both groups may be indicative of another transitional culture phase where the Laurel are moving further out of the forests and into the parkland/grassland zone. Thus, based on provisional available archaeological evidence, both the Whaley Cairn and Bjorklund burials may be representative of archaeological cultures in the state of subsistence transitions. The dental palaeopathological evidence, though tenuous due to small sample size, supports a connection between the Fort Alexander and Slave Falls sites, but refutes the a connection between Whaley Cairn and Bjorklund.

A number of studies have demonstrated that the value of dental palaeopathological evidence for discriminating between horticulturalists and hunter-gatherer societies (Larsen et al. 1991; Milner 1984; Molnar 1971; Patterson 1984; Turner 1979), but few studies have addressed the question of distinguishing intra-subsistence strategy variation. In this study, certain trends were observed that may differentiate hunter-gatherer subsistence strategies. Generally, the dental pathologies present at all five sites are typical of hunter-gatherer groups (specifically, low caries and low calculus frequencies). However, some interesting trends are

apparent in site by site comparisons.

In a comparison between sites, two basic trends in the data were observed: 1) a group of sites with moderate caries, calculus and periodontal disease; and 2) a group of sites with low to moderate caries, and calculus but high rates of tooth fractures. Included in the first group are Fort Alexander, Slave Falls and Whaley Cairn sites, and in the second Bjorklund and Whitemouth Falls. This grouping of sites is congruous with their basic ecoclimatic settings of woodland and plains, respectively. A number of interesting hypotheses emerge from these data. For example, it is argued here that the lower rates of caries and calculus but higher rates of tooth fractures in the plains group is due to a reliance on more fibrous plants and sinewy meats. The higher rate of caries, calculus and periodontal disease amongst the woodland individuals is caused by a heavy reliance on wild rice (i.e., a sticky and possibly sclerotic food if not properly prepared). If there is a relationship between a reliance on wild rice as a staple and moderate rates of caries, calculus and periodontal disease, the Slave Falls site (i.e., an Archaic site) may provide evidence of the earliest exploitation of wild rice. Currently extensive wild rice harvesting is believed to have commenced circa 1150 BP (Dyck 1983:126).

A further distinction can be made between Whaley Cairn and Slave Falls sites. Although many of the dental pathologies between the woodland sites are similar, the rates of trauma are not. Whaley Cairn individuals had a higher rate of antemortem trauma than Slave Falls possibly concomitant with slightly different subsistence and/or labour strategies between the two groups. There is little relationship between the results of the dental analysis and that of the mortuary traits. Since dental pathologies are more directly related to diet than

are mortuary customs more weight is given to the results of the dental evidence. The results of the dental analysis, however, were further tested by stable carbon and nitrogen results.

The stable isotope data provide the most direct and quantitative evidence of diet. However, in order to reconstruct diets using stable isotope analysis, it is first necessary to provide stable isotopic values for local flora and fauna (i.e., food resources). Two of the main sources of food in the Winnipeg River region are fish and terrestrial mammals. The data reported in this study show a distinction between the stable isotope values for aquatic and terrestrial resources, as well as, between terrestrial plains mammals and terrestrial woodland mammals in a  $C_3$  environment. Given these distinctions the isotopic variability between the human samples must reflect some dietary preference if the current theory is correct. Unfortunately, there are limited rules for reconstructing diets in  $C_3$  environments because regional variation plays a decidedly important role in stable isotope values. In order to reconstruct diets under these conditions, dietary resources (preferably archaeological) must be evaluated against baseline values.

Financial constraints limited the number of flora and fauna samples tested in this study. Other food classes required to establish baseline data for stable isotopic analysis are fowl, birds, maize and more mammals. Despite the lack of data on these biota, some general trends are noted for distinguishing between various types of subsistence strategies, but only when both, carbon and nitrogen, isotopes are analysed. Generally, diets consisting of very high proportions of fish have high  $\delta^{15}N$  values and low  $\delta^{13}C$  values (eg., Slave Falls). Any addition of terrestrial meats tends to lower the  $\delta^{15}N$  values. If the added meat source derives its food from a forest environment, the  $\delta^{13}C$  value in the human diet will remain relatively

the same as that of a person subsisting on fish (eg., Whaley Cairn and Fort Alexander); but if the meat source derives its food from the grasslands, the human  $\delta^{13}\text{C}$  will be higher (eg., Bjorklund). Of course these trends all depend on the nutritive qualities of the foods (i.e., the fats, protein and calorie content), and the percentage of each type of food eaten. Thus, if an individual's diet were to consist of 50% plains mammal proteins compared to a diet of 30-40% forest mammal proteins, the stable isotope values may be situated between those of fish-eaters and mixed parkland/plains meat-eaters. This scenario is demonstrated by the hypothetical diet of the Whitemouth Falls individual compared to the diets of the individuals from the other sites.

Stable isotope analysis augments the dental palaeopathological evidence for subsistence reconstructions. The stable nitrogen and carbon data not only groups Fort Alexander, Slave Falls and Whaley Cairn burials together (as did the dental evidence), it demonstrates their reliance on fish as the primary source of protein. Moreover, it can be used to draw finer distinctions between groups relying on varying proportions of the same foods as well as different food sources.

Based primarily on dental pathologies and stable isotope analysis, it is argued that three basic subsistence strategies were used in the Winnipeg River region prior to European contact: 1) diets predominated by fish protein (eg., Slave Falls and Whaley Cairn); 2) diets consisting primarily of forest and parkland animal proteins (eg., Bjorklund); and 3) diets predominated by plains animal proteins, specifically bison (eg., Whitemouth Falls). Unfortunately, the small sample size and limited numbers of biota tested in this study prohibits conclusive claims about the percentages of certain foods in the diets of the groups

represented at the five burial sites. However, there is sufficient evidence to suggest further testing of the Winnipeg River model and stable isotope analysis in  $C_3$  environments could greatly advance palaeodietary studies.

The need for more definitive and quantitative analyses in the field of palaeodietary reconstruction is demonstrated herein. It is apparent that the wide range of fauna exploited during the seasonal round as demonstrated throughout the European fur trade is possibly a post- or proto-European contact phenomenon. According to the reconstructed diets in this study, there is a trend of subsistence adaptation over time where very specialised diets during the Archaic period (i.e., Whitemouth Falls and Slave Falls) were replaced by slightly more diversified diets during the Middle Woodland/Plains Woodland period (i.e., Bjorklund and Whaley Cairn). The dietary diversity observed for the Middle Woodland period, however, is considerably less diverse than that suggested by the hypothetical reconstructed diet of the individuals from the historic Fort Alexander site.

Admittedly, the trend towards resource diversification could have continued and increased from the Middle Woodland to the historic past. Indeed, the hypothesis of a solely post-contact seasonal round directly conflicts with many archaeological studies. There is some evidence in historic documents, however, that supports the view that dietary variation created by the seasonal round was not as great as is initially perceived. For example, according to a reconstruction of travel distances from Fort Alexander post journals, local groups stayed relatively close to the post relying on very few near-by dietary resources. Even within this fairly small catchment area some animals were not hunted — such as, deer that were not usually hunted at Fort Alexander but were hunted at the neighbouring post of

Portage de l'Isle. Therefore, to prove the case for increased food resource diversity over time, materials for the period between that represented by the Whaley Cairn and Slave Falls sites to the post-European contact era are needed for isotopic analysis. Unlike subsistence studies based on archaeological data, stable isotope analysis provides definite and direct evidence of diet that abrogates biota mistakenly accepted as a dietary items.

### **7.1 Summary of Significant Methodological Findings in Stable Isotopic Analysis of the Prairie Fringe**

To date, most stable isotope research conducted in Canada has focussed on the rise of horticulture and the subsequent use of maize (i.e., a  $C_4$  plant) as a dietary staple. The use of maize as a dietary staple is believed to be readily detected using stable isotope analysis. Percentages of  $C_4$  foods in diets are often calculated in such studies. This study indicates that the  $C_4$  percentage calculations for diets are far too simplistic and possibly erroneous in some cases. It has been demonstrated that hypothetical diets consisting of all  $C_3$  foods often yield a  $C_4$  component. This biased  $C_4$  percentage may occur via foods that contribute unequally to human collagen stable isotope values or through meats from animals that ate some  $C_4$  components. In order to better represent palaeodiets, I argue that summed weighted values be used instead of, or in conjunction with,  $C_4$  percentage calculations, and that at least both, carbon and nitrogen, isotopes be used in studies.  $C_4$  dietary percentages are only valuable as a comparative measure in diachronic studies for populations known to be related. There are a number of other problems in stable isotope research that must be addressed.

The accumulation of stable isotope values for regional (and micro-regional) biota is

fundamental to isotope studies. This study indicates that stable isotope values are region-specific, therefore, baseline data must be established for each study area. It is apparent that  $\delta^{13}\text{C}$  values decrease as latitudes north increase. Furthermore, since the variation in stable isotope values for food classes in  $\text{C}_3$  environments are small (especially for carbon), it is necessary to eliminate as much confounding data as possible. Efforts to test archaeological as opposed to modern biota is important to alleviate the burden of estimating modern contaminants, such as carbon-dioxide emissions and fertilizers, which vary from region to region. Also, the use of general averages for  $\text{C}_3$  and  $\text{C}_4$  plants (i.e.,  $\delta_3$  and  $\delta_4$ ) are insufficient when researching within a  $\text{C}_3$  environment. However, regional averages would be very difficult and costly to collect. Yet, researchers should keep in mind that general averages for plants may skew the results.

It is germane to re-emphasise that stable isotopic values obtained from bone collagen represent long-term averages. Bone collagen has a turn-over rate (i.e., the rate of new bone replacing old bone) of ten (10) years depending on an individual's age and health; therefore, stable isotope values of collagen represent an individual's average diet for approximately a ten year period. This averaging effect will also tend to over-represent predominant food sources and underestimate more rare foods. Stable isotope values of bone carbonates can correct this problem since carbonates are replaced in bone at a much faster rate. However, apatite values are also susceptible the diagenic influences and must be used cautiously. Unfortunately, the carbonate data was not received in time for incorporation of this data into this study.

## **7.2 Subsistence Strategy Summary for the Prairie Fringe of Southeastern Manitoba**

Based primarily on stable carbon and nitrogen isotope, and dental palaeopathological analyses of human remains from five burial sites along the Winnipeg River, a model for subsistence strategies used in prairie fringe of southeastern Manitoba from circa 5000 BC to 1800 AD is proposed. I argue that groups in the Winnipeg River region may be divided into aquatic-oriented subsistence strategists and terrestrial strategists. The two-fold division can be further subdivided into three basic subsistence strategies that were adhered to in the prairie fringe: 1) a predominantly fish-oriented diet; 2) a forest/parkland terrestrial mammal-oriented diet; and 3) a plains terrestrial mammal-oriented diet. Furthermore, there appears to be a trend towards greater dietary resource diversity over time. Archaic diets were highly specialised while Middle Woodland diets tended to be more diversified. The range in dietary resources, however, is not as diverse as that of the seasonal round that is suggested by many archaeologists and historians. It is possible that the seasonal round is a post-European contact phenomenon. However, the sample size of this study is small and stable isotope analysis for this region is in its formative stages. Much research is required in this area before valid conclusions can be drawn.

**Appendix I**  
**Faunal Resources by Ecoclimatic Region**  
(Jones et al. 1983; Scott and Crossman 1973; Banfield 1974; Kortright 1967)

| <b>Plains Fauna</b>                                  | <b>Habitat/Behaviour</b>                     | <b>Food</b>   |
|--|--|---|
| <i>Sylvilagus floridanus</i><br>(Eastern Cottontail) | mesic riparian; active year-round            | legumes, grasses, stems, shoots of shrubs; twigs, buds and bark in winter |
| <i>Lepus townsendii</i><br>White-tailed Jackrabbit   | open plains; riparian in severe winters      | grasses, herbs; buds, shoots and bark in winter                           |
| <i>Antilocapra americana</i><br>Pronghorn            | dry prairie                                  | browsers of sagebrush and forbs; some grass                               |
| <i>Bison bison bison</i>                             | plains, grasslands and grassland transitions | short, medium and tall grasses; some sagebrush                            |

| <b>Woodland Fauna</b>  | <b>Habitat/Behaviour</b>   | <b>Food</b>   |
|--|--|---|
| <i>Lepus americanus</i><br>(Snowshoe Hare)   | wooded areas   | grasses, herbs; buds, shoots and bark in winter (affect sapling population)   |
| <i>Marmota monax canadensis</i><br>Woodchuck; Wejack<br>(Algonkian); Wenusk (Cree) | deciduous, boreal and mixed forests; hibernate Oct. to March                             | grasses and forbs   |
| <i>Castor canadensis</i><br>Beaver   | ponds, rivers, lakes; some prairie riparians   | willows, cottonwoods, alders, grasses and greens  |
| <i>Erethizon dorsatum</i><br>American Porcupine                                    | deciduous and coniferous forests   | leaves of forbs, shrubs and trees, yellow pond lily, aspen, white birch, clover, corn; in winter tree cambium, twigs and buds |
| <i>Urocyon cinereoargenteus</i><br>Gray Fox  | forest, woodland, rocky or bush country  | mainly birds and fruit; squirrels, eggs, rodents (except mice); rabbits more in winter  |
| <i>Ursus americanus</i><br>Black Bear  | heavily wooded forests and riparian areas; pseudo-hibernators Nov. to April              | omnivorous: fruit and almost anything organic   |
| <i>Procyon lotor</i><br>Raccoon  | woods near water; preferably hardwood areas near oak, elm, sycamores; pseudo-hibernators | fruits, nuts, grains, insects, crayfish, mollusks and small vertebrates (eg. rodents and birds)                               |

| Woodland Fauna                      | Habitat/Behaviour  | Food  |
|-------------------------------------|--|---|
| <i>Alces alces</i><br>Moose         | boreal forests and aspen-birch parkland; home range 15 sq. miles | mainly browsers of stems, bark and leaves of conifers, deciduous trees and shrubs but also eat grasses, sedges and aquatic plants           |
| <i>Rangifer tarandus</i><br>Caribou | boreal forest and tundra   | browse leaves, buds and bark of deciduous and conifer trees; eat grasses, sedges, horsetails, mushrooms and terrestrial and arboreal lichen |

