

**The Hartley Site (FaNp-19) and
the Use of Sandhill Environments
In the Late Precontact Period**

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Abstract

The Hartley site (FaNp-19) is a Late Precontact Period multicomponent habitation and bison kill and processing site located on the periphery of a sand dune environment surrounded by grasslands. The Hartley site, located within the Saskatoon city limits, was originally identified by Ken Cronk and members of the Saskatoon Archaeological Society in the 1950's. Subsequent excavations by Millenium Consulting Ltd., the University of Saskatchewan, Western Heritage Services Inc., and Stantec Consulting Ltd. have all added to the database of knowledge pertaining to this site. Radiometric dates and the recovery of artifacts characteristic of the Avonlea Horizon, the Old Women's Phase, and the Mortlach Phase have demonstrated that this region was a popular place for occupation and bison procurement during the Late Precontact Period.

A detailed analysis of the faunal remains recovered from the area known as the Wooded Hollow has demonstrated that this assemblage differs significantly from the remains recovered from the previously researched Brushy Depression. It appears that bison were being heavily harvested and that the use of secondary faunal sources was extremely limited. Determination of seasonality is based on cluster and discriminant function analysis of carpal, tarsal, longbone and phalange data. The resulting herd structure of almost equal numbers of males and females suggests an occupation during the rut, or the fall months. Some immature elements and non-bison remains suggest occupation may have occurred in the spring. It is therefore possible that this region was utilized over a period of time for the purposes of procuring animals from the spring to the fall months. The complete lack of foetal bone in this region suggests that, unlike in the Brushy Depression, the Wooded Hollow was not occupied during the winter months.

Taphonomic factors were considered in performing a complete faunal analysis of this thesis. Non-human agents and associated processes suggest that the assemblage was buried quickly after the site was vacated. The extremely fragmented nature of the assemblage, however, suggests that humans had a greater effect on the assemblage than the non-human agents. Based on breakage patterns it is determined that these remains were being processed for the purposes of both marrow and grease extraction. Application of a site determination model also suggests that it is likely that both kill and processing activities occurred in this area.

Location of the Hartley site within a dune environment is linked to the activities that occurred at this site. A review of ethnographic accounts of bison pounding and surrounding activities has revealed that availability of ecological resources such as wood and necessary topographic features characteristic of dune environments were essential to the success of bison procurement. Although it has been suggested that settlement of these regions is also linked to the variety and stability of resources in 'ecotones', or areas of resource overlap, between grassland and sandhill environments, a review of several faunal assemblages from various similar Northern Plains assemblages reveals that bison was by far the dominant species exploited. Variety in terms of faunal resources may not have been a factor at all. It is therefore suggested in this thesis that settlement on the periphery of sandhill environments is linked to the presence of bison in the surrounding grassland region, as well as to the stability of the resources in wetland areas supported by high water tables in the dune environments. Also known as 'ecological islands' these regions may have been more stable in terms of essential resources such as wood and other botanical resources, in addition to providing areas of shelter during the colder winter months. It is concluded that settlement and large scale bison procurement activities in several sandhill environments on the Northern Plains is tightly linked to availability of bison, the availability of wood, a conducive topographic setting, and the stability of resources in these 'ecological islands'.

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Comm.	Comminuted	
Trans. Regular	Transverse Regular	
Trans. Irregular	Transverse Irregular	
Long.	Longitudinal	
Abbreviations From Table 8.1		167
B	<i>Bison bison</i>	
Ftl	Foetal	
C	Canid	
R	Rabbit	
Fx	Fox	
Sq	Squirrel	
Br	Beaver	
Av	Class Aves	
D	Ducks	
Gr	Grouse	
F	Fish	
M	Mustelid	

Chapter One

Introduction, Statement of Objectives, and Chapter Summary

1.1 Introduction and Statement of Objectives

The Hartley site (FaNp-19) has received much attention over the past half century as it has contributed considerable information to the growing data set pertaining to bison kill and habitation sites dating to the Late Precontact Period. Many years of excavation have occurred at this site, including those by Ken Cronk and the Saskatoon Archaeological Society, the University of Saskatchewan Field School, Millenium Consulting Ltd., Western Heritage Services Inc., Stantec Consulting Ltd., and those excavations executed by the author and various volunteers. The majority of the site has been disturbed by cultivation, however, at least four areas with intact deposits have been identified in low lying areas dominated by groves of trees. Much of the previous research that has been executed in this region was concentrated in one of the grove areas, also known as the habitation region of the site, or the Brushy Depression. As Clarke (1995) and Farrow (2004) have demonstrated, the faunal remains identified in the Brushy Depression represent a number of species, although the assemblage is clearly dominated by *Bison bison*. Cultural materials characteristic of the Avonlea Horizon, Old Women's Phase, and Mortlach Phase have been identified at this site.

The goals of this thesis can be broken down into three categories. Firstly, it was imperative to perform a generalized faunal analysis of the faunal remains recovered from the area known as the Wooded Hollow. This was limited to materials recovered from excavations executed by the field school, Stantec Consulting Ltd., and the author. In performing this type of analysis, information pertaining to past subsistence strategies including a complete list of taxonomic species present, and basic quantitative analyses are necessary. Information pertaining to herd structure and season of use are also of value, especially when compared to the season of use that was previously demonstrated in the Brushy

Depression. Secondly, an analysis of taphonomic influences was deemed necessary as it demonstrates both human and non-human influences that may have contributed to the state of the faunal remains analyzed for this thesis. Included in this analysis will be a discussion related to kill and processing sites and the archaeological visibility of marrow and grease production. Sivertson's (1980) site type determination model will be applied to the assemblage in an effort to determine whether the Wooded Hollow section of the Hartley site is characteristic of a bison kill and/or processing area. Lastly, as the Hartley site, similar to many other archaeological sites on the Northern Plains, is located within a sand dune environment it was decided that an analysis regarding the settlement and exploitation of resources in this type of environment would be especially pertinent to increasing the knowledge of subsistence behaviours during the Late Precontact Period. The faunal assemblage from the Wooded Hollow region of the Hartley site will be compared to several other faunal assemblages from sites in similar geographical settings and time periods. Emerging trends in season of use or species exploited will be noted.

1.2 Chapter Summary

Chapter one is an introduction to the Hartley site, including a review of the history of the excavations that have occurred at the site. The history of extensive research relates to the present thesis as it allocates for an inclusion of new thesis objectives. These objectives were outlined above.

Chapter two gives a more detailed review of the history of research at the Hartley site. A basic biophysical overview is performed including discussion of the location of the site, an introduction to the surrounding physiography and soils, followed by a brief overview of the underlying geological formations, past climatic conditions, and relevant surrounding hydrological resources. Attention is then shifted to the local native flora and fauna in the region, including both mammalian and avian fauna. A brief discussion on naturally occurring amphibians, reptiles and fish ensues and mention is also made of molluscs that have been documented in the region.

Chapter three is focused on the cultural occupation of the Hartley site. An overview of the Late Precontact Period, specifically with reference to sites in the Saskatoon area, is presented. The focus of this chapter is then shifted to the site stratigraphy and burial conditions. Cultural materials known from the site are discussed in conjunction with both recent and previously obtained radiometric dates. Discussion is focused on the cultural affiliation of the Hartley site and how it may differ throughout the various intact locations of the site introduced in chapter two.

The function of chapter four is to outline the methods and techniques utilized during the various stages of excavation and analysis of the faunal remains recovered from the Wooded Hollow region of the Hartley site. Particular attention is paid to the excavation and laboratory procedures employed by the various parties that have been involved at this site. These methodologies are presented in chronological order beginning with the University of Saskatchewan field school, followed by a review of Stantec Consulting Ltd., and lastly, by the procedures that were executed in 2004 by the author and volunteers. The focus of this chapter is then shifted to review the qualitative and quantitative analyses that are characteristic of an assemblage dominated by faunal remains. Particular attention is paid to the methodology followed in the cataloguing process, and the calculations related to the quantitative analyses.

Due to the nature of the assemblage, bison and non-bison remains were separated in chapters five and six. Although chapter five begins with an introduction to the Hartley site faunal assemblage as a whole, including a complete list of taxonomic species present, the focus is then shifted to a quantitative analysis specifically related to the bison remains. The basic quantitative analysis is followed by a section focused on aging and seasonality and bison tooth eruption and wear schedules and identification of the herd structure (the sex of the animals). In order to perform such an analysis, various methodologies were followed including Morlan's (1991) methodology for carpal and tarsal data, Walde's (2004b) methodology that employs discriminant function analysis, and Roberts' (1982) methodology pertaining to phalangeal data.

Chapter six is based on the non-bison fauna recovered from the Hartley site. The first portion of the chapter is based on mammalian elements recovered from the Wooded Hollow. Each species discussion is broken down into a description of the material recovered, the known species distribution and habitat, a discussion as to whether the bones are likely naturally or culturally occurring items and whether any taphonomic effects, both of a human and non-human nature, are visible. The specimens that are not identified to the level of species are identified to the most precise taxonomic level possible and are presented in terms of material recovered. The specimens that are not identified as belonging to any specific taxa are classified based on size as outlined by Dyck and Morlan (1995) and modified by Webster (1999). Specimens identified as avian fauna are presented in the following section in the same format as utilized for the mammalian fauna. Lastly, as non-bison fauna can also be used as indicators of seasonality, these species are discussed. This analysis is broken down into those within the Class Aves and those within the Order Rodentia.

Chapter seven is focused on the role of taphonomy and associated butchering practices noted at the Hartley site. In order to perform such an analysis, a short discussion relating to taphonomy, particularly concepts and terminology, is given. Following this introduction are two sections detailing the visible taphonomic effects of non-human agents and associated processes as well as of humans as agents and associated processes. Particular attention with regards to non-human agents and associated processes is paid to those of weathering, deterioration, root etching, and gnawing from carnivores and rodents. Where humans are identified as the acting agent, the effects of butchering forces in terms of breakage patterns and butchering marks are analyzed. Intentionally modified bone is also analyzed as a number of bone tools were recovered from the Hartley site. The last portion of this chapter is devoted to a discussion on the analysis of economic utility, specifically with reference to the archaeological visibility of grease and marrow production. This discussion is then related to the materials recovered from the Wooded Hollow. Sivertson's (1980) site type determination model is applied to this assemblage in an

effort to demonstrate or refute these hypotheses: that the Wooded Hollow was utilized as either a kill and processing site.

Chapter eight addresses the question of settlement and bison procurement in sandhills environments during the Late Precontact Period. In order to perform such a review, thought and discussion are first given to some of the ways in which bison were known to be procured on a large scale. This discussion includes a review of bison pounding and surrounding and their seasons of use, related physical components, and favourable topographic features. Implications of these factors are applied to the Hartley site in order to determine whether or not the site could have functioned as a pound or surround. The following section is devoted to bison procurement and the seasonal round. Questions regarding migratory versus non-migratory behaviour of bison are raised and implications of the bison seasonal round is considered with regards to the Hartley site. The last half of chapter eight is devoted to an introduction of both grassland and sandhill environments, with particular attention paid to ‘ecotone’ overlap between these environments as well as to the presence of clumped stable ‘ecological islands’ that are known to be present within sandhill environments. Keeping these factors in mind, an overview of the faunal assemblages with particular reference to faunal diversity and seasonality in sandhill environments is presented, in order to see if any generalizations are possible.

Chapter nine is the concluding chapter in this thesis. This chapter summarizes the results of the faunal analysis performed on the remains recovered from various seasons of excavation in the Wooded Hollow region of the Hartley site. Several conclusions are made regarding the subsistence strategies employed by the inhabitants of this site and particular attention is paid to the importance of the location of this site in a sandhill environment.

Chapter Two

Introduction to the Hartley Site

2.1 Site History

Archaeological remains in the Hartley site area have been documented since the 1930s. The Hartley Site is in the vicinity of Preston Avenue on the south edge of the City of Saskatoon (Figure 2.1) in the recently established subdivision known as Stonebridge. This site has a long archaeological history beginning as a collecting area for amateur archaeologists and terminating with both academic and resource management activities (Clarke and Meyer 1992; Meyer 1989; 1995; Millenium 1988; Stantec 2003). In the 1950s, Ken Cronk along with other members of the Saskatoon Archaeological Society began excavating at what was then called the Preston Avenue Site which had the Borden designation of FaNp-2 (Clarke and Meyer 1992). Though the locations of Cronk's excavations are uncertain, they are thought to have been located along the eastern side of Preston Avenue, west of two areas called the North and the South Groves, respectively (Meyer 1989; Rollans and McKeand 1992). The remains obtained by Cronk and his companions consisted of Plains Side-Notched points and a large amount of Mortlach pottery (Stantec 2003).

In 1986, the Saskatoon Archaeological Society (SAS) continued work in this area and conducted a surface survey, along with some limited test pits to the north and west of the Hartley Site (Millenium 1988; Rollans and McKeand 1992; Stantec 2003). This site, now known as the Bill Richards Site (FaNp-9), contained areas with remains that were heavily disturbed as well as materials that were relatively intact (Rollans and McKeand 1992; Stantec 2003). Remains from these excavations consisted of debitage, fire-cracked rock, and a small amount of bone. An Avonlea projectile point and an indeterminate Prairie or Plains point was also recovered (Rollans and McKeand 1992).



Figure 2.1 Location of the Hartley site within the city of Saskatoon (taken from googlemaps.ca, modifications made by the author).

In 1987, Cairns Developments Ltd. announced plans to develop a residential area in Saskatoon which was to be called Southridge. Since such a large amount of archaeological materials was previously demonstrated, the proponent was required to conduct an impact assessment prior to any construction (Rollans and McKeand 1992; Stantec 2003). The impact assessment that was conducted included the area that encompassed the Hartley Site, but not the Bill Richards site. Millenium Consulting was contracted to conduct this investigation. The testing program covered an area of approximately 400 by 400m which straddled Preston Avenue beginning just south of Melville Street (Table 2.1). Auger holes were placed on a grid 10 m apart for tests. The results suggested that intact cultural remains were concentrated in an uncultivated Brushy Depression on the west side of Preston Avenue (Millenium 1988). Following the testing conducted by Millenium Consulting, the Hartley Site was recommended as suitable for an area of research for the University of Saskatchewan Archaeological Field

School directed by Dr. David Meyer (Meyer 1989; Rollans and McKeand 1992; Stantec 2003).

Table 2.1 Total number and location of units excavated at the Hartley site.