| Multi-ecosystem Fauna  | Habitat/Behaviour   | Food  |
|--|---|---|
| <i>Ondatra zibethicus</i><br>Muskrat; Musquash (Cree)  | marshlands and lakes  | roots, bulbs and stems of cattails, bulrushes, lilies, pond weeds and other aquatic plants; clams, snails, fish, frogs and crayfish |
| <i>Canis latrans</i><br>Coyote   | grasslands, badlands, bush and woodlands  | mainly carnivorous (almost any meats), eggs, insects and fruit  |
| <i>Canis lupus</i><br>Wolf   | most ecosystems   | bison (when prevalent=symbiotic), rabbits, hares, deer, moose, elk, caribou, beaver, small rodents, fruit                           |
| <i>Vulpes vulpes</i><br>Red Fox  | bushy meadowland fringes of deciduous and coniferous forests; riparian in semi-deserts          | largely carnivorous: rabbits, hares and mice mainly; birds, insects, fish, crayfish, fruit  |
| <i>Ursus arctos</i><br>Grizzly Bear  | riparian woodlands of open plains but also most ecosystems; pseudo-hibernators Oct. to May      | omnivorous: carrion-eaters, fish, rodents, grubs, roots, grass, bark, mushrooms   |
| <i>Cervus elaphus</i><br>(6 out of 10 Pleistocene subspecies are extinct)<br>Wapiti, Elk, red deer | preferably open areas (pastures, meadows, prairies and aspen parkland), some coniferous forests | mainly grass and forb grazers but also browse   |
| <i>Odocoileus hemionus</i><br>Mule Deer  | wooded areas, open plains and transition zones; not migratory                                   | mainly woody plant browsers but also graze grasses and forbs; corn  |
| <i>Odocoileus virginianus</i><br>White-tailed Deer   | preferably woodlands, forest edges, riparian areas but in many ecosystems                       | largely browsers: acorns, corn, leaves, stems, buds and bark but region dependent; also eat grasses, forbs, fungi                   |

| Multi-ecosystem Fauna                        | Habitat/Behaviour                                       | Food   |
|--|---|--|
| <i>Sciurus carolinensis</i><br>Gray Squirrel | grassland transitions with oak, maple, basswood forests | nuts, seeds, fruit, buds, leaves, flowers, bark and some insects |

| Fluvial Fishes  | Migration/Spawning  | Water Depths/ Food  |
|---|---|---|
| <i>Hiodon tergisus</i><br>Mooneye, Toothed Herring                              | migrate upstream in large clear streams; spawn during April to June                     | shallow-feeders: mainly aquatic and terrestrial insects; small fish, molluscs, crayfish, plankton |
| <i>Platygobio gracilis</i><br>Flathead chub, Saskatchewan dace                  | moves from turbid main channels into smaller streams during mid or late summer to spawn | predaceous: mainly aquatic and terrestrial insects but also some small fish and rodents           |
| <i>Moxostoma anisurum</i><br>Silver Redhorse, Silver mullet, white-nosed sucker | prefer slow-current rivers; spawn in main channel rivers                                | bottom-feeders: immature insects (chironomids, ephemeropterids, trichopterids)                    |

| Lacustrine Fishes  | Migration/Spawning  | Water Depths /Food   |
|--|---|--|
| <i>Salvelinus namaycush</i><br>Lake Trout                        | usually spawn in same lake (some move to rivers) in October | predaceous deep water: other fishes (especially ciscoes), invertebrates, freshwater sponges, crustaceans, aquatic and terrestrial insects, small mammals, plankton |
| <i>Coregonus artedii</i><br>Cisco, Lake Herring, Tullibee        | move to shallow water to spawn around November              | mid-water: plankton, zooplankton, <i>Daphnia</i> and <i>Diaptomus</i> nymphs, insects and larvae, fish eggs  |
| <i>Coregonus nigripinnis</i><br>Blackfin Cisco or Tullibee       | November to January   | large lake deep-water: cestodes (particularly <i>Triaenophorus crassus</i> )   |
| <i>Coregonus zenithicus</i><br>Shortjaw Cisco, Paleback Tullibee | November to December  | deep-water: <i>Pontoporeia hoyi</i> , <i>Mysis relicta</i> , plankton, aquatic insect larvae   |
| <i>Coregonus clupeaformis</i><br>Lake Whitefish                  | shallow water spawners in November to December              | bottom-feeder: aquatic insect larvae, molluscs, amphipods, invertebrates, small fishes, "planktonic creatures,"  |

| Lacustrine Fishes   | Migration/Spawning  | Water Depths /Food   |
|---|---|--|
| <i>Ictalurus nebulosus</i><br>Brown Bullhead, Marbled Bullhead, Brown Catfish, common Catfish, Barbotte brune | spawn late spring to summer in shores of lakes or bays; otherwise found in shallow warm-water ponds, small lakes and bays of larger lakes | near bottom-feeding omnivores: offal, waste, molluscs, immature insects, terrestrial insects, leeches, crustaceans, plankton, worms algae, fish, fish eggs |
| <i>Ambloplites rupestris</i><br>Rock Bass, Redeye   | inhabits rocky areas of shallow lakes and spawn in swamps and shoals in June  | deep shallow lake feeders: : mainly insects, crayfish, small fish  |
| <i>Pomoxis nigromaculatus</i><br>Black Crappie, Grass Bass, Shiner, Moonfish                                  | inhabit clear, warm, still small lakes, bays of larger lakes and low-flow rivers near vegetation; spawn May to July in shallow water      | diet variable to size and season: fish, , insects  |
| <i>Perca flavescens</i><br>Yellow Perch, Lake Perch   | inhabit warm to cool open water lakes with moderate vegetation; spawn April to May in lake shallows and tributaries                       | mid to bottom-feeders: immature and mature insects, molluscs, small fish, fish eggs  |
| <i>Stizostedion canadense</i><br>Sauger, Sand Pickerel, Grey Pike Perch                                       | prefer large shallow turbid lakes; spawn May to June in shoals of turbid lakes and rivers   | mid-feeders: mainly fish (gizzard shad, trout-perch, white bass, drum, crappie, chubs), immature insects   |

| Lacustrine/Fluvial Fishes   | Migration/Spawning  | Feeding Depths / Food  |
|---|---|--|
| <i>Acipenser fulvescens</i><br>Lake Sturgeon                                    | migrate up to 250 miles from lakes to rivers May to June to spawn   | bottom-feeders: crayfish, molluscs, insect larvae, nymphs, fish eggs, nematodes, leeches, amphipods, decapods, and rarely fish and plants              |
| <i>Salmo gairdneri</i><br>Rainbow/Steelhead Trout                               | migrate from lakes or rivers to nearby tributaries or streams to spawn April to June  | bottom-feeders but occasionally surface: plankton, larger crustaceans, insects, insect larvae, snails, leeches   |
| <i>Hiodon alosoides</i><br>Goldeye, Yellow Herring                              | winters in deeper lakes and rivers; move to turbid rivers, ponds and lakes from May to July to spawn                                  | summer shallow-feeders/deeper in winter: surface and aquatic insects, crustaceans, molluscs, small fishes, frogs, small rodents                        |
| <i>Esox lucius</i><br>Northern Pike, Jackfish, Great Northern Pickerel, Brochet | prefer clear warm weedy river and lake bays; largely sedentary; spawn April to May in densely vegetated rivers, marshes and lake bays | Shallow to mid-feeders: rapacious piscivorous omnivores, mainly fish, any available vertebrate it can swallow (frogs, crayfish, mice, muskrats, ducks) |

| <b>Lacustrine/Fluvial Fishes</b>   | <b>Migration/Spawning</b>   | <b>Feeding Depths / Food</b>   |
|--|---|--|
| <i>Catostomus catostomus</i><br>Longnose Sucker, Sturgeon Sucker, Northern Sucker, Meunier rouge | move from lake bottoms upstream May to April to spawn   | bottom-feeders: invertebrates (amphipods, trichopterids, chironomid larvae and pupae, ephemeropterids, etc.), plants   |
| <i>Catostomus commersoni</i><br>White Sucker, Common Sucker, Mullet, Meunier noir                | move from lake bottoms upstream May to June to spawn  | bottom-feeders: believed to be fish eggs   |
| <i>Moxostoma macrolepidotum</i><br>Shorthead Redhorse, Northern Redhorse, Red Sucker             | move from shallow clear lakes to smaller rivers to spawn in May   | bottom-feeder: insects (ephemeropterids, trichopterids, etc.), molluscs and crustaceans  |
| <i>Ictalurus punctatus</i><br>Channel Catfish, Spotted Catfish, Lake Catfish                     | inhabit cool, clear deeper water of lakes and mid to large rivers; may or may not migrate to rivers during April to June                                    | bottom-feeders with some surface foods: mainly fish (minnows and yellow perch), mayflies, caddisflies, chironomids, molluscs, crayfish, crabs, green algae, water plants, tree seeds         |
| <i>Micropterus dolomieu</i><br>Smallmouth Bass   | found in moderately shallow lakes and rivers near slopes and shoals; spawn near old nests near rocks, logs or vegetation of lakes and rivers in May to July | surface and bottom-feeders: crayfish, fish, insects, plankton  |
| <i>Stizostedion vitreum</i><br>Walleye, Pickerel, Yellow Pike, Doré                              | most abundant in large, turbid, shallow lakes; spawn April to June preferably in white water below falls and dams in rivers                                 | bottom-feeders: yellow perch and drum mainly, almost any other fish (rainbow smelt, ciscoes, stickleback, suckers, etc.), crayfish, snails, frogs, mudpuppies, small mammals, rarely insects |

| <b>Aquatic Birds</b>                     | <b>Migratory Zones</b>  | <b>Food</b>   |
|--|---|---|
| <i>Branta canadensis</i><br>Canada Goose | Winter inland and on coasts next to fresh and salt water.             | Mainly vegetable (terrestrial & surface aquatic); wild rice, grains, sedges, aquatic plants; insects, larvae, crustaceans, small molluscs |
| <i>Anas platyrhynchos</i><br>Mallard     | Fresh open water; winters in the lower Mississippi valley and Florida | Shallow-water feeders: mostly seeds and plants, acorn, grains, salmon, mosquitos  |

|   |   |   |
|---|---|---|
| <i>Chaulelasmus streperus</i><br>Gadwall            | Fresh open water; winters in the lower Mississippi valley and Mexico                              | Shallow-waters of slough and marshes: sedges, grasses, grains, pond weeds; few bugs and larvae  |
| <i>Mareca americana</i><br>Baldpate                 | Winters in southern coastal US and Mexico   | Mud and shallow-water feeders: pondweeds, grasses, algae, sedges; some molluscs & insects   |
| <i>Dafila acuta tzitzihoa</i><br>American Pintail   | Winters in southern coastal US and Mexico   | Shallow-water marsh feeders: mostly aquatic vegetation; few crustaceans and insects   |
| <i>Nettion carolinense</i><br>Green-Winged Teal     | Winters along the Mississippi valley and southern States, mostly inland but some coastal retreats | Bottom-feeders of shallow marshes and sloughs: acorn, nuts, pondweeds, grasses, algae few insects and molluscs                                  |
| <i>Querquedula discors</i><br>Blue-Winged Teal      | Mostly interior US wintering grounds; seldom on sea coasts  | Very shallow-water feeder of muddy ponds, ditches and creeks: wild rice, grains, sedges, grasses; more animal food than most: molluscs, insects |
| <i>Spatula chrypeata</i><br>Shoveller               | Remains on fresh-water systems; winters mostly in southern west US coast and Mexico               | Bottom-feeders: seeds (grasses, sedges lilies), algae; 1/3 non-vegetal foods: molluscs, bugs, larvae, fishes, "bottom-ooze"                     |
| <i>Nyroca americana</i><br>Redhead                  | Winters mainly in Mexico  | Deepwater vegetation: pondweeds and grasses; few molluscs   |
| <i>Nyroca collaris</i><br>Ring-Necked Duck          | Fresh-water birds that winter in Florida and Louisiana  | Water-lilies, pondweeds and sedges; 1/5 insects and molluscs  |
| <i>Nyroca valisineria</i><br>Canvas-Back            | Winters mostly along the western coast of the US  | Pondweeds, wild celery, grasses, sedges, molluscs, insects, fishes  |
| <i>Nyroca affinis</i><br>Lesser Scaup Duck          | Mostly inland fresh-water birds but some do winter along southern US coasts                       | Largely vegetarians but do scavenge animal remains: sedges, pondweeds, grasses  |
| <i>Glaucionetta clangula</i><br>American Golden-Eye | Winter across the central US  | 3/4 carnivorous: crustaceans, insects, molluscs, fishes; pondweeds, wild celery, grains and bulrushes   |
| <i>Charitonetta albeola</i><br>Buffle-Head          | Open, fresh-water, inland winters of the southern States  | 4/5 carnivorous: insects, crustaceans, molluscs, fishes, pondweeds  |

|  |   |  |
|--|---|--|
| <i>Mergus merganser</i><br>American Merganser    | Both fresh and salt water visitors; winter in the central States        | Aquatic animal eaters: fish, fish-eggs, insects and crustaceans; |
| <i>Mergus serrator</i><br>Red-breasted Merganser | Winter along the western coast of US or from the Great Lakes to Florida | Fish-eaters  |
| <i>Erismatura jamaicensis</i><br>Ruddy Duck      | Winter along the western coast of the US and into Mexico                | Mainly plant-eaters: pondweeds, bulrushes, wild celery           |

**Appendix II  
Individual Remains Summary**

| <b>Whaley Cairn EbKx-10</b>       |                |            |                               |                       |   |                   |
|-----------------------------------|----------------|------------|-------------------------------|-----------------------|---|-------------------|
| <b>Feature/Ind</b>                | <b>Rand. #</b> | <b>Sex</b> | <b>Age</b>                    | <b>Complete/Cond</b>  | <b>Skull/Mand</b>                                 | <b>δ/DNA(AMS)</b> |
| *XU1/I1                           | DE-23          | M          | 44.3±6.6                      | Yes/Good              | Y/Y   | Y/Y (MMMN)        |
| *XU1/I2                           | DE-11          | F          | 33.7±7.7                      | Yes/Good              | Y/Y   | Y/Y               |
| *XU2F1/I1                         | DE-15          | M          | 20-35                         | No/Good<br>Cremation  | N/N   | Y/Y               |
| *XU2F1/I2                         | DE-16          | Ind(F?)    | 8 ± 2                         | No/Good               | Y/Y   | Y/Y               |
| *XU2F1/I3                         | DE-18          | Ind(F?)    | >24                           | No/Poor               | N/N   | Y/Y               |
| *XU2F1/I4                         | DE-19          | F          | 18-24                         | No/Poor               | N/N   | Y/Y               |
| *XU2F1/I5                         | DE-26          | F          | 35-39                         | No/Poor               | N/N   | Y/Y(MMMN+)        |
| *XU2F1/I6                         |                | Ind(F?)    | 16-21                         | No/Poor<br>Cremation  | N/N   | N/N               |
| *XUF2/I1                          |                | Ind        | Perinate<br>36-38wks<br>gest. | No/Poor<br>with ochre | N/N   | N/N               |
| <b>Misc. Skulls and Mandibles</b> |                |            |                               |                       |   |                   |
| <b>Skull No.</b>                  | <b>Sex</b>     | <b>Age</b> | <b>Complete/Cond</b>          | <b>Skull/Mand</b>     | <b>Comments</b>                                   |                   |
| **"Whaley 1"                      | M              | 51±12.6    | No/Poor                       | Y/Y                   |   |                   |
| "Whaley 2"                        |                |            |                               |                       | Renamed & provenienced as F2I1                    |                   |
| **"Whaley 3"                      | Ind(M?)        | 27-38      | No/Poor                       | Y/Y                   |   |                   |
| "Whaley 4"                        |                |            |                               |                       | Renamed F2I2                                      |                   |
| **"Whaley 5"                      | Ind(F?)        | 28-44      | No/Poor                       | Y/N                   | no dentition                                      |                   |
| **"Whaley 6"                      | F              | 34.7±7.8   | No/Good                       | Y/N                   | Was recorded as F2I1 but mismatched; no dentition |                   |
| **"Whaley B"                      | F              | >25        | Yes/Good                      | N/Y                   |   |                   |
| <b>Misc. Vertebral Columas</b>    |                |            |                               |                       |   |                   |
| <b>Column No.</b>                 | <b>Sex</b>     | <b>Age</b> | <b>Complete/Cond.</b>         | <b>Comments</b>       |   |                   |
| *Vert 1                           | Ind(F?)        | Ind        | No/Poor                       |                       |   |                   |
| *Vert 2                           | Ind(M?)        | >30        | No/Poor                       |                       |   |                   |
| *Vert 3                           | Ind            | < 7        | No/Poor                       | Ass. with F2I6 & F2I2 |   |                   |

| <b>Fort Alexander (FA3)</b>       |         |         |                              |               |  |                     |
|-----------------------------------|---------|---------|------------------------------|---------------|--|---------------------|
| Burial/Ind                        | Rand. # | Sex     | Age                          | Complete/Cond | Skull/Mand                                       | δ/DNA(AMS)          |
| *B1I1                             | DE-12   | F       | 15 ± 3                       | No/Good       | Y/Y  | Y/Y(Y)              |
| *B1I2                             | DE-27   | Ind     | Perinate<br>32-34wk<br>gest. | No/Poor       | Y/Y  | Y/N<br>no dentition |
| *B2I1                             | DE-13   | Ind(M?) | 12-36mos                     | Yes/Good      | Y/Y  | Y/Y                 |
| *B2I2                             | DE-25   | Ind(F?) | 2-4                          | No/Good       | Y/Y  | Y/Y(Y)              |
| "Ind 4"<br>Ind. Prov.             |         | Ind(F?) | ~25                          | No/Excellent  | N/N  | N/N                 |
| <b>Misc. Skulls and Mandibles</b> |         |         |                              |               |  |                     |
| Skull No.                         | Sex     | Age     | Complete/Cond.               | Skull/Mand    | Comments   |                     |
| FA3-409                           | F       | 30-50   | No/Poor                      | Y/N           | Indeterminate provenience;<br>no dentition       |                     |
| FA3-410                           | M       | 40-65   | Yes/Excellent                | Y/N           | Indeterminate provenience                        |                     |
| FA3-411                           | F       | 25-40   | Yes/Excellent                | Y/N           | Indeterminate provenience                        |                     |
| FA3-412                           | F       | 12-15   | Yes/Good                     | Y/N           | Indeterminate provenience                        |                     |
| FA3?B2?                           | Ind     | 1-3     | No/No                        | Y/N           | Indeterminate provenience;<br>stored with FA3B2s |                     |

| <b>Slave Falls EbKv-34</b> |         |         |        |               |            |            |
|----------------------------|---------|---------|--------|---------------|------------|------------|
| Feature/Ind                | Rand. # | Sex     | Age    | Complete/Cond | Skull/Mand | δ/DNA(AMS) |
| *F1I1                      | DE-24   | M       | 37±10  | No/Good       | N/Y        | Y/Y(Y)     |
| *F1I2                      | DE-14   | Ind(M?) | 12-17  | No/Good       | Y/N        | Y/Y        |
| *F1I3                      | DE-6    | Ind     | 10±2.5 | No/Good       | Y/Y        | Y/Y        |
| *F2I1                      | DE-7    | Ind     | 10±2.5 | No/Good       | N/Y        | Y/Y        |
| *F3I1                      | DE-9    | M       | 35-50  | No/Good       | Y/N        | Y/Y        |
| *F3I2                      | DE-1    | F       | 30-50  | No/Good       | Y/Y        | Y/Y        |
| *F3I3                      | DE-20   | Ind(M?) | >25    | No/Poor       | N/N        | Y/N        |
| *F3I4                      |         | Ind     | 9-11   | No/Poor       | N/N        | N/N        |

| <b>Whitemouth Falls EaLa-1</b> |                |            |            |                      |                   |                   |
|--------------------------------|----------------|------------|------------|----------------------|-------------------|-------------------|
| <b>Individual</b>              | <b>Rand. #</b> | <b>Sex</b> | <b>Age</b> | <b>Complete/Cond</b> | <b>Skull/Mand</b> | <b>δ/DNA(AMS)</b> |
| *Z25                           | DE-4           | F          | 33-55      | Yes/Excellent        | Y/Y               | Y/Y(Y)            |
| *Z35                           |                | M          | 22-30      | No/Poor              | N/N               | N/N               |

| <b>Bjorklund EaLa-3</b> |                |            |            |                      |                   |                   |
|-------------------------|----------------|------------|------------|----------------------|-------------------|-------------------|
| <b>Individual</b>       | <b>Rand. #</b> | <b>Sex</b> | <b>Age</b> | <b>Complete/Cond</b> | <b>Skull/Mand</b> | <b>δ/DNA(AMS)</b> |
| *Z17                    | DE-8           | F          | 40-55      | Yes/Poor             | Y/Y               | Y/Y(Y)            |
| *"Ind 2"                |                | Ind        | <5         | No/No                | N/N               | N/N               |

#### **Age Categories**

(Modified Buikstra et al. 1994:36; Schentag and Meiklejohn 1985)

Perinate pre-term to 3 months post-term; Infant <2 years; Child 2-6 years; Juvenile 6-12 years;  
Adolescent 12-18 years; Young Adult 18-34 years; Middle Adult 34-49 years; Old Adult 50+ years

\* Indicates the 33 individuals studied. Although approximately 60 "individuals" were recovered from these five burial site, many individuals are represented by only single bones or teeth some of which may belong together. The 41 individuals listed here are represented by multiple elements that could be assigned to a specific individual.

### Appendix III Aging and Sexing Methods

#### Sexing

Generally, aging was determined using morphoscopic methods on all individuals, but the information was only included if the individuals were adolescents or older. More weight was placed on pelvic structures and cranial traits. The following is a listing of the methods used.

- Pelvis: Phenice (1969);  
Pre-auricular sulcus (Brothwell 1981; Ubelaker 1978)  
Sciatic Notch (Houghton 1974; Krogman 1973)  
Weighted multiple characteristics (Buikstra and Ubelaker 1994; Ferembach et al. 1980)
- Skull: Weighted multiple characteristics (Ascádi and Nemerskéri 1970; Novotny 1986; Ubelaker 1978)

#### Aging

For the most part morphoscopic techniques were used unless otherwise required. The techniques used were as follows:

- Perinates: Long bone length (Scheuer et al. 1980)
- Infants to Juveniles: Patellar, tibial tuberosity, os trigonum of calcaneus epiphyseal appearance (Garn et al. 1967)  
Dental development (Gustafson and Koch 1974; Ubelaker 1989)
- Adolescents: Epiphyseal fusion (McKern and Stewart 1957; McKern 1970)  
Sacral segment fusion (McKern n.d. in Steele and Bramblett 1988)  
Dental development (Gustafson and Koch 1972; Ubelaker 1989)
- Adult:<sup>1</sup> Epiphyseal fusion (McKern and Stewart 1957; McKern 1970)  
Basilar suture closure (Ubelaker 1989)  
Sacral segment fusion (McKern n.d. in Steele and Bramblett 1988)  
Pubic symphysis (McKern and Stewart 1957)  
Ectocranial sutures closure (Meindl and Lovejoy 1985)

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<sup>1</sup> Frequently dental attrition is used to assess age (Lovejoy 1985); however, since differences in wear patterns between groups having different subsistence strategies is expected in this study, dental attrition was not used as an age indicator.

## Aging Summary

### Whaley Cairn

XU1/I1 (44.3 ± 6.6 yr.)  
 Dental - all erupted >20  
 Epiphyses - fused >25  
 S1-S2 - fused >30  
 Ectocranial - 44.3 ± 6.6

XU1/I2 (33.7 ± 7.7 yr.)  
 Dental - all erupted >20  
 Epiphyses - fused >25  
 S1-S2 - unfused <30  
 Pubic symphysis - 33 ± 7.7  
 Ectocranial - indeterminate

XU2F1/I1 (20-35 yr.)  
 Dental - n/a  
 Epiphyses - radius fused >20  
 S1-S2 - unfused (poss. heat fracture) <30  
 Pubic - n/a  
 Ectocranial - n/a  
 Pathology - osteoarthritis = middle adult

XU2F1/I2 (8 ● 2 yr.)  
 Dental - M1 erupted;  
           M2 and C in crypt - 7-9 yr.  
 Epiphyses - unfused;  
           no innominate fusion 6-12

XU2F1/I3 (>24 yr.)  
 Dental - n/a  
 Epiphyses - long bones well fused >24  
 S1-S2 - n/a  
 Pubic - n/a  
 Ectocranial - n/a  
 S1-S2 - n/a  
 Auricular surface - 22 ● 2 yr.  
 Ectocranial - n/a

XU2F1/I4 (18-24 yr.)  
 Dental - n/a  
 Epiphyses - 60% iliac crest 18-20 yr.  
           lines visible:  
                   proximal tibia ~22  
                   distal femur ~21

XU2F1/I5 (37 ± 2 yr.)  
 Dental - n/a  
 Epiphyses - iliac crest just visible >22  
 S1-S2 - n/a  
 Auricular surface - 37 ● 2 yr.  
 Ectocranial - n/a

XU2F1/I6 (16-21 yr.)  
 Dental - n/a  
 Epiphyses - ischial crest 16-22;  
           proximal humerus 16-20;  
           iliac crest 18-21;  
           medial clavicle 16-18

Whaley 1 (51 ● 12.6 yr.)  
 Dental - all erupted >20  
 Ectocranial - 51.5 ± 12.6

Whaley 3 (27-38 yr.)  
 Ectocranial -  $\bar{x}$  = 31.5

Whaley 5 (28-44 yr.)  
 Ectocranial -  $\bar{x}$  = 35.5

Whaley 6 (34.7 ± 7.8)  
 Ectocranial -  $\bar{x}$  = 31.5

Whaley B (>25)

Dental - all erupted in wear &gt;25

**Fort Alexander**FA3B1I1 (16-18 yr.)

Dental - mandibular M3 in crypts, M2 in wear &gt;15

Basilar suture - unfused ~16

Epiphyses - distal radius ~17; distal ulna ~17

80% proximal femur &lt;20

S4-S5 - 90% fused 17-22

S3-S2 - 50% fused 16-18

FA3B1I2 (32-34 wk. gestation)

Long bone lengths - 32.75 wk. gest.

FA3B2I1 (12-36 months)

Dental - incisors to m1 erupted;

m2 erupting; M1 in crypt (12-36 mos.)

FA3B2I2 (3 ± 1 yr.)

Dental - incisors to m2 erupted;

M1 in crypt; M2 crypt only

(3 ± 1 yr.)

Epiphyses - frontal fused &gt;2 yr.

**Slave Falls**F1I1 (37 ± 10 yr.)

Epiphyses - all fused &gt;24

S1-S2 - fused &gt;30

Pubic - 37 ± 10 yr.

F1I2 (12-17 yr.)

Dental - M3 in crypt 12-16 yr.

Epiphyses - prox. tibia present 9-14 yr.

ischium/Pubis fused 6-12 yr.

acetabulum unfused &lt;15

os trigonum unfused &lt;13

acromion present 14-17 yr.

F1I3 (10 ± 2.5 yr.)

Dental - mandibular M1 erupted; M2 in crypt

maxillary m1 and m2 present; M1 erupted

(9-10 yr. ± 30 mos.)

Epiphyses - acetabulum &lt;15;

prox. tibia present 9-14;

os trigonum &lt;13

F2I1 (10 ± 2.5 yr.)

Dental - m2 present; M1 erupting;

M2 in crypt (9-10 yr.)

Epiphyses - prox. tibia present 9-14;

os trigonum &lt;13;

patella buds &gt;6; tibial

tuberosity not developed ~9

F3I1 (35-50 yr.)

Dental - all erupted &gt;20

Epiphyses - fused &gt;25

S1-S2 - n/a

Ectocranial - 40-47

Pathology - osteoarthritis mid-adult

F3I2 (30-50 yr.)

Dental - all erupted &gt;20

Epiphyses - all fused &gt;25

S1-S2 - 80% fused 17-30

Ectocranial - 41 ± 10 yr.

Pathology - severe osteoarthritis &gt;30

F3I3 (>25)

Dental - n/a

Epiphyses - ulna, radius, humerus, fibula &gt;22

Pathology - osteoarthritis &gt;25

**Whitemouth**Z25 (33-55 yr.)

Dental - all erupted &gt;20

Epiphyses - all fused &gt;25

Pubic -  $39 \pm 7$  yr.Ectocranial -  $\bar{x} = 41.4$  with parietal thinning  
and pitting

Pathology - osteoarthritis level 2-3

**Bjorklund**Z17 (40-55 yr.)

Dental - all erupted &gt;20

Epiphyses - all fused &gt;25

S1-S2 - 100% fused &gt;30

Ectocranial -  $45.5 \pm 8.9$ F3I4 (9-11 yr.)

Dental - n/a

Epiphyses - prox. ulna <14;  
acetabulum <14

Ulna length - 9-11 (Meiklejohn)

Z35 (22-30 yr.)Epiphyses - trace ischial & iliac crest;  
femur well fused >22Pubic -  $24 \pm 2$  yr.Ind 2 (<5 yr.)