Year	Party Involved	Location	Units Excavated
1950's	Saskatoon Archaeological Society	East Side of Preston Ave	Not Known
1987	Millenium Consulting	Entire Site	Auger Holes
1988-1995	U of S Field School	Brushy Depression	101.5 m ²
1988-1995	U of S Field School	Wooded Hollow	12 m ²
1992	Western Heritage Services Inc.	North and South Groves	15 m ²
2003	Stantec Consulting Ltd.	Wooded Hollow	20 m ²
2003	Stantec Consulting Ltd.	South Grove	26 m ²
2003	Stantec Consulting Ltd.	North Grove	4 m ²
2004	Author and Volunteers	Wooded Hollow	4 m ²
2006	Buena Vista Elementary School	Wooded Hollow	?
Total			182.5 m²

From 1988 to 1995 the field school extended the grid previously established by Millenium Consulting and began excavations in the Brushy Depression and a more northerly area called the Wooded Hollow (Figure 2.2). Most of the excavations were concentrated in the Brushy Depression and, as certain productive units were identified, the excavations were expanded. This work revealed a multi-occupational archaeological site (Clarke and Meyer 1992; Meyer 1989; 1995). Various lithic and ceramic materials were recovered along with an abundance of bison bone (Clarke and Meyer 1992; Meyer 1989; 1995). In total, 104 complete and incomplete projectile points were recovered, consisting of both Prairie Side-Notched and Avonlea type points (Stantec 2003:1.4). Also, hundreds of Old Women's and Avonlea ceramic sherds were documented. In all, 101.5 square metres were excavated in the Brushy Depression (Table 2.1).

The Wooded Hollow excavations were much less extensive compared to those in the Brushy Depression. Excavations in this area of the site were conducted by the field school with the aid of elementary school students from the Saskatoon Catholic School Board Extended Learning Opportunities Program (Meyer 1995). In total, 12 square metres were excavated (Table 2.1). The materials recovered mirrored those of the Brushy Depression, although the occupation in this area appeared to be more consistent with a processing site, and, the artifacts seemed to be widely and evenly distributed (Meyer 1995:17-18).

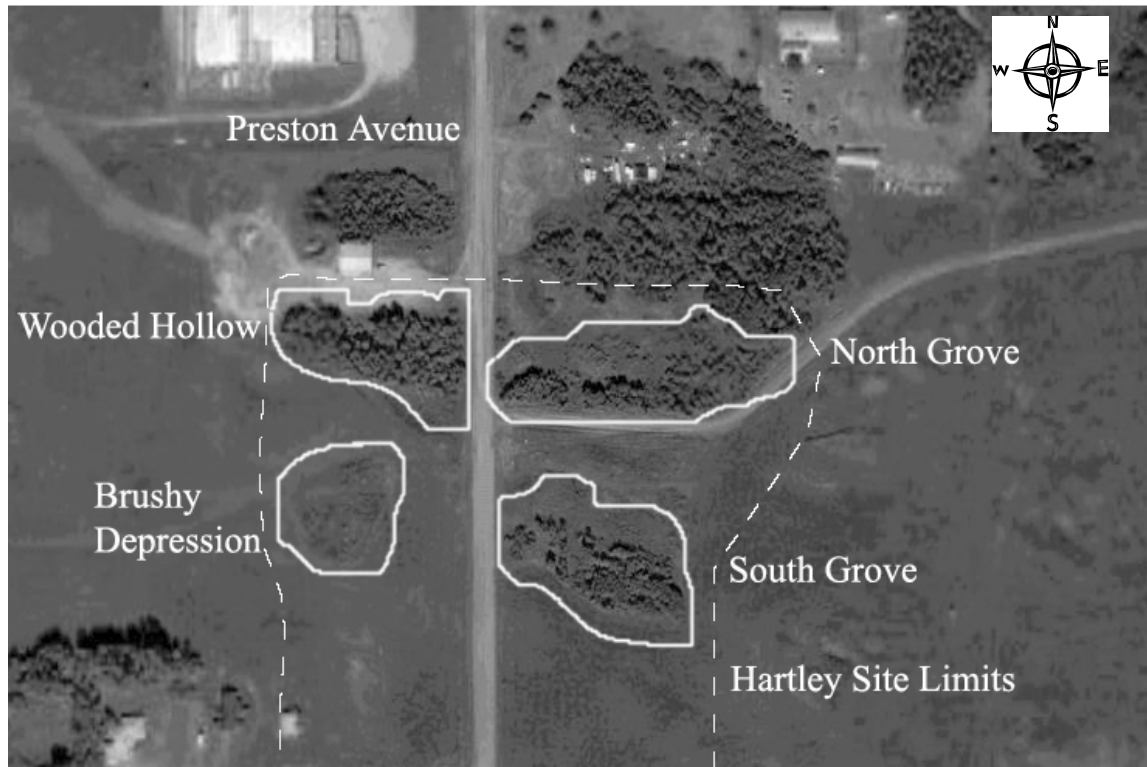


Figure 2.2 Aerial photograph detailing the location and layout of the Hartley site (taken from GoogleEarth.ca, modifications made by the author).

Over the years of 1988, 1989, and 1990, the University of Saskatchewan field school excavated a total of 49.5 square meters located in the area known as the Brushy Depression (Clarke 1995:3). The materials recovered during this time period were analyzed by Grant Clarke for his 1995 thesis entitled “*The Hartley Site (FaNp-19): Interpreting a Transitional Avonlea/Old Women’s Faunal Assemblage*”. Most of the artifacts recovered from these excavations were Avonlea/Old Women’s with occasional Mortlach specimens (Clarke 1995). Subsequently in 1992, Meyer extended the excavations to the south and the east of the Brushy Depression and found material remains indicative of a Mortlach occupation. Eventually it was determined that the Mortlach materials unearthed in the Brushy Depression represented a sparse occupation, or they were intrusive (Clarke 1995:12) (Figure 2.3).

Later in 1992, Western Heritage Services Inc. was hired to conduct an impact assessment at the Hartley site and tested both the North and South groves on the eastern side of Preston Avenue (Figure 2.2). A total of 15 units were excavated (Table 2.1).

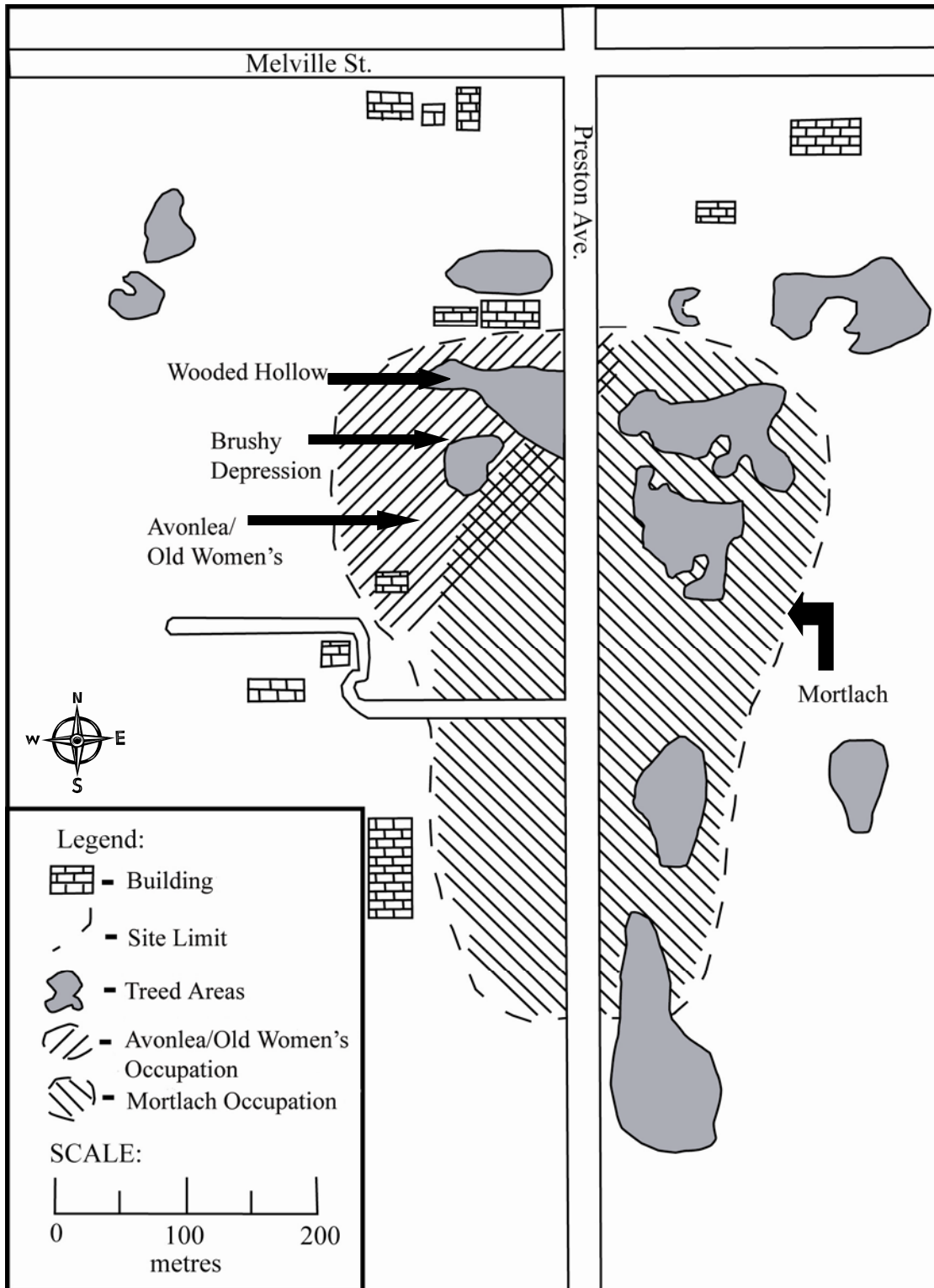


Figure 2.3 Distribution of cultural phases at the Hartley site (taken from Clarke (1995:13), changes made by the author).

All but one of these units contained artifacts. They found the most productive units to be in the southern part of the South Grove, and the eastern part of the North Grove

(Rollans and McKeand 1992). A total of 796 artifacts were recovered consisting of various ceramic sherds (likely from the same vessel), several pieces of lithic debitage including a variety of material types, a number of lithic tools including a biface and two flakes with unifacial retouching, one bone tool, which was likely used as an awl, and many bone fragments. Rollans and McKeand (1992:10-12) noted that 82% of the faunal material was unidentifiable as to skeletal element and taxon, and the greatest amount of unidentifiable bone by weight was burned. Although they concluded that the artifact densities were much lower in this area compared to the western side of Preston Avenue, the remains were still significant in demonstrating a Mortlach assemblage.

In July of 2003 Stantec Consulting Ltd was contracted to excavate an additional 50 units at the Hartley Site in order to fulfill the requirements regarding the upcoming subdivision development in the area. Since so much previous work had been completed in the area, a review was conducted in order to assess all of the previous testing, excavations, locations, and recorded artifact densities for the Wooded Hollow and the North and South Groves on the eastern side of Preston Avenue (Stantec 2003). Stantec Consulting Ltd. adopted the grid that was originally used by Millenium Consulting and later by the University of Saskatchewan field school. All testing was subsequently applied according to this system. This facilitated any re-location of previously tested areas and any grid intersections on the ground. To begin, five new test pits were excavated in the Wooded Hollow, two in the South Grove, and eight in the North Grove. Based on results from these test pits, larger excavation blocks were opened in all three of these areas (Stantec 2003:1.5-1.6). At the end of the excavations an additional 20 square metres were excavated in the Wooded Hollow, 26 square metres in the South Grove, and 4 square metres in the North Grove (Table 2.1).

The intent of the 2003 excavations was to establish the limits of significant areas in which material remains existed. It was determined that all three areas were distinct in terms of materials recovered and could provide additional information to the previous works (Stantec 2003:1.7-1.8). The Wooded Hollow demonstrated a floor covered densely with artifacts (primarily bison remains) while the remains recovered from the North and South Groves were very different. While the South Grove clearly contained

campsite remains, the recoveries from the North Grove were sparse and very limiting for interpretation (Stantec 2003).

In May of 2004, four additional square metres were opened in the Wooded Hollow by the author and various other graduate and undergraduate students (Table 2.1). These units were laid out using the same grid previously established by Millenium Consulting Ltd. The four units excavated were located north of the 2003 excavation, closer to previously excavated units where more significant recovery of materials had been made by participants in past field schools.

In addition to the thesis put forth by Grant Clarke, a second thesis entitled *Fine Screen Analysis from the Hartley Site (FaNp-19)* was completed by Deborah Farrow in June 2004. Farrow (2004) confirmed Clarke's (1995) thesis regarding species consumed, however, additional recovery of specimens from animals that hibernate in the winter suggested that the season of occupation may have extended later into the spring than was previously thought. Lastly, a number of units were also opened and excavated by the Buena Vista elementary school students during the summer of 2006 under the supervision of Butch Amundson. The intent of the 2006 excavations was to introduce the elementary school students to archaeology and proper excavation techniques.

Through the long history of the excavations at the Hartley site, substantial information of an archaeological nature was obtained. Although it was determined that the site consisted of two major, separate occupations (an Avonlea/Old Women's occupation and a Mortlach occupation), it was peculiar in that the earlier Avonlea/Old Women's occupations were not separate and were in fact deemed as being contemporaneous with one another. In part, this conclusion was reached due to the equal numbers of Avonlea and Prairie Side-notched points recovered, and the fact that some points were stylistically intermediate between these two types. Furthermore, it was noted that the pottery appeared to be transitional between Avonlea and later pottery styles (Meyer 1997:7). Lastly, all the bone that was recovered seemed to be weathered in a uniform manner, suggesting that deposition of the materials occurred at one time (Clarke 1995). Meyer (1997) suggested that two possibilities could have accounted for this co-occurrence of materials: either the site represented a transitional culture; or it was co-habitated by two separate groups that had coalesced for a time.

2.2 Location, Physiography and Soils

The Hartley site is located in the NE quarter of section 10, township 36, range 5, west of the third meridian. It is situated in the extreme northern tip of Moose Woods Sand Hills area of the Saskatchewan Plains which is characterized by undulating topography with local relief usually less than 3 metres (Acton and Ellis 1978:3). The regional aspect and relief of the Moose Woods Sand Hills is characterized by heights of 530 meters above sea level except for the alluvial plains at the edge of the South Saskatchewan River. Elevation decreases to 490 metres above sea level in these areas (Acton and Ellis 1978:6; Acton et al. 1998:151).