Epiphyses - thoracics unfused &lt;5

**Appendix IV**  
**1997 Radiocarbon CAMS Dates for Human Bone Collagen (XAD-Gelatin)<sup>1</sup>**

| Site                   | Rand # | NSRL Lab # | mg C Dated | Fraction Modern        | CAMS BP Date ( $\pm 1$ st. d.) | Intercepts Calc. Method ( $2\sigma$ ) | Prob. Dist. Method ( $2\sigma$ ) | Calibration Curve            | Calibrated Calendar Date |
|------------------------|--------|------------|------------|------------------------|--------------------------------|---------------------------------------|----------------------------------|------------------------------|--------------------------|
| Fort Alexander (FA3B1) | DE-12  | 3129       | 1.34       | 0.9695 $\pm$<br>0.0063 | 250 $\pm$ 60                   | 1609-1695 AD<br>1727-1813 AD          | 1478-1702 AD                     | Steep;<br>no inversions      | 1660 AD<br>1780 AD       |
| Fort Alexander (FA3B2) | DE-25  | 3130       | 1.40       | 0.9457 $\pm$<br>0.0062 | 450 $\pm$ 60                   | 1558-1631 AD                          | 1397-1532 AD                     | Steep;<br>no inversions      | 1440 AD<br>1620 AD       |
| Bjorklund              | DE-8   | 3127       | 1.44       | 0.8222 $\pm$<br>0.0055 | 1570 $\pm$ 60                  | 384-640 AD                            | 389-638 AD                       | Flat;<br>3 inversions        | 450 AD                   |
| Whaley Cairn (XU2F1)   | DE-26  | 3126       | 1.41       | 0.8032 $\pm$<br>0.0054 | 1760 $\pm$ 60                  | 129-422 AD                            | 132-417 AD                       | Fairly flat;<br>2 inversions | 290 AD                   |
| Slave Falls (F1)       | DE-24  | 3125       | 1.23       | 0.6068 $\pm$<br>0.0049 | 4010 $\pm$ 70                  | 2641-2397 BC                          | 2643-2288 BC                     | Steep;<br>2 inversions       | 2480 BC                  |
| Whitemouth Falls       | DE-4   | 3128       | 0.97       | 0.4687 $\pm$<br>0.0050 | 6090 $\pm$ 90                  | 5260-4787 BC                          | 5220-4698 BC                     | Steep;<br>1 inversion        | 5010 BC                  |

<sup>1</sup> Calib 3.0.3c, Dataset 2: Decadal tree-ring dataset (0-7050 cal. yr. BP) was used to calibrate the CAMS dates to  $2\sigma$ . I would like to thank Dr. Tom Stafford and the Institute of Arctic and Alpine Research for providing the CAMS dates, and Dr. Scott Hamilton and Sandra Pentney for aiding in the calibration of the dates.

**Appendix V**  
**Previous Radiocarbon Dates**

| Site             | Sample No. | Date         | Director        | Sample Type     |
|------------------|------------|--------------|-----------------|-----------------|
| Whitemouth Falls | Gak-6494   | 6350±110 BP  | Buchner '76     | human collagen  |
| Whitemouth Falls | Gak-6493   | 6070±110 BP  | Buchner '76     | human collagen  |
| Whitemouth Falls | Gak-4248   | 2910±150 BC? | Steinbring ?    | bison collagen  |
| Whitemouth Falls | GX-4416    | 2675±150 BC? | Buchner ?       | bison collagen  |
| Whitemouth Falls | GX-4415    | 1455±175 BC? | Buchner ?       | bison collagen  |
| Bjorklund        | GX-4145    | 3125±135 BP  | Buchner '76     | moose collagen  |
| Bjorklund        | GX-4147    | 3105±150 BP  | Buchner '76     | bison collagen  |
| Bjorklund        | GX-4149    | 890 ±130 BC? | Buchner ?       | bison collagen  |
| Bjorklund        | Gak-4713   | 800 ±95 BC?  | Buchner ?       | bison collagen  |
| Bjorklund        | GX-4144    | 2705±120 BP  | Buchner '76     | bison collagen  |
| Whaley Cairn     | F111-13128 | 1840±60 BP   | Hist. Res. '89? | human collagen  |
| Whaley Cairn     | F215-13283 | 1840±60 BP   | Hist. Res '89?  | human collagen  |
| Bjorklund        | Gak-5447   | AD 690 ±80?  | Steinbring ?    | human collagen  |
| Bjorklund        | GX-3603    | 1230±155     | Saylor '74      | Feat 6 charcoal |
| Bjorklund        | GX-4142    | 922 ±125 BP  | Buchner '76     | animal collagen |
| Bjorklund        | GX-4143    | 900 ±105 BP  | Buchner '76     | animal collagen |
| Bjorklund        | GX-4146    | 735 ±120 BP  | Buchner '76     | animal collagen |
| Bjorklund        | GX-4712    | AD 1330±75?  | Buchner ?       | collagen?       |

| <b>Calibrated Dates for Human Collagen Radiocarbon Dates</b> |                             |                     |                     |   |                                 |
|--|-----------------------------|---------------------|---------------------|---|---------------------------------|
| <b>Site</b>  | <b>Sample No.</b>           | <b>Year Assayed</b> | <b>RC (BP) Date</b> | <b>Intercepts Calc. Method (2<math>\sigma</math>)</b> | <b>Calibrated Calendar Date</b> |
| Bjorklund  | GX3603<br>(Feat 6 Charcoal) | 1974                | 1230 $\pm$ 155      | 658-987 AD  | 768 AD                          |
| Bjorklund  | Gak-5447                    | ?                   | AD690<br>$\pm$ 80   | 671-883 AD  | 776 AD                          |
| Whaley Cairn   | F111-13128                  | post-<br>1989       | 1840 $\pm$ 60       | 65-343 AD   | 215 AD                          |
| Whitemouth Falls   | Gak-6493                    | 1976                | 6070 $\pm$ 110      | 5253-4751 BC  | 4946 BC                         |
| Whitemouth Falls   | Gak-6494                    | 1976                | 6350 $\pm$ 110      | 5447-5050 BC  | 5274 BC                         |

**Appendix VI**  
**Dental Inventory and Conditions Scoring Scheme**

**#1 - Age Category (Buikstra and Ubelaker 1994; Schentag and Meiklejohn 1985)**

|                            |                                 |
|----------------------------|---------------------------------|
| Old Adult (50+ years)      | Juvenile (6-12 years)           |
| Middle Adult (34-49 years) | Child (2-6 years)               |
| Young Adult (18-34 years)  | Infant (< 2 years)              |
| Adolescent (12-18 years)   | Perinate (pre-term to 3 months) |
| 9=Missing value            |                                 |

**#2 - Inventory (modified Buikstra and Ubelaker 1994:49)**

- 0=Missing value; antemortem or postmortem loss unknown; unobservable
- 1=Present, but not in occlusion
- 2=Present, development completed, in occlusion
- 3= Missing, with no associated alveolar bone
- 4=Missing, with alveolus resorbing or fully resorbed: antemortem loss
- 5=Missing, with no alveolar resorption: postmortem loss
- 6=Missing, congenital absence
- 7=Present, damage renders measurement impossible, but other observations are recorded
- 8=Present, but unobservable (eg. Deciduous or permanent tooth in crypt)
- 9=Missing, deciduous tooth naturally lost antemortem
- 10= Missing, age prior to crypt development

**#3 - Development (Patterson 1984:50 after Moorees et al. 1963a)**

|  |                              |
|--|------------------------------|
| 1=Initial cusp formation                                       | 8=Initial cleft formation    |
| 2=Coalescence of cusps   | 9=Root length $\frac{1}{4}$  |
| 3=Cusp outline complete  | 10=Root length $\frac{1}{2}$ |
| 4=Crown $\frac{1}{2}$ complete                                 | 11=Root length $\frac{3}{4}$ |
| 5=Crown $\frac{3}{4}$ complete                                 | 12=Root length complete      |
| 6=Crown complete   | 13=Apex $\frac{1}{2}$ closed |
| 7=Initial root formation                                       | 14=Apex closed               |
| 99=Missing value; tooth missing; not observable; indeterminate |                              |

**#4 - Occlusal Wear (Total) (Buikstra and Ubelaker 1994:52-53; Scott 1979; Smith 1984)**

| Degree | Incisors/Canines   | Premolars   | Molars   |
|--------|--|---|--|
| 99     | No information available (not occluding, unerupted, indeterminate, antemortem or postmortem loss). |   |  |
| 1      | Unworn to polished or small facets (no dentine exposure).  |   | Wear facets invisible or very small.   |
| 2      | Point or hairline of dentine exposure.   | Moderate cusp removal (blunting).                                   | Wear facets large, but large cusps still present and surface features very evident. It is possible to have pinprick size dentine exposures or dots which should be ignored. This is a quadrant with much enamel.                                   |
| 3      | Dentine line of distinct thickness.  | Full cusp removal and/or moderate dentine patches.                  | Any cusp in the quadrant area is rounded rather than being clearly defined as in 2. The cusp is becoming obliterated but is not yet worn flat.   |
| 4      | Moderate dentine exposure no longer resembling a line.   | At least one large dentine exposure on one cusp.                    | Quadrant area is worn flat (horizontal) but there is no dentine exposure other than a possible pinprick sized dot.   |
| 5      | Large dentine area with enamel rim complete.   | Two large dentine areas (may be slight coalescence).                | Quadrant is flat, with dentine exposure $\frac{1}{4}$ of quadrant or less. (Be careful not to confuse noncarious pits with dentine exposure.)  |
| 6      | Large dentine area with enamel rim lost on one side or very thin enamel only.                      | Dentinal areas coalesced, enamel rim still complete.                | Dentine exposure great: more than $\frac{1}{4}$ of quadrant is involved, but there is still much enamel present. If the quadrant is visualised as having three sides the dentine patch is still surrounded on all three sides by a ring of enamel. |
| 7      | Enamel rim lost on two sides or small remnants of enamel remain.                                   | Full dentin exposure, loss of rim on at least one side.             | Enamel is found on only two sides of the quadrant.   |
| 8      | Complete loss of crown, no enamel remaining; crown surface takes on shape of roots.                | Severe loss of crown height; crown surface takes on shape of roots. | Enamel on only one side (usually outer rim) but the enamel is thick to medium on this edge.  |
| 9      |  |   | Enamel on only one side as in 8, but the enamel is very thin - just a strip. Part of the edge may be worn through at one or more places.   |
| 10     |  |   | No enamel on any part of quadrant - dentine exposure complete. Wear is extended below the cervicoenamel junction into the root.  |

**#5 - Wear Direction** (Patterson 1984:376-377; Molnar 1971:175-179)

- 9=Tooth missing, not observable, indeterminate
- 1=Natural form
- 2=Oblique, buccal to lingual
- 3=Oblique, lingual to buccal
- 4=Oblique, mesial to distal
- 5=Oblique, distal to mesial
- 6=Horizontal, perpendicular to the long axis of the tooth
- 7=Rounded, buccal/lingual
- 8=Rounded, mesial/distal

**#6 - Wear Form** (Patterson 1984:377; Molnar 1971:179)

- 9=Tooth missing, not observable, indeterminate
- 1=Natural form
- 2=Flat surface
- 3=One half of surface cupped
- 4=Entire surface cupped
- 5=Notched
- 6=Rounded

**#7 - Caries Type** (modified Buikstra and Ubelaker 1994:55; Moore and Corbett 1971)

- 9=Tooth missing, not observable, indeterminate
- 0=Absent
- 1=Occlusal
- 2=Interproximal (M/D)
- 3=Smooth surface (B/L)
- 4=Cervical (between CEJ and interproximal )
- 5=Radicular (below CEJ)
- 6=Large caries (cannot be designated by a single type)

**#8 - Caries Degree** (Patterson 1984:378-379)

- 9=Tooth missing, not observable, indeterminate
- 0=Absent, sound tooth
- 1=Small lesion, with a small pit or fissure lesion affecting only the enamel. It is generally less than ½ the depth of enamel
- 2=Medium lesion, with an intermediate sized pit or fissure, or, on smooth surfaces, up to moderate size, generally extending to the dentine-enamel junction
- 3=Large lesion, involving the destruction of one half or more of the surface. The lesion is up to half the depth of the dentine and endangers the pulp
- 4=Massive lesion, involving complete destruction of the surface exposing the pulp
- 5=Complete destruction of the crown with the pulp exposed and only the roots remain

**#9 - Caries Surface**

99=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Cusp 1 (mesiobuccal)

2=Cusp 2 (mesiolingual)

3=Cusp 3 (distobuccal)

4=Cusp 4 (distolingual)

5=Cusp 5 (distal - metaconule or hypoconulid)

6=Cusp 6 (next to cusp 5 - entoconulid)

7=Cusp 7 (between cusps 2 and 4)

8=Occlusal

9=Mesial

10=Distal

11=Buccal/Lingual

12=Lingual

**#10 - Calculus Location (Patterson 1984:381)**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Coronal

2=Radicular

3= Both

**#11 - Calculus Surface**

9=Missing value; tooth missing; not observable; indeterminate

M=Mesial

D=Distal

B=Buccal/Labial

L=Lingual

**#12 - Calculus Amount**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Slight (<1 mm)

2=Moderate (1-2 mm)

3=Excessive (2-3 mm)

4=Very excessive (>3 mm)

**#13 - Enamel Hypoplasia Type**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Linear horizontal grooves

2=Linear vertical grooves

3=Linear horizontal pits

4=Nonlinear arrays of pits

5=Single pits

6=Discrete boundary hypocalcification

7=Diffuse boundary hypocalcification

**#14 - Hypoplasia Location**

- in mm from CEJ to most occlusal occurrence

**#15 - Hypoplasia Width**

- of lesion in mm

**#16 - Colour of hypocalcification**

9=Missing value; tooth missing; not observable; indeterminate

1=Yellow

2=Cream/white

3=Orange

4=Brown

5=Other

**#17 - Hypercementosis**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Slight, with expansion of the apical 1/3 of root

2=Moderate, with expansion of the apical half of the root

3=Large, with expansion of more than half of the root

4=Extensive, with expansion of the root completely obliterating the shape of the roots

**#18 - Antemortem Modification (modified Buikstra and Ubelaker 1994:60)**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Aesthetic modification: filling

2=Aesthetic modification: drilling

3=Dental restorations and appliances

4=Dental wear associated with artifact use or production (eg. abrasion, interproximal grooving)

5=Tooth ablation

6=Erosion (eg. acid etching)

7=Trauma (indicate Type)

**#19 - Modification: Trauma Type (Patterson 1984:391)**

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Dilaceration, which is an abnormal angulation of a tooth root in relation to the crown

2=Chipped, the loss of small enamel chips from the margin of the occlusal surface of the tooth

3=Fractured, the loss of a substantial portion of the tooth crown

4=Presence of both chipping and fracturing

5=Crack, without loss of enamel

6=Other

#### #20 - Modification Surface

99=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Cusp 1 (mesiobuccal)

2=Cusp 2 (mesiolingual)

3=Cusp 3 (distobuccal)

4=Cusp 4 (distolingual)

5=Cusp 5 (distal - metaconule or hypoconulid)

6=Cusp 6 (next to cusp 5 - entoconulid)

7=Cusp 7 (between cusps 2 and 4)

8=Occlusal

9=Mesial

10=Distal

11=Buccal/Lingual

12=Lingual

13=Mesiodistal

14=Buccolingual

#### #21 - Alveolar Abscesses (Patterson 1984:380)

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Periapical granuloma. A localised rarefaction of periapical bone, which is limited by a well-defined border of porous spongy bone.

2=Diffuse periapical osteitis. This lesion is characterised by an irregular bony cavity with osteoporotic walls.

3=Apical abscess. This is a chronic proliferative inflammatory reaction. Actually, this category is a lumping of categories 1 and 2, and is utilised when the exact nature of periapical osteitis cannot be determined.

4=Radicular cyst. A smooth walled bone cavity which may have a parchment-like covering that bulges from the bone surface.

5=Apical abscess, which is accompanied by a thinning of the alveolus.

6=Osteitis is present, but its exact nature cannot be determined.

#### #22 - Abscess Aetiology (modified Patterson 1984:380)

99=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Attrition

2=Caries

3=Antemortem fracture of the tooth

4=Periodontal disease

5=1 + 2

6=1 + 3

7=1 + 4

8=2 + 3

9=2 + 4

10=3 + 4

11=3 or more sources

#### #23 - Abscess Location

9=Missing value; tooth missing; not observable; indeterminate

0=Absent

1=Facial

2=Lingual

3=Both facial and lingual

**#24 - Periodontal Fenestrations**

9=Missing value; tooth missing; not observable; indeterminate  
 0=Absent  
 1=Present

**#25 - Periodontal Dehiscence**

9=Missing value; tooth missing; not observable; indeterminate  
 0=Absent  
 1=Present

**#26 - Infradental Resorption**

9=Missing value; tooth missing; not observable; indeterminate  
 0=Absent  
 1=Present

**#27 - Infradental Depth - measured to nearest mm**

99.0=Missing value; tooth missing; not observable; indeterminate

**#28 - Blunting Resorption Rate (Patterson 1984:384)**

9=Missing value; tooth missing; not observable; indeterminate  
 0=Minimal alveolar crest atrophy involving bone loss which exposes less than 2 mm of root surface  
 1=Atrophy of alveolar crest bone involving exposure of the root from just below the margin to exposure of about  $\frac{1}{3}$  the length of the root  
 2=Moderate amount of alveolar crest atrophy involving bone loss which exposes up to half the length of the root (in the molar region, there is exposure of the root bifurcation)  
 3=Large amount of alveolar crest atrophy involving exposure of more than half the length of the root to almost complete loss of bone around the root  
 4=Complete loss of the tooth due to periodontal disease

**#29 - Blunting Measurement**

99.0=Missing value; tooth missing; not observable; indeterminate  
 - measured to the nearest 0.1 mm with calipers from the CEJ to the height of the alveolar margin on the facial aspect over the midline of the root (for molars, taken on the mesial root).

**#30 - Interproximal Septa Inflammation (Patterson 1984:385)**

9=Missing value; tooth missing; not observable; indeterminate  
 0=Absent, with a smooth surface  
 1=Small amount of inflammation, with pitting of the surface  
 2=Moderate amount of inflammation  
 3=Extensive inflammation, with the surface looking like pumice stone

## **Appendix VII**

### **Carbon and Nitrogen Metabolism in Plants and Stable Isotope Analysis**

#### **Carbon Metabolism and Photosynthesis in Plants**

Photosynthesis is a process performed by green plants and certain bacteria (i.e., those organisms containing chlorophyll) whereby the electromagnetic energy of light is converted into chemical energy. As Devlin and Barker (1971:vii) note, "Virtually all life on earth depends on the products of the reactions of photosynthesis which fix carbon dioxide into organic compounds and which free oxygen from water." In 1957, Craig (1957) found that the way in which plants fixed carbon affected the fractionation ratios. It is important, therefore, to understand specific photosynthetic pathways.

#### **The C<sub>3</sub> Pathway (The Calvin Cycle)**

Although there is some debate about how plants convert the carbon found in atmospheric carbon dioxide into the carbon of carbohydrates found in plants (Stiller 1962; Zelitch 1965), the most widely accepted pathway for "fixing" carbon is the Calvin cycle (Figure VII.1) (Devlin and Barker 1971:130-131). The Calvin cycle is divided into three phases: 1) carboxylation, 2) reduction, and 3) regeneration of which phases 2 and 3 occur in light and phase 1 occurs in darkness.

In the Calvin cycle, carbon dioxide (CO<sub>2</sub>) from air is absorbed (accepted by ribulose 1, 5-diphosphate) into the plant. During the first phase (carboxylation), two carboxyl groups<sup>1</sup>

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<sup>1</sup> The basic form of a carboxyl group is -COOH. Carboxylation is the process whereby a hydrogen of a hydrocarbon is replaced with a carboxyl group forming a carboxylic

(i.e., two 3-phosphoglyceric acids or "PGA") and 2 types of enzymes [i.e., adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADPH)] are formed (Devlin and Barker 1971). During the light cycle, PGA is reduced (phase 2) to triose (glyceraldehyde-3-phosphate — a sugar with 3 carbon atoms) and hexoses (6-carbon sugars) that are either changed into polysaccharides (plant starch), or regenerate ribulose 1, 5-

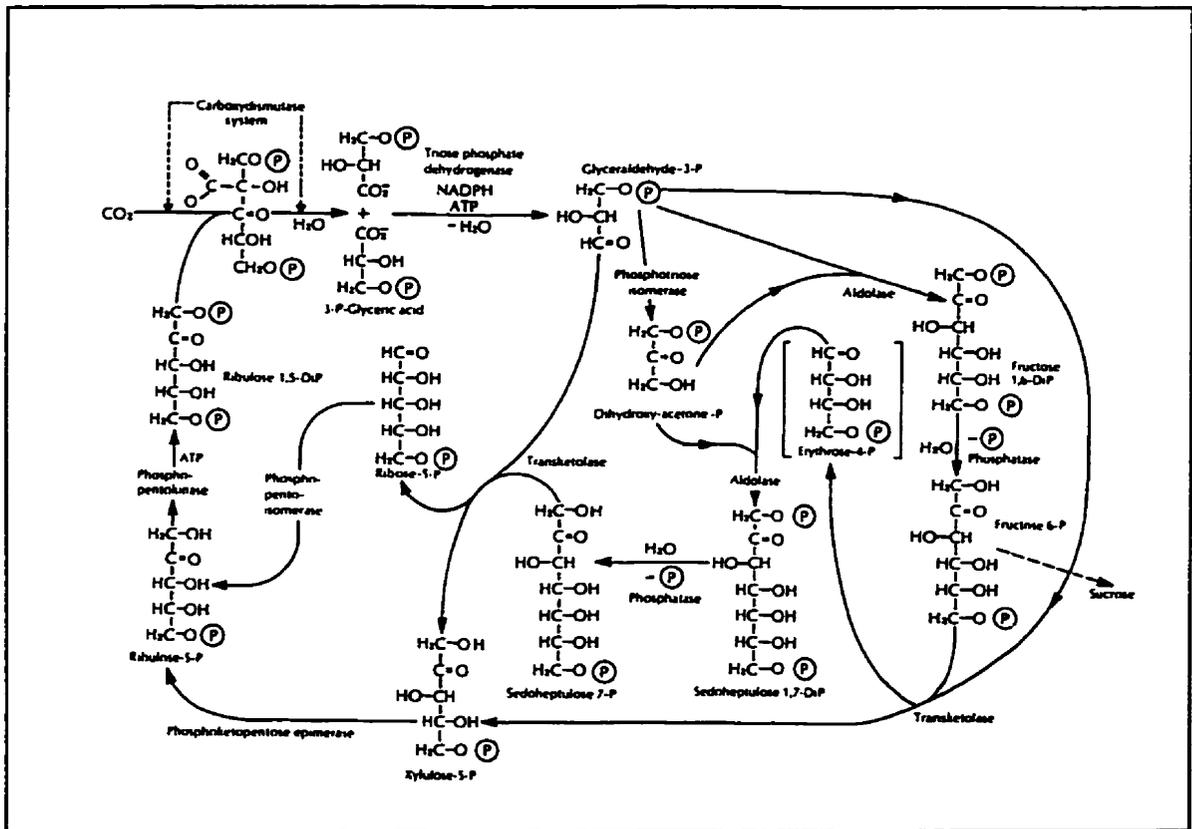
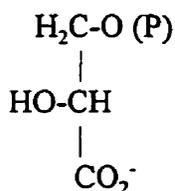


Figure VII.1 - The Calvin Cycle of C<sub>3</sub> Plants (Devlin and Barker 1971:139)

acid.

Carboxylic acids can have numerous carbon atoms in a carbon chain. Carboxylic acids are named by the number of carbons in the chain.

diphosphate (phase three of photosynthesis).<sup>2</sup> Since the first product of photosynthesis is 3-phosphoglyceric acid (PGA) has three carbon atoms (Figure VII.2), the Calvin cycle is also known as the C<sub>3</sub> pathway of plants.



**Figure VII.2 - PGA Molecule**

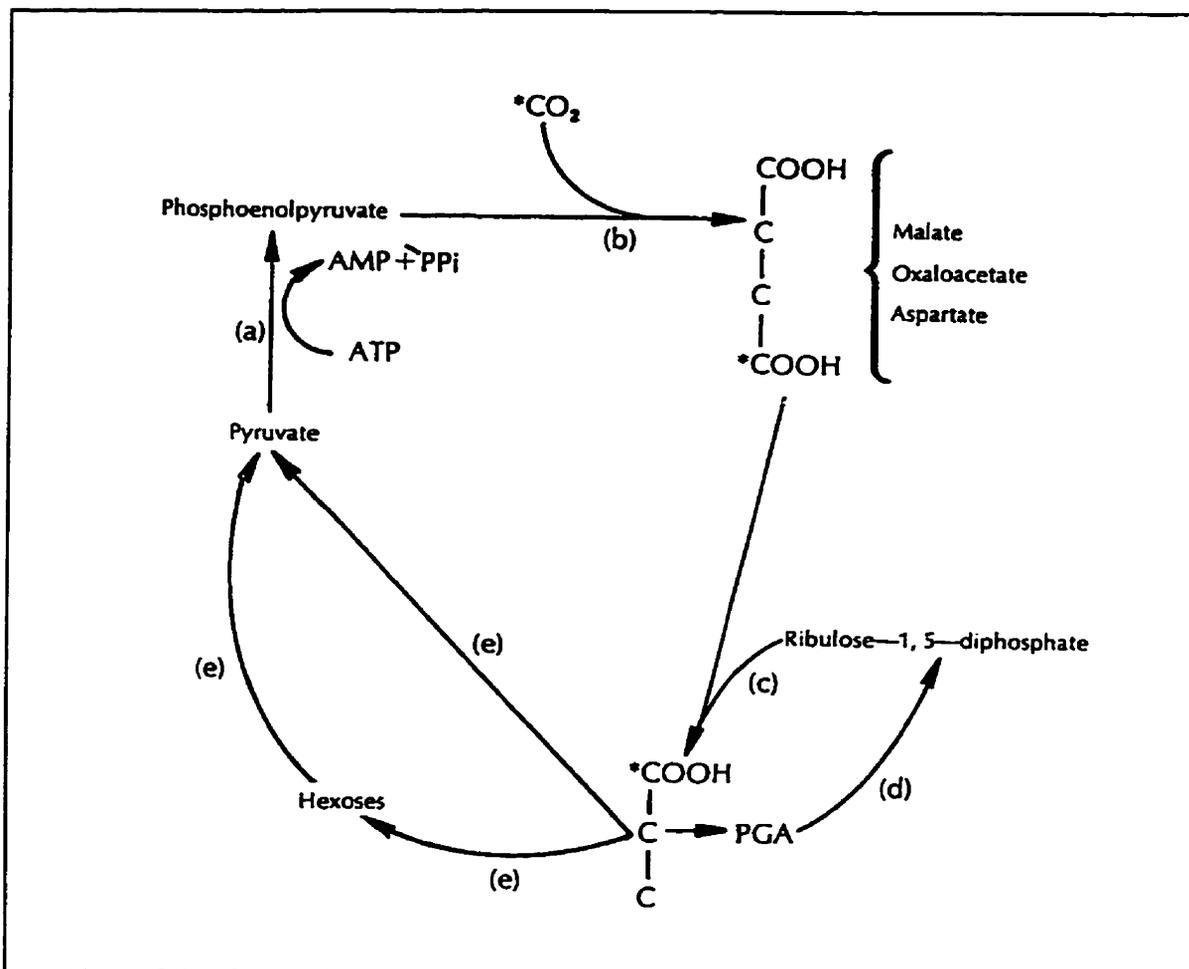
C<sub>3</sub> plants are found largely in North American, Europe and other temperate climates (Sealy 1986:35). This plant group consists of trees, shrubs, temperate grasses, almost all shade plants, and plants in winter rainfall areas. As Sealy (1986:35) explains, “The controlling factor is a combination of radiation and low temperatures during the growing season.”

### **The C<sub>4</sub> Pathway (The Hatch-Slack Pathway)**

The Hatch-Slack, or C<sub>4</sub>-dicarboxylic acid, pathway incorporates the reduction and regenerative phases of Calvin cycle, but absorbs CO<sub>2</sub> and fixes carbon in a different manner (i.e., the C<sub>4</sub> pathway differs from the C<sub>3</sub> pathway in the carboxylation phase). In the Hatch-Slack pathway, phosphoenolpyruvic acid is the acceptor of carbon dioxide which is carboxylised (using phosphoenolpyruvate carboxylase) into C<sub>4</sub>-dicarboxylic acids (i.e., oxaloacetate, malate and aspartate) (Figure VII.3).

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<sup>2</sup> The overall equation of the C<sub>3</sub> pathway is:  
 $3\text{CO}_2 + 9\text{ATP} + 6\text{NADPH} + 6\text{H}^+ + 5\text{H}_2\text{O} \rightarrow \text{Triose-P} + 9\text{ADP} + 8\text{P}_i + 6\text{NADP}$   
 (where P<sub>i</sub> = inorganic phosphate)



**Figure VII.3** - The C<sub>4</sub> Photosynthetic Pathway (Devlin and Barker 1971:149)

At this point transcarboxylase turns these acids into ribulose 1, 5-diphosphate that, in turn, carboxylises into PGA; however, the major carboxylation phase is into the C<sub>4</sub> acids as opposed to the PGA. This could be due to the lack of necessity of the dark cycle of this pathway — indeed, the carboxylation of C<sub>4</sub> acids is enhanced by light which, in the Calvin cycle, inhibits PGA production. As Devlin and Barker (1971:148) explain,

Only with illumination does the [carbon], initially fixed in C-4 or C<sub>4</sub>-dicarboxylic acids, move into the carboxyl group of PGA and subsequently into hexose phosphate.

After PGA is formed, the reduction and regeneration cycle is like that of the Calvin cycle. It has been found that primarily tropical grasses (that have adapted to greater sunlight intensity and less water) use the transcarboxylase reaction (Devlin and Barker 1971:148; Katzenberg and Schwarcz 1986:17). This mechanism increases the efficiency of photosynthetic and metabolic reactions resulting in less fractionation of carbon isotopes, and more positive  $\delta^{13}\text{C}$  values than in  $\text{C}_3$  plants. This distinction between plant types is significant since a number of  $\text{C}_4$  plants are agricultural plants (eg. maize, sugar cane, millet).