Ecologically, the Hartley site is located within the Moist Mixed Grassland Ecoregion which extends from Saskatchewan southward all the way to Texas (Acton et al. 1998). The Moist Mixed Grassland Ecoregion represents the northernmost extension of the open grasslands that lie, for the most part, to the south (Figure 2.4). Often, small concentrations of wooded vegetation such as trembling aspen are found in association with more moist areas. The immediate area surrounding the Hartley site is characterized by a series of sand dunes that have, over a long period of time, collected vegetation and moisture on their advancing sides and, as a result, these dune sides have stabilized.

The soils within the study area belong to the Asquith soil association. These are Dark Brown Chernozemic soils formed under grassland vegetation (Acton and Ellis 1978; Acton et al. 1998; Christiansen 1970). As the name implies, the dark brown soils have a dark-coloured surface layer characterized by a relatively high concentration of organic matter. A reddish-brown layer free of carbonates, calcium, and magnesium separates this brown layer from a greyish-brown layer, which represents the parent material of the soil (Acton et al. 1998; Canada Department of Agriculture 1974). In terms of composition, the Dark Brown Chernozemic soils developed on coarse to moderately coarse textured fluvio-lacustrine deposits containing less than 50 percent clay. Surface textures are characterized by loamy sand, sandy loam, and very fine sandy loam. Although this Orthic Dark Brown Chernozem is the predominant soil type in this area it can also frequently be found in combination with Gleysolics, Calcareous Dark Brown, and salinized or carbonated Chernozems (Christiansen 1970).

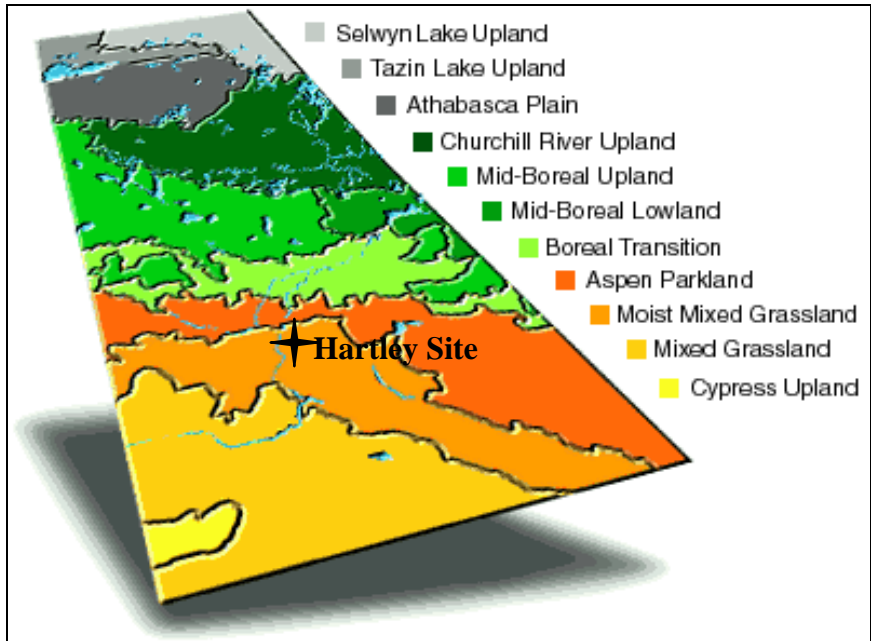


Figure 2.4 Ecoregions of Saskatchewan (taken from goCanada.com, additions made by the author).

2.3 Geology

The bedrock geology of the Moist Mixed Grassland Ecoregion consists mainly of marine sedimentary rocks of the Bearpaw Formation (Acton et al. 1998). The Bearpaw Formation is characterized largely by shales and gray-green silty mudstones that resulted from sedimentary deposition during the later end of the Cretaceous Period (Acton et al. 1998; Gordon 1979). Saskatchewan, along with much of North America, was covered by a large marine seaway that extended from the Arctic to the Gulf of Mexico throughout this time period (Fung 1999). The Cretaceous rocks have been an important resource for Saskatchewan as they are major reservoirs of oil and natural gas. In addition, many of the Cretaceous deposits have been very productive for paleontologists as they are highly fossiliferous. Many species of bivalves and cephalopods have been recovered from these deposits (Gordon 1979).

2.4 Climate

The climatic episodes that correspond with the time of occupation at the Hartley site are known as the Neo-Atlantic and Pacific. The Neo-Atlantic period ranges in time from 1260 to 850 BP and represents the culmination of a warming trend that began in

the preceding Scandic climatic episode (Wedland 1978:281). In terms of precipitation, it is thought that rainfall was similar to that of today. The Neo-Atlantic was more moist, however, than the preceding Scandic episode, as well as the two episodes that followed (Semken and Falk 1987). The Pacific climatic episode ranges from *ca.* 400 to 850 BP and began with an increase in droughty conditions. This period ended with the onset of the neo-Boreal, or Little Ice Age, when the climate began cooling (Wedland 1978).

Köppen's climate classification scheme, which defines climactic regions with respect to natural vegetation type, classifies the modern climate of the Hartley site as *Dfb* (Fung 1999). *Dfb*, or the humid continental type, roughly corresponds with the aspen parkland and mixed forest regions of Saskatchewan. Winters are characteristically long and cold and summers are rather warm. The annual mean temperature for the city of Saskatoon is 2.0 degrees Celsius while monthly mean temperatures range from -25.7 degrees Celsius in January to 25.3 degrees Celsius in July. The annual mean precipitation for this area is 360 mm, however, the mean annual snowfall contributes roughly 106 mm to this precipitation. The number of annual hours of bright sunshine is 2,381 which contribute to a mean percent sunshine of 50.5 percent. The average speed of surface winds ranges between 14 and 18 km per hour (Fung 1999:100-115).

2.5 Hydrology

The Hartley site lies approximately five kilometres to the southeast of the South Saskatchewan River. This river is thought to be the closest and most reliable supply of good quality water in this area of the province. Water from the Red Deer, Bow, and Oldman rivers are the three main tributaries that contribute to the South Saskatchewan. These rivers originate on the eastern slopes of the Rocky Mountains and converge near the Alberta border to form the South Saskatchewan River. Previous to the construction of the Gardiner Dam, the river was subjected to much more flooding than is experienced today. Excessive spring runoff was the major cause of flooding prior to the construction of the dam (Sask Water 1999). The only other sources of water that have been documented in the area consist of ephemeral sloughs in which of local runoff collects.

These sloughs are not permanent and 90 percent of their water will be returned to the atmosphere via evaporation (Sask Water 1999).

2.6 Local Flora

Agriculture has largely affected the vegetation present around the Hartley site. Approximately 80 percent of the ecoregion is currently under cultivation (Acton et al. 1998:142). Spring wheat and other cereal grains are produced by utilizing wheat or other grain-fallow rotation. Oilseed crops such as canola are also becoming increasingly important. In some areas nearly all farmland is cropland and in other areas some of the land is not suited for cultivation and are used instead as pasture for livestock. In the immediate area of the Hartley site, three large PFRA community pastures are present and occupy much of the sandy soil. Other introduced species to the area include the red elder (*Sambucus racemosa*), the Manitoba maple (*Acer negundo*), and the buckthorn (*Frangula alnus*). In terms of precontact vegetation, various areas in which cultivation has proven to be unsuitable, the native vegetation has prevailed. It is from these small windows of information that a larger picture has been drawn with regards to the floral species that were prevalent prior to the arrival of the Europeans.

There is an abundance of native vegetation in the vicinity of the Hartley site and the majority of the plant life alternates between those of shrubland and grassland origin. Although Thorpe (1999) places the site within an outlier of the Aspen Parkland, Acton et al. (1998) have composed a much more detailed analysis of the ecoregions of Saskatchewan. In this analysis, the Hartley site has been placed within the Moist Mixed Grassland Ecoregion. The Moist Mixed Grassland Ecoregion represents a transition in which tree cover becomes much less significant within areas of natural vegetation. Occasional aspen groves are noted on this landscape, however, the occurrence of such vegetation is the result of growth around small water bodies. The decline of fescue prairie as a major community type is the result of replacement by mixed prairie. Mixed prairie is the term used to describe a mixture of midgrasses (grasses with foliate reaching heights of 20 to 30 cm) and shortgrasses (grasses with foliage below the height of 10 cm). Various species of midgrasses and shortgrasses have been documented near the Hartley site (Acton et al. 1998; Thorpe 1999).

The abundant vegetation that is found in the Moist Mixed Grassland Ecoregion consists of a variety of midgrasses and shortgrasses. The midgrasses that are present in the area are western porcupine grass (*Stipa curtisetata*), needle-and thread grass (*Stipa comata*), green needle grass (*stipa viridula*), northern wheat grass (*Agropyron dasystachyum*), and western wheat grass (*Agropyron smithii*). June grass (*Koeleria macrantha*) and plains reed grass (*Calamagrostis montanensis*) are also present. The shortgrasses that are also dominant in the area consist of blue gamma grass (*Bouteloua gracilis*) and a variety of sedges such as the low sedge (*Carex eleocharis*), sun loving sedge (*Carex pennsylvanica*), and thread-leaved sedge (*Carex filifolia*). It should be noted that the majority of this region is dominated by western porcupine and northern wheat grasses. Plants of this sort are typical of loamy-textured morainic uplands (Fung 1999). Juniper (*Juniperus sp.*), chokecherry (*Prunus virginiana var melanocarpa*), saskatoon (*Amelanchier alnifolia*), willow (*Salix sp.*), wolf willow (*Elaeagnus commutate*), western snowberry (*Symphoricarpos occidentalis*), and the prairie rose (*Rosa arkansana*) also thrive in this area (Acton et al. 1998; Thorpe 1999).

The small aspen groves interspersed on the landscape are composed of trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), a few Manitoba maples (*Acer negundo*) diamond willows (*Salix rigida*), and an understory of shrubs, herbs, and grasses. The shrubs prevalent in this area include western snowberry (*Symphoricarpos occidentalis*), creeping juniper (*Juniperus horizontalis*), bearberry (*Arctostaphylos uva-ursi*), dogwood (*Cornus sp.*) and the prairie rose (*Rosa arkansana*) while the herbs are represented by the western Canadian violet (*Viola canadensis var rugulosa*), smooth and showy aster (*Aster conspicuus* and *Aster laevis*), and small bedstraw (*Galium trifidum*). Bluegrass, as well as a variety of other sedges, are the characteristic grasses in the aspen groves (Acton et al. 1998).

Wetlands are also present in the Moist Mixed Grassland Ecoregion. Although not common, wetlands provide a different array of vegetation as the salinity in the soils cause a shift towards salt-tolerant species. Saltgrass (*Distichlis spicata*), Nuttall's alkali grass (*Puccinellia nuttalliana*), red samphire (*Salicornia rubra*), sea blite (*Suaeda maritima*), and alkali bulrush (*Scirpus paludosus*) are all common to wetland habitats. In areas where accumulations of soluble salts are prevalent, the representative plant

species include desert saltgrasses and Nuttall's alkali grass. In cases where the salinity becomes too high for these species, annual halophytes, especially red samphire (*Sarcocornia quinqueflora*) and sea blite (*Suaeda sp.*), are common (Acton et al. 1998).

2.7 Local Fauna

The Moist Mixed Grassland Ecoregion supports numerous species of birds, mammals, and to some degree fish. The variety of species can be attributed to the diversity in the landscape. Local settlement and the growth of the city of Saskatoon have resulted, however, in a scarcity of some forms of local wildlife compared to those of past times. It should be noted that a compilation with regards to the present fauna inhabiting the Opimihaw Creek Valley in Wanuskewin Heritage Park north of Saskatoon has recently been documented, and although the Opimihaw creek offers a more diverse array of resources to its inhabitants it is unlikely that the fauna of the area would have been restricted only to this creek. It has therefore been suggested that many of the species that have been documented in the Opimihaw Creek Valley could also be found around the area surrounding the Hartley site. For a more detailed listing of regional mammalian fauna, avian fauna, amphibians, reptiles, and fish consult Webster (1999:233-249).

2.7.1 Mammalian Fauna

Prior to the arrival of the Europeans, vast herds of ungulates and their predators represented a large portion of the mammalian fauna on the Plains. During the fur trade, the pursuits of animals such as the beaver (*Castor canadensis*), mink (*Mustela vison*), and other fur-bearing animals caused a large reduction in the numbers of these animals. Also, in order to make room for agricultural settlement, the great herds of bison (*Bison bison*) were essentially wiped out by the mid 1880s. Remnant herds of elk (*Cervus elaphus*) and pronghorn (*Antilocapra americana*) also contracted their ranges to the southwest and forested central areas. Large carnivores, as a result, lost their prey and subsequently became the targets of massive poisoning, trapping, and shooting campaigns. The grizzly bear (*Ursus arctos*), wolf (*Canis lupus*), and wolverine (*Gulo gulo*) were all sought out and extirpated. Smaller mammalian species such as the black-

tailed prairie dog (*Cynomys ludovicianus*) were also targeted, the latter becoming extinct. The black-footed ferret (*Mustela nigripes*) and swift fox (*Vulpes velox*) were unintended victims of this poisoning campaign, but suffered the consequences nonetheless (Waple 1999).

Various species of large mammals still inhabit the area around the Hartley site. Some larger mammals that have been documented over the area include the coyote (*Canis latrans*), wolf (*Canis lupus*), mountain lion (*Felis concolor*), striped skunk (*Mephites mephites*), badger (*Taxidea taxus*), red fox (*Vulpes vulpes*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and pronghorn (*Antilocapra americana*) (Waple 1999). The smaller mammals that have been noted include the mink (*Mustela vison*), the raccoon (*Procyon lotor*), and the least weasel (*Mustela nivalis*). Three species of leporids have also been spotted including the white-tailed jackrabbit (*Lepus townsendii*) and Nuttall's cottontail (*Sylvilagus nuttallii*) as well as the reintroduced snowshoe hare (*Lepus americanus*). This species flourished after reintroduction to the area as a result of the presence of moderately sparse aspen vegetation. This species is adapted to areas consistent with the plant life of the Hartley site (Acton et al. 1998; Waple 1999).

Various rodents have also been identified around the Hartley site. The least chipmunk (*Eutamias minimus*), Franklin's ground squirrel (*Spermophilus franklinii*), Richardson's ground squirrel (*Spermophilus richardsonii*), the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), and the northern pocket gopher (*Thomomys talpoides*) are all common. Various species of mice, voles, and shrews have been noted and the most common species include the meadow vole (*Microtus pennsylvanicus*), the sagebrush vole (*Lemmiscus curtatus*), the meadow jumping mouse (*Zapus hudsonicus*), the prairie vole (*Microtus ochrogaster*), the deer mouse (*Peromyscus maniculatus*), and the white-footed mouse (*Peromyscus leucopus*) (Acton et al. 1998).