### **$\text{C}_3$ Versus $\text{C}_4$ Processes and Structures**

Carbon dioxide fixation and light saturation rates also differ between  $\text{C}_4$  and  $\text{C}_3$  pathways. Generally,  $\text{C}_4$ -dicarboxylic acid grasses (i.e., “tropical” grasses, and *Amaranthus* spp. and *Atriplex* spp.) photosynthesise  $\text{CO}_2$  twice as fast as  $\text{C}_3$  grasses (“temperate” grasses), and have higher light saturation (8000 foot candles or greater for  $\text{C}_4$  plants, and 2500-5000 ft-c for  $\text{C}_3$  plants)(Devlin and Barker 1971:150). However, unlike the glycolate pathway of  $\text{C}_3$  plants, varying concentrations of atmospheric carbon dioxide does not seem to alter the rate of fixing carbon dioxide into  $\text{C}_4$ -dicarboxylic acids. The processes that create these characteristics in each of these plant types are little understood, but they may have ramifications on the structures of the plants.

It is actually possible to distinguish between  $\text{C}_4$  and  $\text{C}_3$  plants by their physical structures. Structurally,  $\text{C}_4$  plants differ from  $\text{C}_3$  plants in leaf anatomy and chloroplast form. Both of these structures appear to affect (or are affected by) the respiration of gases: generally, while  $\text{C}_3$  plants require illumination for gas exchanges (i.e., photorespiration), the

respiration of  $C_4$  plants is inhibited by light (i.e., lack photorespiration).<sup>3</sup> Therefore, due to respiratory effects, grasses can be divided into two basic groups based on their leaf structures: 1)  $C_4$  “tropical” grasses (*Panicoid*), and 2)  $C_3$  “temperate” grasses (*Festucoid*) (Devlin and Barker 1971:206-212). In plants that fix carbon using the  $C_4$ -dicarboxylic acid pathway and lacking photorespiration, a parenchyma bundle sheath (“Kranz type”) is present (Figure VII.4). The parenchyma has a regular arrangement within the mesophyll and is comprised of “chlorenchyma cells [that] are radially-arranged around the vascular bundles” (Devlin and Barker 1971:206; Tregunna et al. 1970:1209).<sup>4</sup> In  $C_3$  plants the chlorenchyma cells are randomly dispersed throughout the mesophyll between the vascular bundles. The arrangement of the parenchyma bundle sheath in  $C_4$  plants thus facilitates the storage of large amounts of starch while also providing for the quick exchange of photosynthetic products needed in environments of high light intensity and periods of water stress (Devlin and Barker 1971:211). Sealy (1986:36) summarises this environmental adaptation as follows,

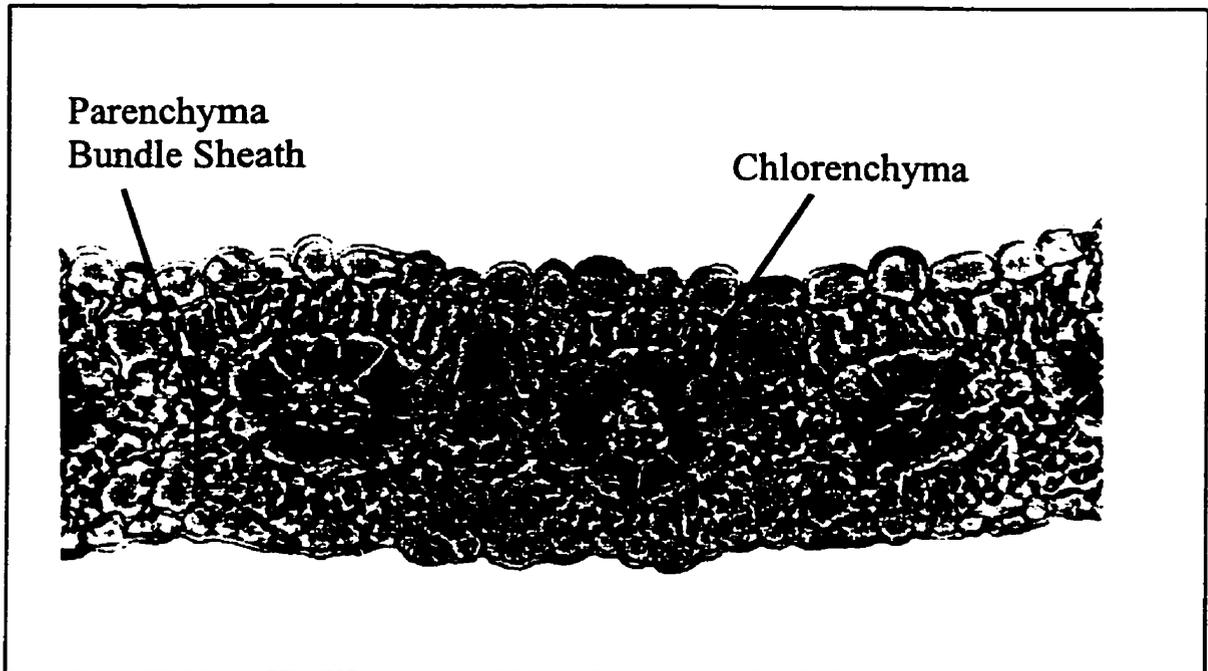
The  $C_4$  pathway thus incorporates the  $C_3$  cycle, but differs in the initial carboxylation step. This is more efficient in  $C_4$  than  $C_3$  plants, and a combination of this factor and a lack of light respiration makes  $C_4$  crops twice or three times as productive as their  $C_3$  counterparts, i.e. they are more efficient converters of atmospheric  $CO_2$  to plant biomass.

It is interesting to note that the parenchyma bundle of  $C_4$ -dicarboxylic acid

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<sup>3</sup> Photorespiration is considered to be the reverse of photosynthesis.

<sup>4</sup> Chlorenchyma cells are large chloroplasts. In  $C_4$  plants chlorenchyma contain starch grains but lack grana, whereas the smaller chloroplasts in the mesophyll have grana but do not store starch. In  $C_3$  plants only smaller chloroplasts, which have grana and store starch, exist throughout the mesophyll.



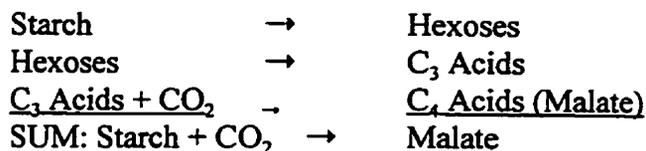
**Figure VII. 4 - Cross-section of C<sub>4</sub> Leaf (Devlin and Barker 1971:206)**

plants contain Calvin cycle enzymes while the mesophyll contains the C<sub>4</sub>-dicarboxylic acid enzymes (Devlin and Barker 1971:152). This might explain why older leaves of C<sub>4</sub> plants with a more developed vascular system synthesise CO<sub>2</sub> more quickly than younger leaves. Devlin and Barker (1971:207) note that both immature maize and sugar cane leaves have chloroplasts with grana that are lost when the plant matures, while the bundle sheath chloroplasts of *Atriplex* and *Amaranthus* continue to maintain grana.

### **Crassulacean-Acid Metabolism (CAM)**

Like C<sub>3</sub> plants, CAM plants synthesise acids during a dark cycle and deacidify during illumination (Devlin and Barker 1971:152). However, the acid that is formed is malic acid (the one C<sub>4</sub>-dicarboxylic acid that requires darkness to be reduced). In this way, CAM plants share commonalities with both C<sub>4</sub> and C<sub>3</sub> pathways. The CAM pathway works as follows

(Devlin and Barker 1971:153):



CAM plants include Crassulaceae and many Bromeliaceae (pineapple) plants which grow in semiarid conditions and open their stoma to take in CO<sub>2</sub> at night in order to conserve water.

In summary, different photosynthetic pathways fix atmospheric carbon dioxide in different ways. Since certain pathways are more efficient (i.e., C<sub>4</sub> plants) than others (i.e., C<sub>3</sub>), the fractionation of isotopes is different in each group of plants thereby distinguishing them in their isotopic signatures. CAM plants that share characteristics of both plant types have δ<sup>13</sup>C values that fall between C<sub>3</sub> and C<sub>4</sub> plants. These distinctions are significant especially in dietary reconstruction involving agriculture.

### Nitrogen Metabolism in Plants

The nitrogen metabolic pathways of plants may be categorised into four areas: 1) the incorporation of nitrogen into the plant, 2) the production and reduction of amino acids, 3) the synthesis of nitrogen into amides, polyamides and peptides, and 4) the production and reduction of proteins and nucleic acids (Webster 1959:1). However, for stable isotope analysis, it is the incorporation of nitrogen into plants that is of primary concern since that is the site of most isotopic fractionation for the plant.

Plants can be divided into two groups by the manner and the source from which they

assimilate their nitrogen. Nitrogen may be derived from organic nitrogen (such as urea and amino acids), ammonia and nitrate nitrogen from soil, and molecular nitrogen from air and in aquatic environments. However, only one group of plants can use all four sources of nitrogen, while the remaining plants rely on the remaining three sources (Rigaud 1981:18).

There is only one group of plants with the ability to assimilate molecular nitrogen. These plants are known as “nitrogen-fixers” since they are the only group of plants that have the ability to convert molecular (atmospheric or aquatic) nitrogen into  $\text{NH}_3$  (ammonia), although they have the ability to utilise the other sources of nitrogen as well (Rigaud 1981:18; Schwarcz et al. 1985:188). Commonly these plants are known as legumes (i.e., peas, beans clover, alfalfa and peanuts), and include certain species amongst the genera of *Azotobacter*, *Clostridium*, *Rhizobium*, *Rhodotorula*, and certain photosynthetic bacteria.

The mechanism by which terrestrial nitrogen-fixers perform the conversion of nitrogen to ammonia is in the form of bacteria on their roots, and two special iron-containing enzymes. Molecular nitrogen can be assimilated by certain plants only in the presence of a metabolic endproduct (such as, carbohydrates), thereby requiring a high metabolic rate (Webster 1959:14). The metabolic rate has a tendency to decrease as the plant matures as does the rate of nitrogen fixation (Rigaud 1980:24-28). There is also a seasonal or growth pattern to nitrogen-fixing rates. Using soybeans as an experimental case, Rigaud (1981:28) states,

In soybeans, activity starts at the initial flowering stage which occurs, on average, 4 weeks after sowing. Nitrogen fixation increases rapidly during the mid-part of pod filling, and then declining sharply with senescence. . . . about 80% of the nitrogen was fixed between flowering and the subsequent green bean stage.

Another plant type belongs to the group of nitrogen-fixers, yet it is not a legume and does not have bacteria containing nodules on its roots. *Nostocaceae*, cyanobacteria or blue-green algae also has the ability to fix molecular nitrogen, which is atmospheric  $N_2$  dissolved in water (DeNiro 1987:187).

The remaining group of plants (i.e., non-legumes) utilise the other three sources of nitrogen often with higher absorption rates than legumes (Rigaud 1981:19). Non-leguminous plants directly use the nitrate and ammonia from decaying organic matter that has been reduced by bacteria found in soil (Schwarcz and Schoeninger 1991:304).

There are factors (environmental and otherwise) that affect a plant's respiration, and therefore the assimilation, of nitrate and ammonium. Some of these environmental factors are oxygen tension, temperature, and soil acidity (Webster 1959:13). One of the crucial environmental factors to respiration is soil acidity. While high pH (low acidity or alkaline soils) favours ammonia assimilation, low pH (higher acidity) favours nitrate assimilation. However, plant age also plays a role in nitrogen assimilation. As Webster (1959:13) explains,

rice utilizes ammonia, but can utilize nitrate only very poorly when young. However, rice gains the ability to assimilate nitrate when mature. Likewise, both wheat and oat seedlings assimilate nitrate ammonia better than nitrate, but attain the ability to assimilate nitrate equally well upon maturation.

Therefore, the differential intake of ammonia or nitrate is plant dependent, plant age dependent as well as soil acidity and environmentally dependent.

The distinction between legume and non-legume plants is important to isotopic analysis, primarily, for two reasons: 1) legumes, like  $C_4$  plants, are often cultivated plants, and 2) legumes are also a good source of protein that is important when considering

proportions of dietary fractions.

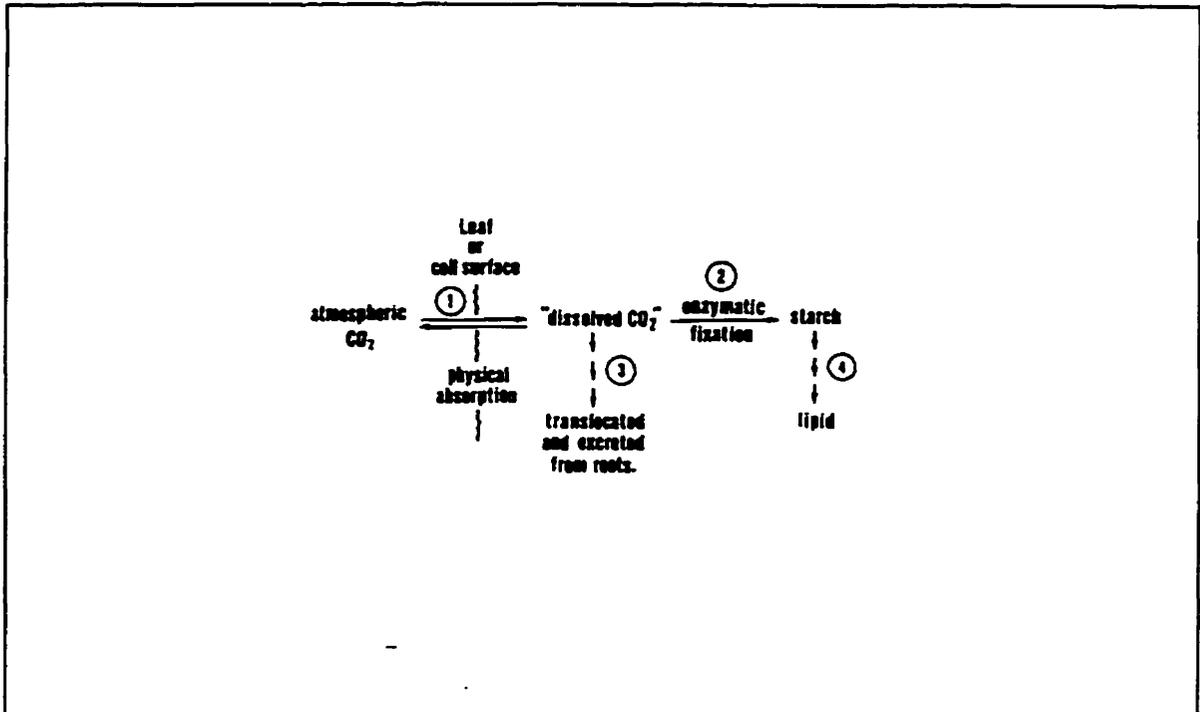
### **Metabolic Pathways of Plants and Stable Isotope Analysis**

In nature, the ratio of all carbon isotopes of  $^{13}\text{C}:^{12}\text{C}:^{14}\text{C}$  is approximately 99:1:10<sup>-10</sup> (Sealy 1986:34; Smith 1972:226), and of nitrogen isotopes  $^{15}\text{N}:^{14}\text{N}$  is approximately 0.36:99.64 (Schwarcz and Schoeninger 1991:288). It has been noted that heavier isotopes of an element are discriminated against in favour of lighter isotopes during reactions. Thus, the isotopic fractionation of a system will be determined by any factors influencing its chemical behaviour (such as, chemical composition and activity of an organism, atmospheric pressure and composition, temperature, the source of carbon and nitrogen, etc.)(Smith 1972:226).

It has been found, since  $\text{C}_4$  and  $\text{C}_3$  plants have different chemical behaviour (i.e., they synthesise  $\text{CO}_2$  differently), that they also have different  $^{13}\text{C}/^{12}\text{C}$  ratios (Park and Epstein 1960; Sealy 1986; Tregunna et al. 1970). According to Park and Epstein (1960), there are four major sites of fractionation during photosynthesis that account for isotopic variation in plants (Figure VII.5): 1) between the cytoplasm and atmosphere during the intake of  $\text{CO}_2$  (the “boundary effect”), 2) during carboxylation and reduction reactions, 3) between the roots and plant during the excretion of some of the dissolved  $\text{CO}_2$ , and 4) during metabolic reactions converting starches into lipids.

The differences in fractionation between  $\text{C}_4$  and  $\text{C}_3$  plants are largely realised during the carboxylation and reduction reactions (i.e., site 2). While carboxylation and reduction in  $\text{C}_3$  plants (using ribulose 1, 3-diphosphate carboxylase) causes fractionation of at least 17‰ ( $\delta^{13}\text{C}$ ), these processes are markedly smaller in  $\text{C}_4$  plants (using phosphoenolpyruvate

carboxylase) (Park and Epstein 1960; Smith 1972). The presence of more (enriched)  $^{13}\text{C}$  in  $\text{C}_4$  plants result in higher  $^{13}\text{C}/^{12}\text{C}$  ratios, and therefore more positive  $\delta^{13}\text{C}$  values (Katzenberg and Schwarcz 1986:17; Sealy 1986). The fractionation during metabolic reactions largely affects the different  $\delta^{13}\text{C}$  within a plant in its various tissues.



**Figure VII.5 - Fractionation Sites during Photosynthesis (Smith 1972:229)**

The largest percentage of available nitrogen (99%) is in the form of molecular nitrogen found in the atmosphere or is dissolved in oceans, rivers and lakes. Of all nitrogen isotopes available from all sources,  $^{14}\text{N}$  is most prevalent (99.6%) (Schwarcz and Schoeninger 1991). Two plant types reflect their close relationship to molecular nitrogen, and their conversion of  $\text{N}_2$  to ammonia within their structures (i.e., depleted  $\delta^{15}\text{N}$  values) (Schwarcz et al. 1985:17). Legumes and blue-green algae, which are the only plants able to

fix molecular nitrogen, both have a  $\delta^{15}\text{N}$  value close to 0‰ (DeNiro 1987:187; Katzenberg and Schwarcz 1986:17; Schwarcz and Schoeninger 1991:304).

Non-leguminous plants, which cannot fix  $\text{N}_2$ , rely on soil nitrate and ammonia taken directly into their systems. These sources of nitrogen have fractionated in the soil during the processes of nitrification and denitrification of decaying organic matter. However, fractionation is negligible in this situation leading to enriched  $\delta^{15}\text{N}$  values (Webster 1959:3). These terrestrial plants have an average isotopic composition ( $\delta^{15}\text{N}$ ) of +3‰, and a wide range of isotope values. Non- $\text{N}_2$  fixing marine plants have a  $\delta^{15}\text{N}$  value of +7‰, and also demonstrate a wide range of  $\delta^{15}\text{N}$  values (DeNiro 1987:187). Schwarcz and Schoeninger (1991:304), summarise these findings as follows,

$\delta^{15}\text{N}$  of marine organisms is typically higher than that for terrestrial ones, with some values ranging above 20‰. A similar effect is seen in aquatic systems (river, lakes, swamps), in which organisms may have  $\delta^{15}\text{N}$  values elevated with respect to terrestrial organisms.

For the purposes of dietary reconstruction using stable isotopic analysis, the ability to distinguish between various plant types is important. By knowing the occasions under which most isotopic fractionation occur, allows the analyst to identify common traits and determine when other factors may be influencing isotopic values.

## **Appendix VIII**

### **Collagen Preparation by Stable Isotope Laboratories**

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**University of Florida (Departments of Anthropology and Geology under the direction of Dr. Norr and Dr. Summers, respectively; laboratory instruction by Theresa Schober)**

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Bone collagen sample preparation for stable carbon and nitrogen isotope analysis at the University of Florida under the direction of Dr. L. Norr was as follows: bone samples were scrapped clean of discolouration, visible dirt and rootlets. The samples were then repeatedly cleaned in distilled water using a ultrasonic waterbath until the water was clear. Manually cleaned samples were freeze dried. Dried bone was ground and screened through two screens (i.e., 500  $\mu\text{m}$  and 250  $\mu\text{m}$ ). All bone was passed through the 500  $\mu\text{m}$  screen. The sample remaining in the 250  $\mu\text{m}$  screen (i.e., particle size 250 to 500  $\mu\text{m}$ ) was used for collagen analysis.

Approximately 0.75 g of crushed bone was used for collagen preparation per sample. Biochemical bone minerals, carbonates and fulvic acids were removed by soaking the sample in 0.2N HCl until demineralisation was complete (i.e., until reaction ceased and the particles were translucent). The samples were rinsed to neutral pH, drained, and then soaked in 0.125N NaOH for approximately 10 hours to eliminate remaining lipid and humic acid contaminates. Microscopic contaminants were removed by dissolving the collagen 10<sup>-3</sup>N HCl at 90°C for 5 hours, adding 100  $\mu\text{L}$  of 1N HCl and heating for another 5 hours, and finally filtering through glass filter funnels. The filtered collagen solute was reduced to approximately 2 mL, frozen and freeze dried.

Approximately, 0.5 mg of dried homogenised collagen was used for combustion for

carbon isotopes, and 1 mg for nitrogen isotopes and C:N ratios. Carbon and nitrogen isotopes samples were loaded separately into an auto-loading light element isotope-ratio mass spectrometer with reference standards of Peedee belemnite (PDB) for carbon and atmospheric nitrogen (AIR) for nitrogen resulting in delta-values ( $\delta$ ) measured in parts per mil (‰). The University of Florida carbon to nitrogen ratios (C:N) are typically lower than those calculated using atomic C:N ratios and require a correction factor of 1.167 for comparative purposes.<sup>1</sup>

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**McMaster University** (Department of Geology under the direction of Dr. Schwarcz and Martin Knyf; collagen preparation by Scott Fairgrievs, University of Toronto)

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The collagen preparation by Mr. Fairgrievs was similar to the above method except for the following: cleaned bone was broken up into approximately 1 mm pieces, bones minerals were removed using 0.25N HCl, soil humic contaminants were removed using 0.1N NaOH. Dissolved collagen was separated from remaining contaminants by centrifuge. Approximately 10 mg of collagen was combusted using the static combustion method and ran through an IRMS.

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<sup>1</sup> “Atomic C:N ratios are higher than C:N ratios calculated from weights of C and N because the former are calculated directly from the numbers of atoms of each element in a sample. Nitrogen and carbon atoms have atomic masses of 14 and 12, respectively, to convert from weight % C:N ratios to atomic C:N ratios one multiples the former by 14/12, or 1.16667” (Ambrose and Norr 1992:403).

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**University of Colorado** (Institute of Arctic and Alpine Research under the direction of Dr. Thomas W. Stafford, Jr.)

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Dr. Stafford decalcified 5 mm whole bone fragments with 0.6*N* HCl. Blocks of gelatin (washed in KOH) are produced using a hot water extraction method using 0.05*N* HCl at 110°C for 5-300 minutes. When soluble the collagen is passed through a 0.45 µm filter. The gelatin is hydrolysed with 6*N*HCl for 24 hours at 110°C, filtered and passed through XAD2-resin. Collagen is statically combusted and run through an IRMS.

**Appendix IX**  
**Archaeological Sites and Relative Dates of Animals Samples<sup>1</sup>**

| Common Name     | Genus Species               | Site (Artifact #)            | Approximate RC Date (BP)            | Calibrated Calendar Date |
|-----------------|-----------------------------|------------------------------|-------------------------------------|--------------------------|
| Beaver          | <i>Castor canadensis</i>    | Whitemouth (N5E1L7-W9489)    | 4625±150                            | 3700-2900 BC             |
| Beaver          | <i>Castor canadensis</i>    | Whitemouth (N5E1L7-W9498)    | 4625±150                            | 3700-2900 BC             |
| Bison           | <i>Bison bison</i>          | Mullet (#2-4-7)              | 1230±100                            | 640-1020 AD              |
| Bison           | <i>Bison bison</i>          | Whitemouth (N5W1L8-W13086)   | 3405±175                            | 2190-1270 BC             |
| Moose           | <i>Alces alces</i>          | Bjorklund (N70E45L6-40192)   | 3125±135                            | ca. 790 AD               |
| Channel Catfish | <i>Ictalurus punctatus</i>  | Lockport (XU142W36L31-44523) | 1410±290 in L29                     | 26-1218 AD               |
| Pike            | <i>Esox lucius</i>          | Whaley Cairn (XU2L7F2-60)    | 1760±60 <sup>2</sup> human collagen | ca. 290 AD               |
| Pike            | <i>Esox lucius</i>          | Whaley Cairn (XU2L7F2-60)    | 1760±60 <sup>2</sup> human collagen | ca. 290 AD               |
| Sturgeon        | <i>Acipenser fulvescens</i> | Whitemouth (N5E1L9-W9534)    | 6090±90 <sup>2</sup> human collagen | ca. 5010 BC              |
| Sturgeon        | <i>Acipenser fulvescens</i> | Whitemouth (N5E1L8-W9522)    | 6090±90 <sup>2</sup> human collagen | ca. 5010 BC              |
| Walleye         | <i>Stizostedion sp.</i>     | Whaley Cairn (XU2L7F2-60)    | 1760±60 <sup>2</sup> human collagen | ca. 290 AD               |
| Walleye         | <i>Stizostedion sp.</i>     | Whaley Cairn (XU2L7F2-60)    | 1760±60 <sup>2</sup> human collagen | ca. 290 AD               |
| Walleye         | <i>Stizostedion sp.</i>     | WhaleyCairn (XU2L7F2-60)     | 1760±60 <sup>2</sup> human collagen | ca. 290 AD               |

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<sup>1</sup> Identifiable bone samples were taken in as close proximity as possible to the actual dated bone. Relative provenience noted if the sample was taken from another level.

<sup>2</sup> AMS date. Also see Appendix IV.

## Appendix X Calculated Weighted Stable Isotope Values for Specific Resources

The following  $\delta_{\infty}$  values were all taken from archaeological contexts except for the berries mean which was used to offset the wild rice values. Although specific food names are used in the charts below, each food is considered to be representative of foods sharing the same qualities in proteins, calories, and stable isotope values. For example, the value for berries also represent those plants with moderate calories, low nitrogen (i.e., protein), and moderate  $\delta^{13}\text{C}$  and low  $\delta^{15}\text{N}$  values, such as, fungi and wild tuber plants.  $\delta_{\text{food}}$  values were calculated with collagen to flesh correction factors (i.e.,  $\delta_{\text{collagen}} + \Delta_{\text{collagen to flesh}}$ , where  $\Delta^{13}\text{C}_{\text{CO-F}} = -3.7\text{‰}$ , and  $\Delta^{15}\text{N}_{\text{CO-F}} = 1.7\text{‰}$ ) (DeNiro and Epstein 1978 and 1981). The isotopic signatures of the foods were converted into consumer collagen values using  $\Delta_{\text{DC}}$  correction factors (i.e.,  $\Delta^{13}\text{C}_{\text{DC}} = 5\text{‰}$ , and  $\Delta^{15}\text{N}_{\text{DC}} = 3.0\text{‰}$ ). The percentage of calories and protein in foods was taken from the *USDA Nutrient Database for Standard Reference* (1997).

**Weighted  $\delta$  values are calculated as follows (Schoeninger 1989:46-47):**

$$\text{Weighted } \delta^{13}\text{C}_{\text{collagen consumer}} = \% \text{ calories in food} \times (\delta^{13}\text{C}_{\text{food}} + \Delta^{13}\text{C}_{\text{DC}}),$$

$$\text{where } \Delta^{13}\text{C}_{\text{Diet-Collagen}} = 5\text{‰} \text{ (van der Merwe 1982).}$$

$$\text{Weighted } \delta^{15}\text{N}_{\text{collagen consumer}} = \% \text{ protein in food} \times (\delta^{15}\text{N}_{\text{food}} + \Delta^{15}\text{N}_{\text{DC}}),$$

$$\text{where } \Delta^{15}\text{N}_{\text{Diet-Collagen}} = 3\text{‰} \text{ (DeNiro and Epstein 1981).}$$

| Food                           | $\delta^{13}\text{C}_{\text{co}}$ | $\delta^{13}\text{C}_{\text{food}}$ | $\delta^{13}\text{C}_{\text{food}} + \Delta^{13}\text{C}_{\text{DC}}$ | Calories(%) | Wt. $\delta^{13}\text{C}_{\text{co}}$ consumer |
|--------------------------------|-----------------------------------|-------------------------------------|---|-------------|--|
| Berries ( $\bar{x}$ )          |                                   | -25.78                              | -20.78  | 0.56        | -11.64   |
| Wild Rice                      |                                   | -25.57                              | -20.57  | 1.01        | -20.77   |
| Bison (Whitemouth)             | -16.28                            | -19.98                              | -14.98  | 1.09        | -16.33   |
| Moose                          | -20.67                            | -24.37                              | -19.37  | 1.02        | -19.76   |
| Beaver                         | -19.97                            | -23.67                              | -18.67  | 1.46        | -27.26   |
| Pike/Walleye ( $\bar{x}$ )     | -20.28                            | -23.98                              | -18.98  | 0.90        | -17.08   |
| Sturgeon/Catfish ( $\bar{x}$ ) | -21.81                            | -25.51                              | -20.51  | 1.0         | -20.51   |

| Food                           | $\delta^{15}\text{N}_{\text{co}}$ | $\delta^{15}\text{N}_{\text{food}}$ | $\delta^{15}\text{N}_{\text{food}} + \Delta^{15}\text{N}_{\text{DC}}$ | Protein(%) | Wt. $\delta^{15}\text{N}_{\text{co}}$ consumer |
|--------------------------------|-----------------------------------|-------------------------------------|---|------------|--|
| Wild Rice                      |                                   | 3.69                                | 6.69  | 0.399      | 2.7  |
| Bison (Whitemouth)             | 5.52                              | 7.22                                | 10.22   | 2.162      | 22.1   |
| Moose                          | 3.5                               | 5.2                                 | 8.2   | 2.224      | 18.2   |
| Beaver                         | 3.92                              | 5.62                                | 8.62  | 2.405      | 20.7   |
| Pike/Walleye ( $\bar{x}$ )     | 10.08                             | 11.78                               | 14.78   | 1.92       | 28.4   |
| Sturgeon/Catfish ( $\bar{x}$ ) | 9.59                              | 11.29                               | 14.29   | 1.626      | 23.2   |