2.7.2 Avian Fauna

The species of birds known to inhabit the Moist Mixed Grasslands Ecoregion include 92 summer residents and 10 species of permanent residence. Sixteen additional species are summer visitors which do not breed in the district while seven species of

birds are winter residents (Acton et al. 1998:146). The most common of the avian fauna includes three raptors: the short-eared owl (*Asio flammeus*), the northern harrier (*Circus cyaneus*), and the burrowing owl (*Speotyto cunicularia*). The sharp-tailed grouse (*Tympanuchus phasianellus*) is known to inhabit the area as is the Baird's sparrow (*Ammodramus bairdii*), Sprague's pipit (*Anthus spragueii*), the chestnut-collared longspur (*Calcarius ornatus*), the horned lark (*Eremophila alpestris*), the savannah sparrow (*Passerculus sandwichensis*), the vesper sparrow (*Pooecetes gramineus*), McCown's longspur (*Calcarius mccownii*), and the western meadowlark (*Stumella neglecta*). As Saskatchewan is located along a major migratory route, it is not surprising that such a large number of species of avian fauna have been documented to date (Acton et al. 1998).

Saskatchewan, the Saskatoon region in particular, is an important area for breeding birds (Smith 1999:150). Up to one third of Canada's gadwall (*Anas strepera*), american wigeon (*Anas americana*), mallard (*Anas platyrhynchos*), blue-winged teal (*Anas discors*), northern shoveler (*Anas clypeata*), northern pintail (*Anas acuta*), canvasback (*Aythya valisineria*), ruddy duck (*Oxyura jamaicensis*), willet (*Catoptrophorus semipalmatus*), american avocet (*Recurvirostra americana*), redhead (*Aythya americana*) california gull (*Larus californicus*), and franklin's gull (*Larus pipixcan*) are known breeding species in marshes and sloughs. American white pelicans (*Pelecanus erythrorhynchos*) and bald eagles (*Haliaeetus leucocephalus*) are often found summering in this region. During the migration season the white-fronted goose (*Anser albifrons*), lesser snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*) ross's goose (*Anser rossii*), sandhill crane (*Grus canadensis*), and sandpiper (*Calidris pusilla*) stop over in the province (Bellrose 1980; Smith 1999).

2.7.3 Amphibians and Reptiles

Amphibians and reptiles are not prevalent in the Moist Mixed Grasslands Ecoregion. Five species of snake, six species of frogs and toads, one species of turtle, and one species of salamander have been documented in the range of this ecoregion. The tiger salamander (*Ambystoma tigrinum*), the great plains toad (*Bufo hemiophrys*), the painted turtle (*Chrysemys picta*), the plains garter snake (*Thamnophis radix*), the

boreal chorus frog (*Pseudacris triseriata*), the wood frog (*Rana sylvatica*), and the northern leopard frog (*Rana pipiens*) are the most common amphibians and reptiles that have been noted to date (Acton et al. 1998).

2.7.4 Fish

Forty-one species of fish have been documented in the Moist Mixed Grasslands Ecoregion. The most common species that have been recorded to date include the walleye (*Stizostedion vitreum*), the northern pike (*Esox lucius*), the yellow perch (*Perca flavescens*), and the burbot (*Lota lota*). In addition, several species of trout have been introduced. Lastly, the goldeye (*Hiodon alosoides*), sauger (*Stizostedion canadense*), and the lake sturgeon (*Acipenser fulvseceus*) are fish that inhabit the South Saskatchewan River (Acton et al. 1998).

2.7.5 Molluscs

The only species of molluscs that have been documented at the Hartley site came from the excavation of the Brushy Depression (Clarke 1995). Evidence of gastropods from the family Lymnaeiform and the family Planorbis both suggest a wetter environment in the past than today. The presence of the genus Vallonia suggests, however, that the area was similar to today's physiographic environment with copses of aspen bluffs interspersed throughout the landscape (Clarke 1995).

Chapter Three
Cultural Occupation at the Hartley Site
3.1 Cultural Chronology

Prior to discussing the cultural occupations noted at the Hartley Site it is required to discuss the cultural developments on the Northern Plains and how they have been placed within a cultural historic framework. First, however, it is necessary to discuss taxonomic terms and their common usage in devising an appropriate chronology of the Northern Plains archaeological remains. Willey and Phillips (1958:21-37) presented an early approach to classifying past cultures, including components, phases, traditions, and horizons. Firstly, a component is defined as the manifestation of a single occupation period at any given site. Therefore, an archaeological site whereby the material remains are limited to one level can be considered as a single component site. Secondly, a phase is a series of components limited spatially by a locality or a region and chronologically to a relatively brief period of time. Conversely, a tradition is defined as the persistence of a single technology or other cultural expression that appear with temporal continuity. In the case of this thesis, Dyck's (1983:69) definition of a horizon is employed. A horizon is represented by cultural traits that show a broad and rapid expansion, whereas a series is a set of components which display progressive change over time in a common spatial area.

Several archaeologists have attempted to establish a recognized cultural chronology for the Plains region. As the focus of this thesis is limited to one of the most recent time frames, discussion will not focus on the chronological divisions of the time periods known as the Paleo-Indian and Middle Precontact Periods as defined by Walker (1992:120). Dyck (1983) was one of the first to propose a framework specifically geared towards the cultural history of Southern Saskatchewan. In this framework, the term Late Plains Indian Period was proposed and it was suggested that this period spanned the time frame from 2000 B.P. to 170 B.P. Dyck defined this period by the appearance of arrow points and ceramics, however, it was noted by both Dyck (1983)

and others (Vickers 1994:7) that the selection of the beginning of this period was rather arbitrary while at the same time noting that to define the beginning of this period is, indeed, somewhat of a guessing game (Dyck 1983:110). In Dyck's (1983) chronology, the Late Plains Indian period is divided into various complexes and series. More recently, however, Walde et al. (1995) employed the term Late Plains Period to identify the time period beginning roughly 2,000 years ago, although it has been cited as beginning as far back as 2,500 years ago beginning with the Besant phase (Harty 2005:17). For simplicity, this period will be referred to as the Late Precontact Period. The Protohistoric period is also of significance to the Hartley site as materials of this nature have been recovered in certain areas of the site. In this chapter, an overview of the Late Precontact and Protohistoric Periods with reference to the Saskatoon area is attempted, followed by a discussion of the stratigraphy and burial conditions in the Wooded Hollow. A brief overview of some of the cultural materials recovered from this site is given as well as discussion relating to radiocarbon dates.

3.2 Late Precontact and Protohistoric Cultural History of the Saskatoon Area

The Saskatoon area is well-known for the presence of a variety of sites dating to the Paleo-Indian, Middle, and Late Precontact Periods in addition to sites of a Protohistoric nature (Linnamae and Jones 1988). In southern Saskatchewan, the onset of the Late Precontact Period was denoted by a shift in technology associated with the presence of pottery as well as a series of side-notched projectile points believed to be associated with bow and arrow technology, although it is unlikely that the development of these two technologies are related (Walker 1999:26). The northern portion of Saskatchewan has a slightly different culture history when compared to the south and it has been suggested that there is evidence of ongoing interaction between plains peoples and groups from the boreal forest during the Late Precontact Period, particularly in the northern periphery of the parkland region (Meyer and Epp 1990:321). As the Saskatoon area falls within southern Saskatchewan, only the culture history pertaining to this region will be discussed. For further information on the culture history during the Late Precontact Period in northern Saskatchewan, see Meyer (1999:23-24).

3.2.1 The Besant Phase

It is currently debated in the literature whether to include the Besant phase within the Late Precontact Period, as it is thought to be a transitional phase from the preceding Middle Precontact Period (Walde et al. 1995:11). Besant phase materials were first excavated by Boyd Wettlaufer at the Morlach site during the early 1950s (Wettlaufer 1955:39). The Besant phase is thought to be the first cultural period in which the bow and arrow was used, as well as when the first pottery made its appearance (Dyck 1983; Vickers 1994; Walde et al. 1995). The presence of these new technologies is attributed to migration of new peoples into the area from the north-central United States (Dyck 1983). In the Saskatoon area, Besant sites are represented by numerous kill sites, bison jumps, bison pounds, processing areas and habitation sites. Various examples include the Meewasin bison pound in the Opimihaw Valley and the Fitzgerald site just south of the city of Saskatoon (Hjermstad 1996).

Lithic materials recovered from Besant sites are often dominated by an exotic raw material, Knife River flint, but do not exclude local lithic materials (Walde et al. 1995). In addition, Dyck (1983) notes that the initial heavy reliance on Knife River flint seems to taper off in later sites as more local materials seem to be utilized, however, it has also been noted that large bison kill sites characteristic of the Besant Phase are predominantly associated with Knife River flint materials. Due to the frequent presence of abundant bison remains in Besant sites, it has been suggested that people of this phase were extremely effective large-scale bison hunters (Frison 1971).

3.2.2 The Avonlea Horizon

Kehoe and McCorquodale (1961:179) originally suggested that the Avonlea point was sufficiently unique and temporally delimited to function as a useful marker for the Late Precontact Period. Diagnostic Avonlea points have been described as "...ubiquitous small, triangular, side-notched projectile points" (Kehoe and McCorquodale 1961:179). In terms of overall morphology, the Avonlea projectile point is a small, thin, and finely pressure flaked projectile point with low shallow notches and a concave base (Kehoe 1966; Walde et al. 1995). These points are considered to be the

first true arrow points, as Besant points are thought to have been used with atlatls (spear throwers) and darts.

The numbers of Avonlea sites that have been analyzed and interpreted over the last number of decades have resulted in the redefinition of the Avonlea entity. Walde and Meyer (2003:139) have suggested that regional variants found at Avonlea sites have made it difficult to accommodate the range of regional variation within the confines of the phase concept. Therefore, it has been suggested to identify the Avonlea entity as a horizon composed of a number of named phases describing regional variants. The regional variants in question are distinguished by the type of pottery that has been found at Avonlea sites. Walde (2006a:189-192) and Walde and Meyer (2003:139-142) note that four types of pottery have been identified, based on the characteristic surface finish. Rock Lake Net-Impressed ware, Truman Parallel Grooved Ware, Plain, and Ethridge Ware have been noted at numerous Avonlea sites, although Harty (1995:19) notes that the net-impressed pottery is the most common. This horizon is recognized on the Canadian Plains from 1,500 BP (Walde et al. 1995:24) to roughly 1,100 BP (Reeves 1983:102). With the exception of the Hartley site, other sites in the Saskatoon area containing Avonlea components are of the Amisk, Bill Richards, Rousell and Newo Asiniak sites. For a more complete overview of Avonlea sites on the Northern Plains, see Davis (1988).

3.2.3 The Old Women's Phase

The Old Women's phase is characterized by thick, poorly consolidated pottery, and inhabitants from this time period employed split pebble techniques to produce blanks for a variety of tools. This phase is characterized by the presence of both Prairie Side-notched and Plains side-notched projectile points (Vickers 1994). Vickers (1994: 22) suggested that the Old Women's phase may be the continuation of the Besant phase, with the exception that the bow and arrow were more commonly used during the former phase. It has also been argued that the Old Women's phase originated as the result of the amalgamation of Avonlea and Besant cultural elements. It has been suggested that increased climatic aridity led to reduced numbers both of bison and human populations, and as a result, people adopted an exogamous marriage system. The sharing of mates

and likely information between Avonlea and Besant peoples could have led to the cultural amalgamation seen in the Old Women's phase (Vickers 1994).

Walde and Meyer (2003:142) have noted that a solid relationship exists between pottery from the Old Women's phase and Ethridge Ware pottery commonly found in Avonlea sites in Alberta. It is proposed that the presence of Ethridge Ware in later Avonlea Horizon assemblages in addition to the subsequent dominance of this ware in Old Women's components reflects cultural continuity. The most famous site containing an Old Women's component is the Old Women's buffalo jump site in Alberta. In the Saskatoon area, however, other sites known to have Old Women's Phase components include the Tipperary Creek site (FbNp-1), the Tschetter site (FbNp-1) and the Hartley site (FaNp-19).

3.2.4 The Mortlach Phase

It appears that the Old Women's phase was eventually expelled from the plains of Saskatchewan by the Mortlach phase, and in Alberta, by the One Gun phase. The Mortlach phase has been characterized containing Plains Side-Notched points and ceramics that demonstrate some attributes derived from the Middle Missouri area (Vickers 1994:24). Malainey (1991:4) noted that the definition of Mortlach has changed from a type, to a ware, to a phase, to a complex and even an aggregate. Walde (2004a:40-41) chooses, however, to utilize the word "phase" when discussing Mortlach materials and for simplicity and consistency, this taxonomy is followed, although it is recognized that two subphases known as the Lozinsky Subphase and the Lake Midden Subphase have been proposed as representing groups identified by different ceramic attributes and participation in exchange networks (Walde et al. 1995).

According to Walde (2004a), the Mortlach phase is relatively well defined geographically. Sites containing Mortlach components have been identified in southwestern Manitoba, southern Saskatchewan, northeastern Montana and the northern portion of North Dakota. Walde (2004a) suggests that although *in situ* Mortlach components have not yet been identified in southeastern Alberta, pottery characteristic of the Mortlach phase has been identified in avocationalist collections from the region. Walde and Meyer (2003:144) note that Mortlach pottery is quite distinctive in the thin-

walled vessels with complex dentate-stamped decoration on wedge-shaped rims. A variety of surface finishes are noted in Mortlach assemblages: cord-roughened, smoothed, fabric impressed, however, the check-stamped exterior surfaces are the most readily identified.

Mortlach phase components can also be identified through the analysis of lithic assemblages. Knife River Flint materials from the Middle Missouri area and fused shale from the Big Muddy and northern Souris river drainages are often found in Mortlach phase sites. Walde (2004a) notes that the identification of exchange networks through exotic materials is an important component in identifying Mortlach assemblages. The presence of bifacially flaked knives, specifically those formed to be set in slot knives are also characteristic of Mortlach assemblages. Knife River flint end scrapers and potsherd gaming discs are also characteristic of Mortlach assemblages and also suggest contact between Mortlach and Middle Missouri peoples. Worked bone pieces, including ice-gliders have also been noted in a number of Mortlach assemblages. Two ice-gliders were recovered at the Hartley site during Ken Cronk's excavations in the 1950s (Nicholson et al. 2003:129). Based on ethnographic accounts Nicholson et al. (2003:121) suggested that these artifacts were used in a recreational manner and can be dated as far back in the parklands of southern Manitoba and the southern plains of Saskatchewan ca. 1440 A.D.