Food classes in the text are noted as having low, moderate, or high percentages of calories and proteins. The calorie and protein classes are designated as follows:

| Plants   |                          |                         |
|----------|--------------------------|-------------------------|
| Level    | Calories % per 100 grams | Protein % per 100 grams |
| Low      | 0.00 to 0.59             | 0.00 to 0.19            |
| Moderate | 0.60 to 0.89             | 0.20 to 0.29            |
| High     | 0.90 or greater          | 0.30 or greater         |

| <b>Mammals</b> |                                 |                                |
|----------------|---------------------------------|--------------------------------|
| <b>Level</b>   | <b>Calories % per 100 grams</b> | <b>Protein % per 100 grams</b> |
| Low            | 0.00 to 0.89                    | 0.00 to 1.99                   |
| Moderate       | 0.90 to 1.29                    | 2.00 to 2.39                   |
| High           | 1.30 or greater                 | 2.40 or greater                |
| <b>Fish</b>    |                                 |                                |
| Low            | 0.00 to 0.89                    | 0.00 to 0.79                   |
| Moderate       | 0.90 to 1.29                    | 0.80 to 1.69                   |
| High           | 1.30 or greater                 | 1.70 or greater                |

### Dietary Reconstructions by Cluster and Site

**Cluster 1** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -21.197\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 12.96\text{‰}$ )

0.55 Rice + 0.2 Pike + 0.1 Sturgeon + 0.15 Beaver =  $-20.98\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $12.59\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Cluster 2** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -19.18\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 12.92\text{‰}$ )

0.6 Rice + 0.4 Pike =  $-19.29\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $12.98\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Cluster 3** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -20.05\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 11.20\text{‰}$ )

0.6 Rice + 0.2 Pike + 0.05 Moose + 0.05 Beaver + 0.1 Bison  
=  $-19.86\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $11.45\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Whaley Cairn** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -19.68\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 11.99\text{‰}$ )

0.625 Rice + 0.35 Pike + 0.025 Beaver =  $-19.65\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $12.14\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Fort Alexander (DE-12)** ( $\delta^{13}\text{C}_{\text{co}} = -20.41\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}} = 11.50\text{‰}$ )

0.6 Rice + 0.2 Pike + 0.1 Beaver + 0.05 Moose + 0.05 Bison  
=  $-20.41\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $11.38\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Slave Falls** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -19.36\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 13.17\text{‰}$ )

0.05 Berries + 0.5 Rice + 0.25 Pike + 0.2 Sturgeon =  $-19.34\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $13.09\text{‰}\delta^{15}\text{N}_{\text{co}}$

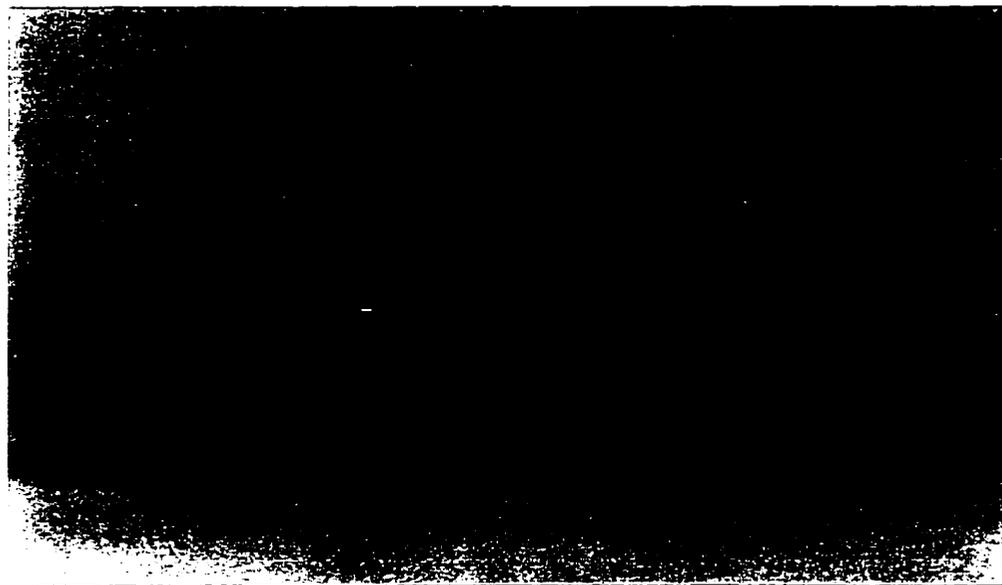
**Whitemouth Falls** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -18.81\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 12.01\text{‰}$ )

0.1 Berries + 0.4 Rice + 0.4 Bison + 0.1 Beaver =  $-18.73\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $11.99\text{‰}\delta^{15}\text{N}_{\text{co}}$

**Bjorklund** ( $\delta^{13}\text{C}_{\text{co}}\bar{x} = -17.48\text{‰}$ ;  $\delta^{15}\text{N}_{\text{co}}\bar{x} = 10.41\text{‰}$ )

0.4 Berries + 0.15 Rice + 0.2 Bison + 0.2 Beaver + 0.05 Sturgeon  
=  $-17.51\text{‰}\delta^{13}\text{C}_{\text{co}}$ ;  $10.13\text{‰}\delta^{15}\text{N}_{\text{co}}$

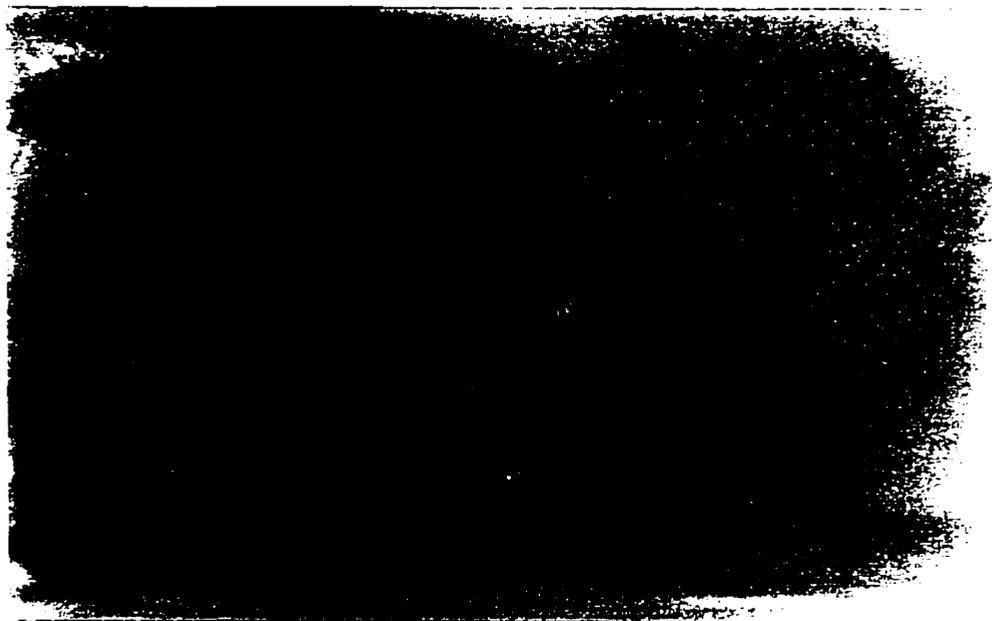
**Appendix XI**  
**Photographs of Comparative Dentitions**



Top Photo - Whaley Cairn X111

Bottom Photo - Slave Falls F312

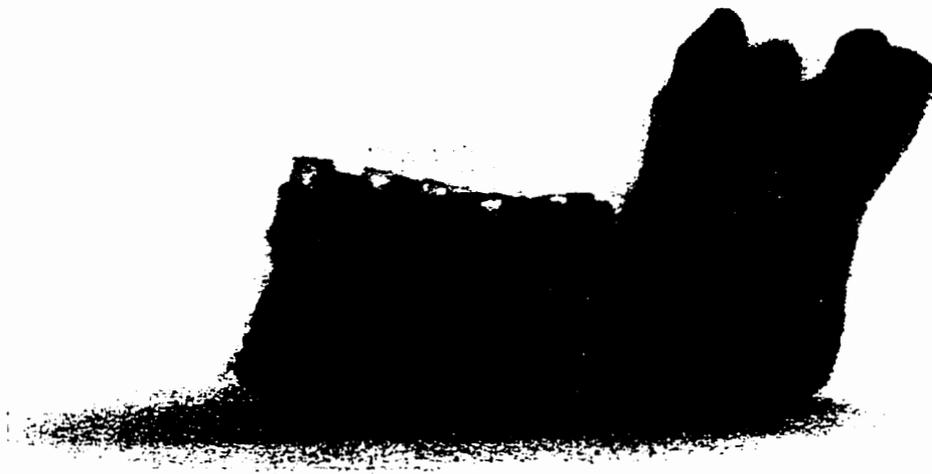
The Whaley Cairn individual demonstrates moderate caries, calculus and periodontal disease. The Slave Falls individual demonstrates greater occurrence of calculus and periodontal disease. Both individuals are of similar age (i.e. "middle adults"). Generally, Whaley Cairn individuals demonstrate a higher rate of fractures, while Slave Falls individuals demonstrate a higher rate of chips.



Top Photo - Whitemouth Falls Z-25

Bottom Photo - Bjorkland Z-17

Both of these "old adults" demonstrate lower rates of periodontal disease than Whaley Cairn and Bjorkland individuals.



Top Photo - Whaley Cairn XU112

Bottom Photo - Slave Falls F111

Greater wear and more oblique wear patterns may be more evident in more boreal-oriented (i.e. fish and wild rice eating) populations.



Top Photo - Whitemouth Falls Z-25      Bottom Photo - Bjorkland Z-17

More even wear patterns are apparent in plains-oriented populations.

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B.3/a/72-73 Albany 1777 to 1778  
B.3/a/168 Albany 1836 (1M13)  
B.4/a/1-7 Fort Alexander 1795 to 1834 (1M13-14)  
B.22/a/1-3 Brandon House 1793 to 1796 (1M17)  
B.22/a/7 Brandon House 1799 to 1800 (1M17)  
B.64/a/1 Escabitchewan 1792-1793 (1M57)  
B.78/a/15 Gloucester House 1786 (1M57)  
B.103/a/1 Lac du Bonnet 1807 to 1808 (1M67)  
B.166/a/1-3 Portage de l'Isle 1793 to 1795  
B.198/a/9 The Pas  
B.211/a/1 Sturgeon Lake  
B.236/a/1 Winnipeg Lake 1796 to 1797 (1M154)

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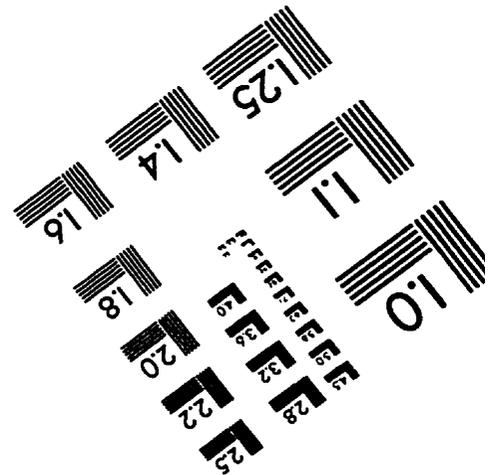
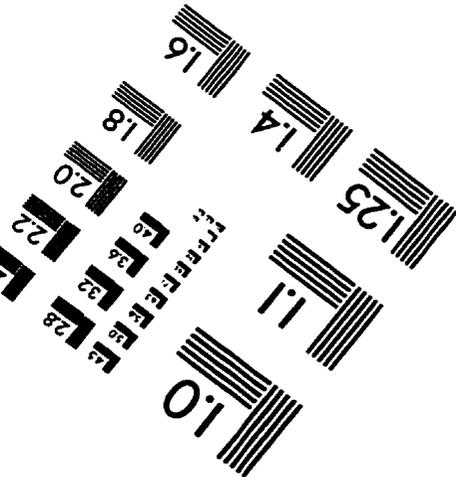
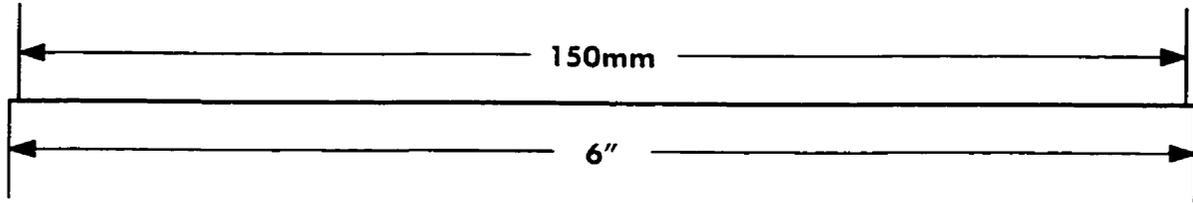
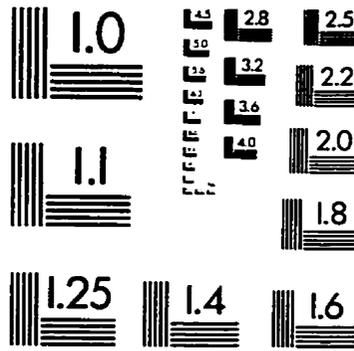
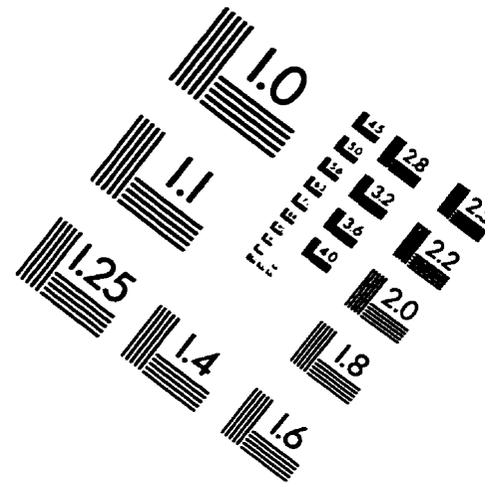
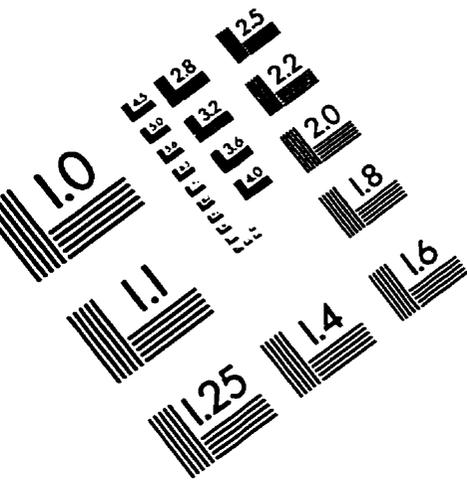
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