As was mentioned above, Plains Side-Notched projectile points are often found in association with Mortlach phase sites. Recently, Peck and Ives (2001:163) have suggested a new classificatory system for the projectile points dating from 1,250 B.P. and later. In the article, it is suggested that Plains Side-Notched points in southeastern Saskatchewan dating from 650 B.P. onwards should be referred to as Mortlach points and those from 1,250 to 650 B.P. in southern Alberta and Saskatchewan should be referred to as Cayley Series points. For the purposes of this thesis, however, the projectile points will be referred to by the original terms of Prairie and Plains Side-Notched points. Both Prairie and Plains Side-Notched projectile points and pottery were recovered from the Amisk (FbNp-17), Thundercloud (FbNp-25) and Newo Asiniak (FbNp-16) sites, although it is not clear as to whether these components belong to the Old Women's or Mortlach phases (Amundson 1986; Kelly 1986; Webster 1999). The

Dog Child Site (FbNp-24) was noted as having an identifiable Mortlach component in levels 1a and 1b based on the recovery of diagnostic pottery (Cyr 2006:64-65). The Bill Richards site (FaNp-9) also has a known Mortlach affiliation.

3.2.5 The Protohistoric Period

The Protohistoric period also warrants discussion in this thesis as materials of this nature have been identified at the Hartley site. The Protohistoric Period is often identified at archaeological sites dating to a time during which there was indirect or little contact between the Plains Indians and European people (Russell and Meyer 1999:33). The presence of European trade goods in Mortlach occupations is not uncommon as trade networks were being utilized at least by the mid A.D. 1500s to the mid A.D. 1700s. In an excavation trench to the south of the Brushy Depression, a small piece of sheet copper or brass was recovered. Furthermore, in a second excavation trench located directly east of the Brushy Depression, an iron projectile point was retrieved. Meyer (1995:9) suggested that the presence of these pieces of European goods suggested that the occupation was likely a late Mortlach occupation, dating in the A.D. 1600's. A second site known to have produced Protohistoric material in the Saskatoon area is the Bill Richards site. Trade metal consisting of a copper fragment was recovered during the most recent excavations of this site (Enns-Kavanagh and Whatley 2005:3.28).

3.3 Site Stratigraphy and Burial Conditions

The Hartley Site is located within the Moose Woods Sand Hills area of the Saskatchewan Plains. The stratigraphy of the Wooded Hollow is illustrated in Figure 3.1. Consisting of silty sands which overlie Aeolian sand, it was noted that the well sorted sands were located at the base of the stratigraphic profile which likely represent a time of active dune formation. Once stabilization of this dune formation occurred, the lee side of the dune formed a local wetland and the silty sands found in the area likely represent the catchment of sediments from rainfalls and spring runoffs (Stantec 2003:3.1).

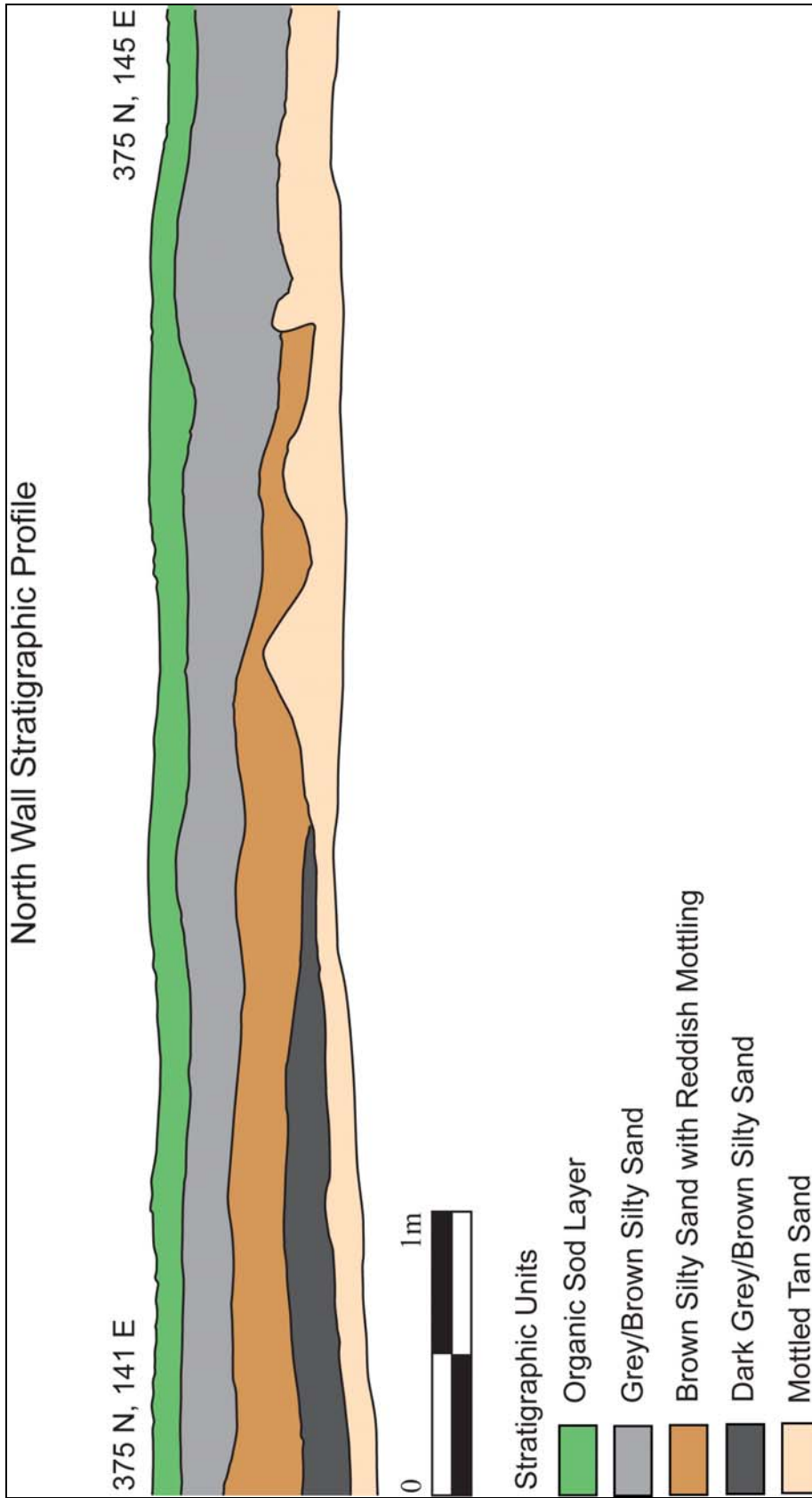


Figure 3.1 Stratigraphic profile of the Hartley Site.

In terms of the overall distribution of cultural materials at the Hartley site, it is thought that occupation began in an early stage of this wetland. It is likely that once the artifacts were deposited, they became buried under further catchment of silty sands as well as a significant accumulation of organic matter from the trees that now occupy the hollow. It is believed that the artifact trap was thick in the loose sand when deposition occurred and, subsequent to burial, bioturbation and frost heave caused considerable vertical migration of the artifacts (Stantec 2003:3.1). Although the occupational layer in the Wooded Hollow is up to 30 cm thick, beginning approximately 8 centimetres depth below surface (DBS) and extending to roughly 40 cm DBS, all evidence, including mended artifacts and consistent faunal content and stages of weathering, points to a single occupation (Clarke 1995:15; Meyer 1990:12-13). It is unfortunate that separation of strata was not more successful, as it is not clear from the stratigraphy whether the Wooded Hollow was occupied once, or several times.

3.4 Cultural Materials and Radiometric Dates

Avonlea, Plains Side-Notched, and Prairie Side-Notched points have been noted in the Brushy Depression and Wooded Hollow areas of the Hartley Site. Clarke's (1995) research demonstrated that a significant intact Avonlea/Old Women's occupation was present in the Brushy Depression, while a Mortlach occupation was noted to the south and to the east (Figure 2.3). In terms of the Brushy Depression, early excavations by the University of Saskatchewan Field School revealed the presence of a few Mortlach pottery sherds. In addition, Clarke (1995:12) notes that other Mortlach materials included "...a bifacially worked slot knife blade and a ground stone axe blade with raised ridges on each side of the central groove". Clarke (1995) suggests that these items are more likely to be associated with the Mortlach occupation than the Avonlea/Old Women's occupation. Because these materials recovered in the Brushy Depression were not found in significant concentrations, they were considered to relate to an extremely sparse part of the Mortlach occupation, which overlapped with the Avonlea/Old Women's occupation, or the materials were intrusive in some way (Clarke 1995). There was never any indication, however, in the field school, consulting, or research excavations that the faunal materials were significantly mixed. To complicate

matters further, other elements of pottery and projectile points that were recovered from the Brushy Depression were noted as somewhat of an anomaly. Meyer (1997:8) believes that the Brushy Depression assemblage is representative of a transitional assemblage between Avonlea and a subsequent compilation dominated by side-notched projectile points and coarse, thick pottery. According to Meyer (1997:7) the pottery appeared, on the whole, to be transitional between Avonlea assemblages characteristic of central Saskatchewan and pottery from later phases. Though equal numbers of Avonlea and Prairie Side-notched projectile points were recovered, a number of points could not be readily classified as either Avonlea or Prairie Side-notched for they had attributes of both. The materials excavated from the Wooded Hollow by the Stantec crew were identified as only Plains Side-Notched points, although a number of triangular points were also recovered (Butch Amundson, personal communication 2007).

A recent radiocarbon date obtained from the Hartley site also appeared to support the idea that the Wooded Hollow may have contained a more substantial amount of Mortlach materials than previously thought. One calibrated radiocarbon date of 660 ± 40 years B.P. was acquired on a single bone sample from the Hartley site (Table 3.1). The sample taken was of an adult bison distal left humerus taken from unit 374N 141E, located in the main excavation block of the Wooded Hollow. The sample was taken from level 3 from a depth of 24.6 cm DBS. This radiocarbon date was calibrated to cal A.D. 1239-1322 at 2 sigma using the Brock University Earth Sciences Radiocarbon Lab (Table 3.1).

Table 3.1 Radiocarbon dates obtained from the Wooded Hollow.

Sample Number	RC Age (Yrs B.P.)	Average Age Reported (Yrs B.P.)	2 Sigma Calibrated A.D.	2 Sigma Calibrated B.P.	Probability Distribution at 2 Sigma
BGS 2663	709 ± 40	660 ± 40	1224-1227	726-723	0.005
			1239-1322	722-628	0.772
			1350-1390	600-560	0.223
BGS 2790	814 ± 40	720 ± 40	1074-1076	876-874	0.003
			1131-1135	819-815	0.005
			1159-1284	791-666	0.992

Due to the nature of this date, a second sample was submitted to the same lab in January of 2007 and the results were similar to that of the original results as a date of 720 ± 40 years B.P. was acquired (Table 3.1). The sample in question, a shaft portion of a right humerus, was taken from a similar depth of 24.0 cm DBS from unit 375N 145E. At two sigma the calibrated date is cited as A.D. 1159-1284 (Table 3.1; Stuiver and Reimer 1993).

The dates obtained proved to be somewhat different when compared to the dates obtained by previous researchers. Clarke (1995:18) obtained both a radiocarbon and a thermoluminescence date. The radiocarbon date, based on a bone sample, was calibrated to cal A.D. 762-1013 ($p=1.00$), with a midpoint of A.D. 930 at 2 sigma using the University of Washington Quaternary Isotope Lab Radiocarbon Calibration Program, Rev. 2.0 (1987). A fired silt sample from a large hearth feature located in unit 280N 106E in the Brushy Depression was processed by the thermoluminescence laboratory at Durham University, England. The sample consisted of pieces of fired sediment collected from the subsoil directly below the hearth and dated to A.D. 700 ± 360 (DUR 93TL170-1Spfg). Clarke (1995) noted that although the standard deviation for the thermoluminescence date is not as refined as the radiocarbon date, the two dates do appear to be comparable in age. A number of other radiocarbon and thermoluminescence dates from the Bill Richards site have also been obtained over the years. These dates can be found in Enns-Kavanagh and Whatley (2005:3.4), but are also summarized in Table 3.2.

Table 3.2 Absolute dates obtained from the Bill Richards site.

Sample Number	Material Submitted	Method	Normalized RC Age B.P.	2 Sigma Calibrated A.D.	2 Sigma Calibrated B.P.
Beta-198692	Bison Metacarpal	RC date	1160 ± 70	690-1010	1260-940
Beta-198693	Bison Mandible	RC date	270 ± 60	1470-1680 1740-1810 1930-1950	480-270 210-140 20-0
Beta-198694	Bison Metacarpal	AMS	50 ± 40	1690-1730 1810-1920 1950-1960	260-220 140-30 0-0
S-2884	Bison Metacarpal	RC date	990 ± 110	890-930	1060-1020

DUR88TL				950-1300	1000-650
124-1BS	Ceramic	TL	320 ± 70	1560-1700	
DUR88TL					
124-2BS	Ceramic	TL	270 ± 60	1620-1800	

Table 3.2 (continued) **Absolute dates obtained from the Bill Richards site**

3.5 Summary

An examination of the culture history of the Late Precontact period of the parkland area of southern Saskatchewan has revealed a complex array of occupations over the last 2,000 years. The Hartley site, located over a large area of the Moose Woods Sand Hills within the City of Saskatoon, provided an ideal location for settlement as well as communal bison hunting. A review of the culture history of the Saskatoon area has revealed that communal bison hunting techniques, specifically those related to the use of the bow and arrow were popular ways of hunting bison over the last 2,000 years.

Two recent radiocarbon dates have revealed that the occupation of the Wooded Hollow area of the Hartley site may be associated with the later Mortlach phase materials in addition to the materials recovered characteristic of the Avonlea Horizon and the Old Women's phase that have been previously found in this area. The remains in the Brushy Depression located immediately to the south of the Wooded Hollow were characteristic of either a transitional or co-occupational Avonlea/Old Women's cultural group. It is not unforeseeable, however, that Mortlach peoples may have occupied the Wooded Hollow, as numerous Mortlach materials have been recovered in the area. A review of the stratigraphy did not yield much additional information as mixing has occurred as a result of rodent behaviour, tree root disturbance and frost action. Associated lithic and ceramic materials indicate that the Avonlea Horizon, Old Women's Phase and Mortlach Phase are represented at this site and in the surrounding region.

Chapter Four

Methodology

4.1 Excavation Methods and Laboratory Work

Different field methodologies have been employed at the Hartley site due to the extensive history of excavation and research in the area. In the Wooded Hollow, three different parties conducted archaeological investigations using different excavation and laboratory methodologies. From 1988 to 1995, the University of Saskatchewan field school excavated a total of 12 square metres. In 2003, Stantec Consulting Ltd. was responsible for the excavation of 20 square metres and finally, in 2004, an additional four square metres were excavated by the author along with the help of various volunteers (Figure 4.1). A review of all of the field and laboratory procedures employed by each of the parties is performed.

4.1.1 Field School Excavation and Laboratory Methods

The field seasons from 1988 to 1995 were a learning experience for undergraduate students enrolled in the department of archaeology field school. The field school was supervised by Dr. David Meyer with the assistance of various graduate students. Excavation procedures began when the units were laid out using the same grid that was established in 1988 by Millenium Consultants (Clarke 1995:22). In the Wooded Hollow, the units were widely spaced throughout this area and aligned five metres apart from one another along the north-south and east-west axes (Figure 4.1). The reason for the spacing of the units was to enable the researchers to determine the extent and nature of the intact occupation in the area (Clarke 1995). Once the units were established, they were divided into four equal quadrants in order to maintain tight horizontal provenience. To maintain a tight vertical provenience the field school students were responsible for excavating in natural layers, except where layers exceeded 10 cm, in which case they were arbitrarily ended and a new level was started (Clarke 1995:22).

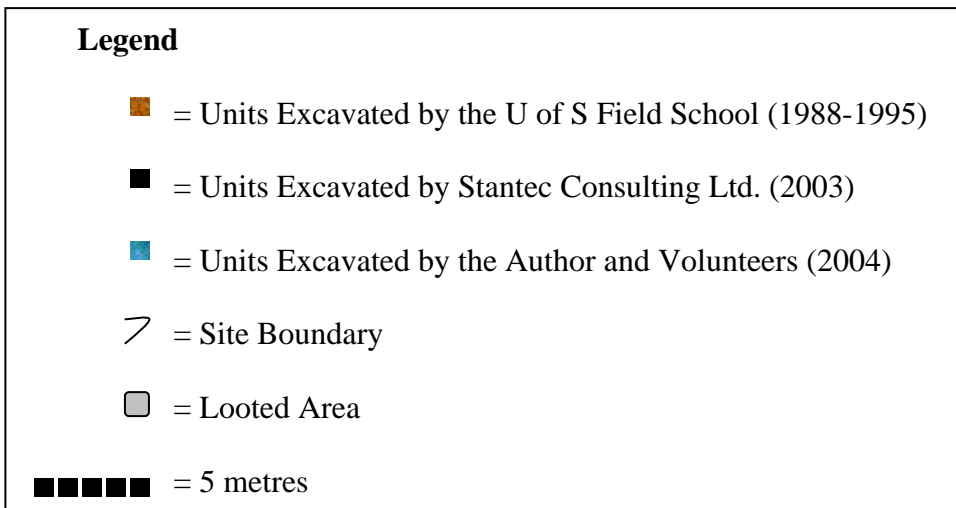
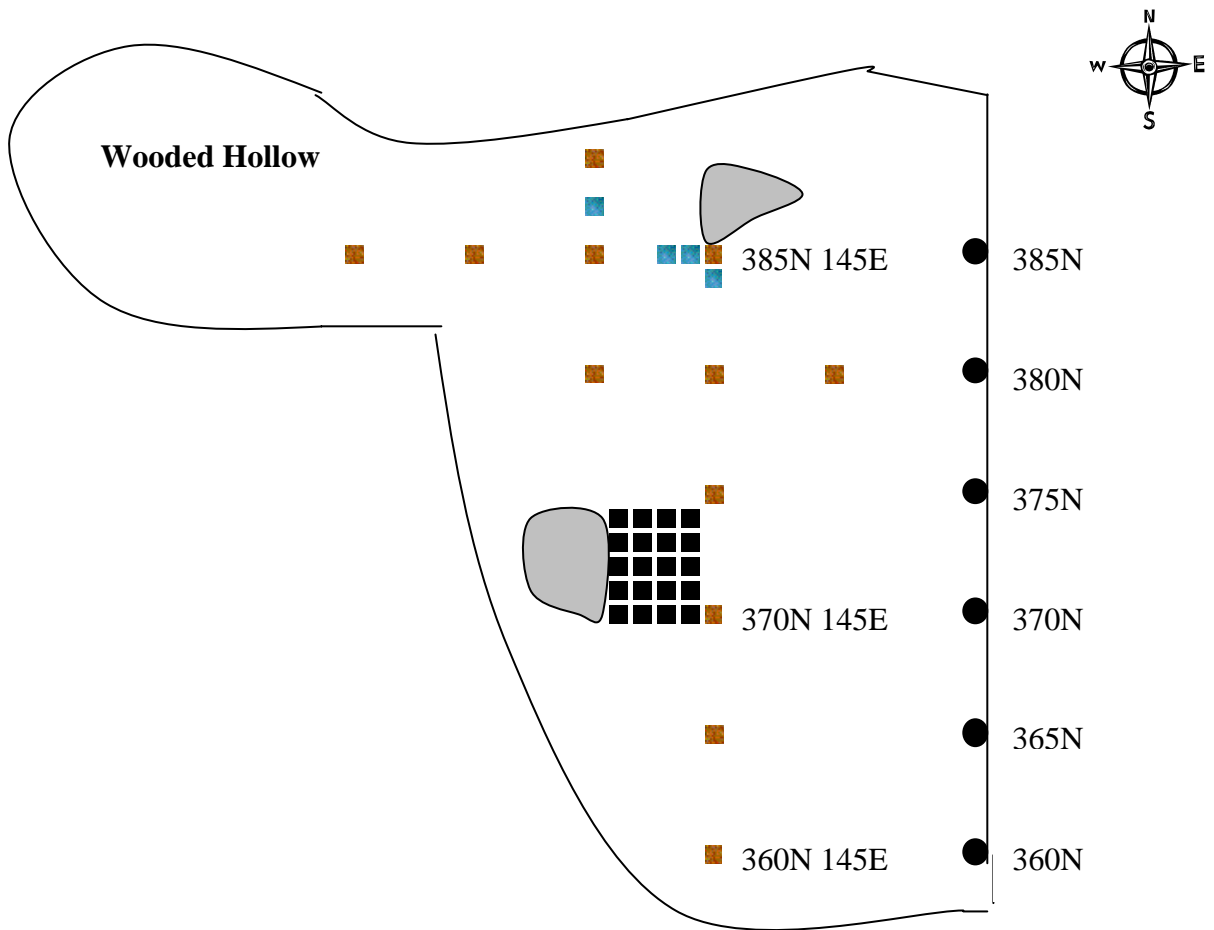


Figure 4.1 Map of the units excavated in the Wooded Hollow.

By the 1989 field season, excavation by natural levels was abandoned and instead units were excavated in 10 cm arbitrary levels and in 1990, it was determined that 5 cm arbitrary levels were more appropriate in maintaining vertical provenience (Clarke 1995:23). All artifacts that were large or potentially significant were hand-drawn on a sheet specified for this activity and the three dimensional provenience was recorded as the distance north of the south wall and the distance east of the west wall. Depth was recorded with a line level by measuring the distance below the surface of the south-west corner. Photographs were also taken of each completed level prior to the removal of artifacts. After planviews were completed, the excavator proceed onto the next level.

Screening of the soils by field school students was done by passing the soil through a 6 mm mesh to retrieve any artifacts that were missed during the excavation of the unit. Fine screen samples were collected from 1990 to 1993 from the northeast quadrant of each unit (Farrow 2004:33). Fine screening was proven very time consuming and in 1994 it was decided that the matrix from the northeast quadrants would be simply passed through a 3 mm mesh screen (Meyer 1995:12). Once all units were excavated to the bottom of the occupation, each student was responsible for the cleaning and initial cataloguing of all recovered materials.

4.1.2 Stantec Consulting Ltd. Excavations and Laboratory Methods

In 2003 Stantec Consulting Ltd. was contracted to excavate 20 square metres from the area known as the Wooded Hollow (Figure 4.1). Units were placed on the same grid as the one previously established by Millenium Consultants. This was done through the location of old pins from units excavated by the field school. Instead of spacing these units five metres apart from one another, as was done from 1988 to 1995, the 20 square metres were all placed in one area, producing an excavation block running five metres north-south by four metres east-west. Units were again divided into four 50x50 cm quadrants and were excavated in 10 cm arbitrary levels. Natural levels were again attempted in this area, but it was determined that due to the extreme rodent and tree root disturbance, this methodology would not be appropriate (Stantec 2003).

When the excavation was started, the overlying materials were shoveled off until the excavator recognized an increase in artifact density. At this point, shovels were abandoned and trowels were used instead. At the completion of excavation of each 10 cm arbitrary level, all materials large enough to be left *in situ* were photographed using a digital camera. Each of these images was printed off at the site in order to record the 3 point provenience. The planviewed images that were produced were used in conjunction with a Sokkia total station. Each artifact was given a number based on a number present on a given beverage ticket. This number was recorded as the identification number for the total station which, in turn, recorded the horizontal and vertical provenience within the unit, as well as the elevation of the artifacts as related to a datum of known elevation. At the end of each day, all of the provenience information recorded by the total station was downloaded onto a computer in order to make certain that no data was lost. Lastly, one deep test pit was dug in order to ensure the crew that the Wooded Hollow consisted only of the intact layers that had just been excavated. All soils recovered during the excavation of these units were passed through a 6 mm mesh. Again, all artifacts were washed, dried, and bagged. Identification of all of the faunal materials was done by the author in the lab.

4.1.3 2004 Excavations and Laboratory Methods

The 2004 excavations mirrored those of the field school. Due to upcoming subdivision development in the area, four additional units were excavated in May by the author and volunteers in order to acquire any additional information that was pertinent to the analysis of the Hartley Site (Figure 4.2). Units were once again laid in according to the previously established grid. Upon consultation with Dr. David Meyer (personal communication 2004), these units were scattered from nine to twelve metres north of the block of units excavated by the Stantec crew. Two units were placed directly west and directly south of unit 385N 145E. These units were placed as such because of the materials recovered in this unit during the field school excavations, including two bone spatulas, as well as various potsherds (Meyer 1995:14). One other unit was positioned at 387N 140E. The last unit to be excavated was placed at 385N 143E. A large mandible was found in level three of 385N 144E and extended west into unit 385N

143E. The decision on where to open the last unit was not made in the beginning so that a placement could be chosen based on what was found in the other units (Figure 4.1).



Figure 4.2 Volunteers excavating at the Hartley site in May of 2004.

In addition to the four units excavated in 2004, it was discovered that two areas within the Wooded Hollow had been looted. Many, if not all, of the faunal remains discovered during this looting had been left on the ground causing one to suspect that the looter had taken the lithics and possibly the pottery. All of the soil that had been disturbed in two areas was screened and the artifacts were taken back to the lab. The two areas that were looted were also recorded on a map to ensure that some sort of provenience could be established when cataloguing these items (Figure 4.1).

The excavations of the four units were taken down in 10 cm arbitrary levels. As was the case with the field school, sediments recovered from the northeastern quadrant were passed through the fine screen and the rest of the sediments were passed through the standard 6mm mesh. Planviews were prepared by using a digital camera. All artifacts were mapped in with three point provenience and recorded on sheets designed

for this activity. In terms of elevation, each unit was assigned a datum based on which of the four corners was the highest. Once the corner with the highest elevation was determined, this corner was assigned as the unit datum. Each of the unit data were then related back to a site datum that had a previously assigned elevation from the summer of 2003. The stratigraphy of the site was recorded by the author in the form of profile drawings.

Once all of the artifacts were recovered from the field, they were washed and dried at the laboratory at Stantec Consulting Ltd and sorted according to material type. The materials were moved to the Department of Archaeology at the University of Saskatchewan, where the cataloguing process took place. Once this process was completed, the artifacts were boxed according to material type, and if possible, according to excavation unit.

4.2 Qualitative and Quantitative Analysis

4.2.1 Methodology and Qualitative Analysis

The cataloguing process was essentially the same for all materials recovered from the various field seasons. These materials consisted of 10.5 square metres worth of material from the University of Saskatchewan field school (one and a half units could not be found in storage at the Department of Archaeology), the 20 square metres excavated by Stantec Consulting Ltd., and the additional 4 square metres excavated by the author and volunteers. A combination of databases consisting of programs including Microsoft Access™ and Microsoft Excel™ (2003) were created. Microsoft Excel™ played the role of calculating all of the quantitative analyses (such as MNI, MNE, MAU and %MAU), as well as recording all measurements that were taken for determination of sex.

The cataloguing process began with the artifacts recovered by the Stantec crew, and was followed by those recovered from the summer of 2004, and lastly, those materials recovered by the field school. All artifacts in the quadrant bags were sorted according to material type. This consisted of separating all the bone fragments, tooth fragments, pieces of enamel, lithics specimens, ceramics, and other organic materials. Only the faunal and organic remains were catalogued by the author with the exception of

the recoveries from the four units excavated in 2004. The latter were catalogued in order to fulfill the permit requirements outlined by the Saskatchewan Culture and Heritage Branch.

A combination of Microsoft Access™ and Microsoft Excel™ was used to catalogue the faunal remains recovered from the Wooded Hollow. These consisted of individual artifacts that had been left *in situ*, and, therefore, had information regarding three dimensional provenience, as well as those artifacts that had only provenience by quadrant and excavation level. Each individual artifact was analyzed to determine whether it should be classified as an element, specimen, or fragment, according to the definitions outlined by Grayson (1984), Webster (1999) and Brink and Dawe (1989). Grayson (1984:16) defines a specimen as "...a bone or tooth, or fragment thereof, from an archaeological or paleontological site" while an element is defined as "...a single complete bone or tooth in the skeleton of an animal." As Webster (1999:38) found, the definition of a specimen excluded all remains of a non-vertebral nature. Therefore, Webster's (1999:38) modified definition was used and a specimen was considered "... a bone, tooth, shell or seed, or fragment thereof, from an archaeological or paleontological site." Webster (1999) reasons that these items were not considered as elements due to the fact that an element in itself describes an item that is a part of a whole. For example, a complete bone would be considered an element in the entire skeleton. As shells and seeds could not be described in this manner, they were considered as specimens. The definition put forth by Brink and Dawe (1989:80) was followed when analyzing a fragment. In their definition a fragment is considered a fraction of an element which cannot be recognized to a specific element but may be assigned to a class of elements such as tooth enamel or long bones.

The remaining fields in the database program consisted of various pieces of information. Each artifact was assessed to determine whether it was **unburned**, **burned**, or **calcined**. The quantity and weight of each item was recorded (in grams). If possible, the age of the specimen in question was also assessed. Degree of fusion was noted as **not fused**, **partially fused**, **fusion line still visible** and **completely fused**.

Each piece was also analyzed to determine the stage of weathering. Although it is common to utilize Behrensmeyer's (1978) six stages of weathering on bones of large

mammals from archaeological sites, it was found that a revised version of this classification scheme presented by Todd et al. (1987:64) was more suitable for this analysis. Todd et al. (1987) essentially divided Behrensmeyer's six stages of weathering into seven stages, as stage zero was divided into two parts. The revised stage zero was devised to designate the elements that were fresh and still greasy with soft tissue still present, whereas stage one was used to denote elements where no soft tissue was present and the bones showed no other signs of weathering. The remaining stages of weathering were identical to those described by Behrensmeyer (1978), although the stage number itself was increased by one (Todd et al. 1987:64). For the small mammals, Andrews' (1990:11) weathering categories were utilized.

If it was possible, each piece was assigned to a species, or if that was not possible, it was classified to the lowest taxonomic level possible. Specimens where a species identification could not be made were classified according to size (Table 4.1). The size classes used in this thesis followed those created by Dyck and Morlan (1995:140) and modified by Webster (1999:40). Weight specification was not used to create the size classes for birds and the small vertebrate and overall body size was used instead. Although there could be a problem due to the large overlap in body size, few avian elements were recovered.

Table 4.1 Description of size classes followed in this thesis as employed by Dyck and Morlan (1995:140) and modified by Webster (1999:40).

Size Class	Weight	Associated Terms	Examples
SC6	200-700 kg	Very Large Mammal	Bison, Moose, Elk, Deer
SC5	25-200 kg	Large Mammal	Wolf, Pronghorn
SC4	5-25 kg	Medium Mammal	Coyote, Badger, Beaver
SC3	700-5000 g	Small-Medium Mammal	Fox, Hares, Skunk
SC2	100-700 g	Small Mammal	Ground Squirrels, Muskrat
SC1	<100 g	Micro-Mammal	Mice, Voles
SC5	-	Large Bird	Crane, Eagle
SC4	-	Medium Bird	Raven
SC3	-	Small-Medium Bird	Ducks, Grouses
SC2	-	Small Bird	Robin
SC1	-	Micro-Bird	Warblers, Sparrow
SC2	-	Small Vertebrate	Ground Squirrel, Meadow Lark
SC1	-	Micro-Vertebrate	Mice, Frogs, Salamanders, Warbler

Many of the remaining fields in the database were concerned with taphonomic patterns on the faunal remains and each fragment, specimen and element was evaluated based on the following seven categories: types of breakage, root etching, gnawing, butchering, abrasion and polish and class of deterioration (Table 4.2). Types of breakage were divided into one of 9 classes; root etching was evaluated based on one of six classes; carnivore gnawing was evaluated based on one of eight classes; and signs of butchering was evaluated based on one of seven classes. Deterioration was based on those categories outlined in the analysis of the taphonomy of the Horner II bone bed. The corresponding description of stages of deterioration can be found in Todd (1987:123). The types of breakage utilized in the cataloguing system were those outlined by Todd (1987) and Marshall (1989). The root etching classification system was adopted from Johnston's (1995) thesis. The remainder of the categories followed those outlined by Todd (1987) in his taphonomic analysis of the Horner II bone bed.

Table 4.2 Taphonomic categories used for evaluation on each available specimen, element, and fragment.

Breakage	Root Etching	Gnawing	Butchering	Weathering	Deterioration
Spiral	None	None	Chop Marks	0	1
Transverse Regular	Light	Crenelated/ Scalloped	Cut Marks	1	2
Transverse Irregular	Light to Moderate	Pitting	Groove(s)	2	3
Steppe	Moderate	Puncture	Scraping (Parallel Striations)	3	4
Comminuted	Moderate to Heavy	Puncture and Pitting	Shovel Trauma	4	5
Impact Fracture	Heavy	Scooping	Trowel Trauma	5	6
Longitudinal		Rodent	None	6	
Saw Tooth		Chipped			
Unidentifiable					

4.2.2 Quantitative Analysis

The quantitative analysis procedures followed in this thesis were adopted from several sources. In a faunal analysis, statistical abbreviations are common and include

the following: **N** (number), **NISP** (Number of Individual Specimens), **MNI** (Minimum Number of Individuals), **MNE** (Minimum Number of Elements), **MAU** (Minimum Animal Units) and **%MAU**. **N** is a simple abbreviation for number and is used to calculate specimen counts. The **NISP** refers to a unit of abundance in which all of the specimens that were identified to a specific element or class of elements in a taxon are counted (Brink and Dawe 1989; Lyman 1994). The **MNI** refers to the minimum number of individual animals needed to account for the **NISP** in the assemblage (Grayson 1984; Lyman 1994). For the purposes of this thesis, the **MNI** takes sides into account. It has been noted that while **MNI** and **NISP** are the fundamental observational units of zooarchaeology, it should be noted that the identification skills and the tenacity of the analyst will have an effect on the **NISP** measurements.

Although the **MNI** values can account for size, they do not account for the degree of fragmentation of the assemblage. For this reason, it has been found that **MNE** is a more accurate count of the number of animals present in the assemblage. The **MNE** simply refers to the minimum number of elements needed to account for the **NISP**. It has been noted that several methods exist to calculate the **MNE** from the **NISP** (Lyman 1994:102-104). In the analysis of these faunal remains **MNE** values were derived by counting anatomical landmarks (such as the greater trochanter on the femur). Once all of the assemblage has been evaluated and all landmarks counted, the landmark with the highest count became the count for that element (for a list of landmarks counted for each bone see Webster 1999:253-260). In some instances the side of the specimen was taken into account to determine these values.

Once the **MNE** values were calculated, the **MAU** was then determined. Lyman (1994:510) defines the **MAU** as the observed bone count for each anatomical unit (**MNE**) divided by the number of times that anatomical unit occurs within the animal's complete skeleton. For example, if the greater trochanter was observed a total of 18 times, the total would be divided by two (the number of times the greater trochanter occurs in the body) to give a **MAU** of 9. The **MAU** values can be used to determine how humans affect an assemblage with their butchering practices, and furthermore, how taphonomic forces influence which elements survive (Binford 1978). Following the determination of the **MAU**, the **%MAU** was calculated by dividing all **MAU** values by

the highest MAU value calculated for the assemblage. The %MAU provides an archaeologist with a method of measuring how well different elements are represented within the archaeological assemblage.

Chapter Five

The Hartley Site *Bison bison* Faunal Assemblage

5.1 Introduction to the Hartley Site Faunal Assemblage

For the purposes of this thesis, the Hartley site faunal assemblage is defined as the material excavated in the Wooded Hollow during the University of Saskatchewan Field Schools between 1988 and 1995, the faunal remains excavated by Stantec Consulting Ltd. in the summer of 2003 and by the author and volunteers in the summer of 2004. Although additional excavations have taken place at this site, these materials will not be considered in this analysis.

A total of 168,451 faunal specimens with a weight of 226.90 kg (Table 5.1) were recovered and catalogued from the Hartley site. Due to the high degree of fragmentation the majority of the assemblage (98.57%) is unidentifiable. The assemblage is also dominated (98.12%) by unburned bone.

Table 5.1 Hartley site faunal assemblage separated by degree of burning.

	Identified			Unidentified			Total	
	N	%N	Wt. (g)	N	%N	Wt. (g)	N	Wt. (g)
Unburned	2,284	1.88	78,815.22	119,068	98.12	117,718.84	121,352	196,534.06
Burned	119	0.27	1,775.84	43,383	99.73	27,452.3	43,502	29,228.14
Calcined	0	0	0	3,597	100	1,135.43	3,597	1,135.43
Total	2,403	1.42	80,591.06	166,048	98.57	146,306.57	168,451	226,897.63

If one is to calculate the specimens of unburned bone as represented by weight, it is noted that the unburned bone represents approximately 86.61% of the assemblage, while the burned and calcined bones represent 12.88% and 0.50% respectively. In comparison to the weight of the burned and calcined specimens, it can be seen that the majority of the burned bone (93.92%) and all of the calcined bone (100%) is unidentified.

At least 24 taxa were noted in the Wooded Hollow assemblage (Table 5.2). All faunal materials were identified to the most precise taxonomic level possible. Due to a lack of identifiable characteristics, 596 specimens were assigned to the category of size class. It is possible that some of these specimens may represent taxa that are not identified in Table 5.2.

Table 5.2 Summary of the Hartley site fauna.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	<i>Bison bison</i>	1,611	16
Wolf	<i>Canis lupus</i>	75	2
Rabbit Family	Family Leporidae	4	1
Rabbit/Hare	<i>Lepus sp.</i>	12	2
White-tailed Jack Rabbit	<i>Lepus townsendii</i>	1	1
Snowshoe Hare	<i>Lepus americanus</i>	3	1
Nuttall's cottontail	<i>Sylvilagus nuttallii</i>	3	1
Fox	<i>Vulpes sp.</i>	6	2
Red Fox	<i>Vulpes vulpes</i>	1	1
Swift Fox	<i>Vulpes velox</i>	4	1
Ground Squirrel	<i>Spermophilus sp.</i>	34	4
Richardson's Ground Squirrel	<i>Spermophilus richardsonii</i>	3	2
13-Lined ground squirrel	<i>Spermophilus tridecemlineatus</i>	2	1
Northern Pocket Gopher	<i>Thomomys talpoides</i>	19	1
Meadow Vole	<i>Microtus pennsylvanicus</i>	5	3
Unidentified Cricetine	Family Cricetidae	2	1
Unidentified Rodents	Order Rodentia	3	1
Birds			
Unidentified Birds	Class Aves	5	
Falcon	<i>Falco sp.</i>	1	1
Mallard/Teal	<i>Anas sp.</i>	6	1
Mallard	<i>Anas platyrhynchos</i>	3	1
Northern Shoveller	<i>Anas clypeata</i>	1	1
Sharp-tailed Grouse	<i>Tympanuchus phasianellus</i>	2	1
Lesser Yellowlegs	<i>Ringa flavipes</i>	1	1
Miscellaneous			
Very Large Mammal	-	534	-
Large to Very Large Mammal	-	34	-
Large Mammal	-	6	-
Medium to Large Mammal	-	3	-
Medium Mammal	-	1	-
Small to Medium Mammal	-	3	-
Small Mammal	-	11	-
Micro Mammal	-	4	-
Total	-	2,403	

5.2 Quantitative Analysis of Bison Remains

5.2.1 Order Artiodactyla, Family Bovidae

Bison bison

Specimens identified: NISP = 1,611; see table 5.3 for a summary. MNI and MNE values were calculated by noting the presence of landmarks. A list of these landmarks can be found in Webster (1999).

Distribution and Habitat: Bison are gregarious animals that travel in cohesive herds, or bands, consisting between four and twenty individuals, although it is noted that bands of bison may join to form herds numbering in the thousands (Banfield 1987:405). This species is generally thought of as migratory, although much debate exists concerning the manner in which this process occurred (Epp 1988; Malainey and Sheriff 1996; Morgan 1980).

Bison can be found in a wide range of habitats from the plains to aspen parklands, meadows, river and stream valleys, and even into the boreal forest (Banfield 1987:406). In terms of distribution within Canada, it is well documented that bison have existed on lands ranging from eastern Manitoba to eastern British Columbia and northward to the Peace River district and Great Slave Lake region of the Northwest Territories. This distribution is reflective of the two different subspecies of bison in Canada: *Bison bison athabascae* and *Bison bison bison*. The latter of the two subspecies is the typical plains form, which is smaller and lighter than its northern relative (Banfield 1987:406).

Table 5.3 Summary of Hartley site bison counts.

BONE	NISP	MNI	MNE	MAU	%MAU
Axial Skeleton					
Zygomatic	2	2	2	1	6.67
Jugular	2	2	2	2	13.33
Premaxilla	2	2	2	1	6.67
Maxilla	1	1	1	0.5	3.33
Squamous Temporal	25	12	24	12	80.00
Occipital	6	2	3	1.5	10.00
Parietal	2	1	2	1	6.67
M ³ and M ₃	15	9	12	6	40.00
Horn Core	2	1	2	1	6.67
Petrous Temporal	52	14	27	13.5	90.00
Mandible	50	9	17	8.5	56.67
Hyoid	11	3	10	5	33.33

Atlas	13	6	6	6	40.00
Axis	26	8	8	8	53.33
Cervical Vertebrae	74	6	30	6	40.00
Thoracic Vertebrae	84	3	34	2	13.33
Lumbar Vertebrae	33	2	14	2	13.33
Sacrum	17	3	12	12	80.00
Caudal Vertebrae	10	2	7	1	6.67
Forelimb					
Scapula	23	8	15	7.5	50.00
Humerus	48	13	17	8.5	56.67
Radius	92	16	30	15	100.00
Ulna	55	7	13	6.5	43.33
Internal Carpal	11	6	11	5.5	36.67
Radial Carpal	18	10	18	9	60.00
Accessory Carpal	19	15	19	9.5	63.33
Ulnar Carpal	15	9	13	6.5	43.33
Unciform Carpal	24	12	24	12	80.00
Fused 2/3 Carpal	13	7	13	6.5	43.33
Metacarpal	58	12	21	10.5	70.00
5 th Metacarpal	1	1	1	0.5	3.33
Hindlimb					
Innominate	22	5	7	3.5	23.33
Femur	55	9	18	9	60.00
Patella	5	3	4	2	13.33
Tibia	75	11	21	10.5	70.00
Lateral Malleolus	14	7	14	7	46.67
Calcaneus	28	9	16	8	53.33
Astragalus	18	7	13	7.5	50.00
Fused C/4 Tarsal	27	17	27	13.5	90.00
Fused 2/3 Tarsal	13	8	12	6	40.00
1 st Tarsal	2	2	2	1	6.67
Metatarsal	50	8	15	7.5	50.00
Other Elements					
1 st Phalanx	47	5	40	5	33.33
2 nd Phalanx	52	6	45	5	33.33
3 rd Phalanx	36	4	34	4	26.67
Proximal Medial Sesamoid	20	5	20	3	20.00
Proximal Lateral Sesamoid	10	2	10	1	6.67
Distal Inferior Sesamoid	16	4	16	2	13.33
Miscellaneous					
Vertebrae Indeterminate	43	-	-	-	-
Metapodial Indeterminate	19	-	-	-	-
Phalanx Indeterminate	2	-	-	-	-
Molar Indeterminate	40	-	-	-	-
Premolar Indeterminate	45	-	-	-	-
Molar/Premolar Indeterminate	68	-	-	-	-
Incisor Indeterminate	18	-	-	-	-
Rib Head/Neck	55	-	-	-	-
Cranium Indeterminate	27	-	-	-	-
Total	1,611				

Table 5.3 (continued) Summary of Hartley site bison counts.

Table 5.3 demonstrates that many of the identified specimens consist of indeterminate molars and premolars as well as a number of indeterminate rib and cranial fragments. At least 17 individuals were identified as represented by the fused central and fourth tarsal. The MAU as derived from the radius is 15. The maxilla and fifth metacarpal were the least commonly found or preserved items (Table 5.4).

Table 5.4 MNE, MAU and %MAU for the Hartley site bison elements.

Skeletal Element	MNE	MAU	%MAU
Radius	30	15	100.00
Petrous Temporal	27	13.5	90.00
Fused C/4 Tarsal	27	13.5	90.00
Squamous Temporal	24	12	80.00
Sacrum	12	12	80.00
Unciform Carpal	24	12	80.00
Metacarpal	21	10.5	70.00
Tibia	21	10.5	70.00
Accessory Carpal	19	9.5	63.33
Radial Carpal	18	9	60.00
Femur	18	9	60.00
Mandible	17	8.5	56.67
Humerus	17	8.5	56.67
Axis	8	8	53.33
Calcaneus	16	8	53.33
Scapula	15	7.5	50.00
Astragalus	13	7.5	50.00
Metatarsal	15	7.5	50.00
Lateral Malleolus	14	7	46.67
Ulna	13	6.5	43.33
Ulnar Carpal	13	6.5	43.33
Fused 2/3 Carpal	13	6.5	43.33
M3 and M3	12	6	40.00
Atlas	6	6	40.00
Cervical Vertebrae	30	6	40.00
Fused 2/3 Tarsal	12	6	40.00
Internal Carpal	11	5.5	36.67
Hyoid	10	5	33.33
1st Phalanx	40	5	33.33
2nd Phalanx	45	5	33.33
3rd Phalanx	34	4	26.67
Innominate	7	3.5	23.33
Proximal Medial Sesamoid	20	3	20.00
Jugular	2	2	13.33
Thoracic Vertebrae	34	2	13.33
Lumbar Vertebrae	14	2	13.33
Patella	4	2	13.33
Distal Inferior Sesamoid	16	2	13.33
Occipital	3	1.5	10.00
Zygomatic	2	1	6.67

Premaxilla	2	1	6.67
Parietal	2	1	6.67
Horn Core	2	1	6.67
Caudal Vertebrae	7	1	6.67
1st Tarsal	2	1	6.67
Proximal Lateral Sesamoid	10	1	6.67
Maxilla	1	0.5	3.33
5th Metacarpal	1	0.5	3.33

Table 5.4 (continued) MNE, MAU and %MAU values for the Hartley site bison elements.

By graphing the %MAU of the Hartley site bison elements, it is noted that most of the specimens fall somewhere in the range of 40 and 80% MAU (Figure 5.1). Many of the specimens that fall within this range are longbones, carpals and tarsals as well as axial elements; specifically cervical vertebrae. Many cranial elements, vertebrae as well as sesamoid bones occupy the bottom 20% of the range.

5.2.2 Discussion

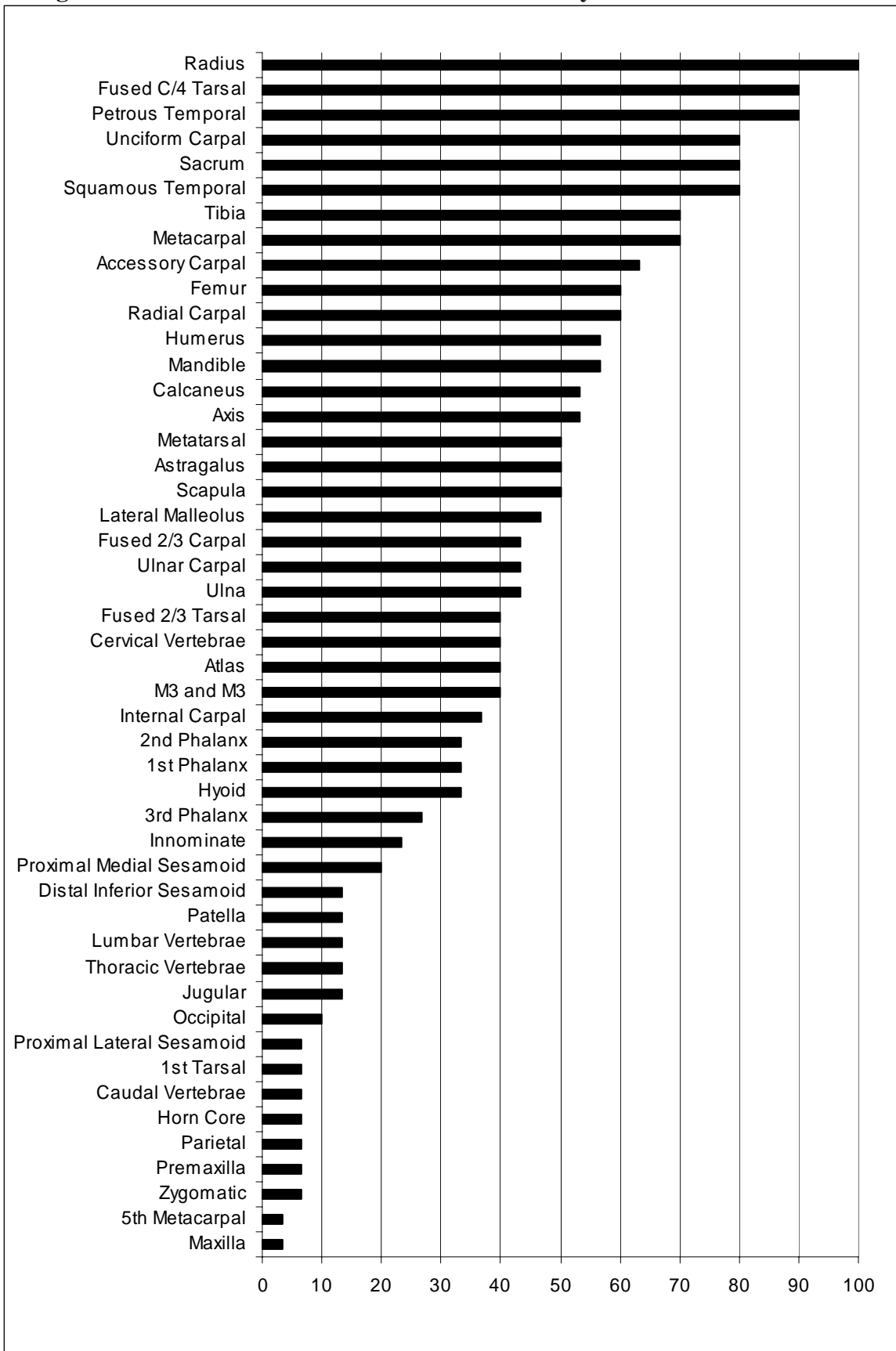
The apparent heavy processing of the remains recovered from the Hartley site is indicative of processing with the intention of extracting bone marrow and grease. These are a particularly important food resource for people whose diets are largely based or derived from wild animals (Enloe 1993:84). It is known that during Precontact times, the Plains adapted peoples were very dependent upon a variety of faunal species, but in particular, they relied on the bison as a mainstay of their diet (Bryan 1991:32-53). By observing the results obtained from the calculation of %MAU, the assemblage is suggestive of a site that was utilized for procurement and processing purposes. A more in-depth discussion processing activities, specifically of marrow and grease production and representation of faunal elements, can be found in Chapter 7.

5.3 Aging and Seasonality

5.3.1 Foetal Bison and Immature Elements

Although previous research has demonstrated that the Brushy Depression contained a large number of foetal remains (Clarke 1995:37), no foetal remains were identified in the assemblage from the Wooded Hollow. Preservation can often be a key factor in determining whether foetal remains are present or absent in an assemblage.

Figure 5.1 %MAU for Bison elements at the Hartley site.



It should be noted that it is unlikely that preservation was a factor in this case. Stage of weathering according to Todd (1987) was consistently recorded at stage two, regardless of deposition depth. Preservation and other taphonomic considerations are discussed in greater detail in Chapter 7.

In terms of modern bison, the sexes are mainly separated for most of the year, however, during the summer the cows are joined by the bulls. In Wood Buffalo Park, it has been observed that the rutting period extends from early July to late September with a peak in mid-August (Banfield 1974:406). Occasionally, unseasonable matings have been observed. According to Banfield (1974) gestation period of modern bison lasts between 270 and 300 days and parturition occurs between mid-April and the beginning of June, but peaks in May. It should be noted, however, that out-of-season calves are certainly not uncommon in archaeological sites (Wilson 1974:151). Furthermore, recent work by Walde (2006b:481) conducted on bison population suggests that the breeding window may extend over a longer period of time than was previously thought. Walde's (2006b) review of bison populations over the last 30 years suggests that the bison breeding season extends over a much longer period of time, lasting from three to four months. Therefore, based on this large breeding window, it is suggested that initiation of foetal development will range over this same period of time. Seasonal determination of archaeological sites based on foetal remains is therefore much less precise than previously thought (Walde 2006b).

Foetal bison bone has been utilized as a seasonal indicator in the archaeological record under the notion that the breeding schedule was short and controlled. Previous studies have utilized foetal remains to define a wide seasonal window during which a particular site may have been occupied, ranging from late fall to early spring depending on the age of the foetus (Clarke 1995:38; Reher 1974:115; Unfreed and Van Dyke 2005:69; Wilson 1974:145). Smaller sized foetal bones were thought to imply that the animal died earlier in the pregnancy, therefore suggesting a fall occupation, whereas larger foetal elements may suggest an occupation closer to late winter or early spring. More precise descriptions of seasonality through the identification of bison foetal remains are common throughout the literature and consist of quantitative measurements as well as descriptions of growth rates of foetal bone. Both measurements and periosteal

counts have been demonstrated as valid techniques for establishing ages of complete elements such as humeri, the femora, tibiae, metapodials and radii (Wilson 1974:147). It should be noted, however, that Walde's (2006b) recent publication concerning foetal development suggests that foetal bison characteristics may not be as reliable as previously thought. It is suggested that other methods of determining seasonality such as physical characteristics of dental cementum incrementation would be more reliable. As foetal remains were absent from the Wooded Hollow faunal assemblage, none of these techniques were applied in the faunal analysis.

Various immature elements were recovered during excavation of the Wooded Hollow. Age identifications were based on the overall physical size and appearance of each specimen. These were then compared to the immature bison elements of known age in the University of Saskatchewan comparative collection. This type of analysis can be somewhat problematic as it has been noted that if only one element is being aged, only an approximation can be made as to the age of the animal at the time of death (Duffield 1973:133).

According to Duffield (1973), utilization of epiphyseal fusion information derived from extensive studies of the European bison (*Bison bonasus*) can lead to determination of the age of an animal at the time of death up to eleven years. Duffield (1973:132) notes that the age and rate of epiphyseal fusion of the bones of both the European and American varieties of bison should be roughly the same for the two groups of animals. The argument that American and European bison are sub-specific is invalid, as Duffield (1973) notes in the very same paper that the taxonomic classification for European bison is *Bison bonasus* and American bison as *Bison bison*. If they were indeed sub-specific, they should be noted as *Bison bison bonasus* and *Bison bison bison*. It is unfortunate that no other studies document the epiphyseal fusion of American bison (*Bison bison*) as a number of immature elements were recovered from the Hartley site assemblage. In spite of this lack of information regarding epiphyseal fusion, documentation of the presence of immature individuals within the Hartley site assemblage was still performed. In terms of categorization of the elements, they were evaluated and placed within one of the following five categories outlined by Todd (1987:122) and discussed in Chapter 4.

One hundred and twenty-three unfused immature bison elements with a total weight of 6225.0 grams were recovered from the Hartley site. Surprisingly, none of the specimens had been burned or calcined. Ninety-three of the unfused immature specimens were from the axial portion of the body, whereas only thirty were from the appendicular portion of the skeleton. Only one partially fused element was found within the assemblage, again unburned. A total of eight specimens were recorded as having the fusion line still visible, seven of which were axial elements. The remaining specimens within the assemblage were either too fragmentary to be evaluated or represented a portion of the bone that did not have an epiphysis.

Despite the lack of literature surrounding the age at which epiphyses fuse in North American bison, an attempt was made on some specimens of a very young age. All of these specimens were aged based on size and morphological characteristics similar to those housed at the University of Saskatchewan comparative collection in the Department of Archaeology. Of particular note was a right humerus shaft fragment that is of the same size as that of a one week old specimen. Secondly, an occipital fragment that was recovered was classified as belonging to an individual of approximately one week old (Figure 5.2). The only other specimen to have been approximately aged was a mandible belonging to an immature individual. This specimen is discussed in the following section.

5.3.2 Bison Tooth Eruption and Wear Schedules

The analysis of bison tooth eruption and wear patterns has proven to be important in indicating seasonality of archaeological sites (Todd and Hofman 1987; Frison and Reher 1970; Reher 1970; 1974; Wilson 1974; 1988). Mandibles or maxillaries are the most commonly used specimens in faunal analyses, particularly those associated with catastrophic events such as bison pounds or jumps. Mandibles and maxillaries can often be separated into age groups on the basis of observable tooth eruption and tooth wear (Reher 1970:51). It is through comparisons of the mandibular and maxillary teeth from large bison kill sites to modern bison of known ages that archaeologists have been able to describe mandibular tooth eruption and wear patterns for precise age groups.



Figure 5.2 Example of immature specimens recovered from the Hartley site.

The Glenrock buffalo kill (Frison and Reher 1970), the Horner and Finley sites (Todd and Hofman 1987) and the Henry Smith and Hawken sites (Frison et al. 1976; Wilson 1988) are often used as baseline comparisons as they provide data based on metaconid heights in order to determine precise age groups of archaeological specimens. The Glenrock kill site was found to have an assemblage of animals consistent with an X.5 year increment, the Horner and Finley sites provided data consistent with an X.6 year increment and the Henry Smith and Hawken sites were found to have animals consistent with an X.7 year increment. It is of note that Clarke (1995:50) demonstrated through an analysis of eruption patterns and rates of attrition that the faunal remains recovered from the Brushy Depression were consistent with age groups of X.6 year increments.

The primary way of determining seasonality through dentition is by measuring the height of the metaconid on the first molar. This may be done on teeth that are still located within the mandible or even those that are loose. In principal, if there were enough identifiable teeth to measure, one would measure the height of the metaconid

from the root-enamel juncture to the top of the cusp (Frison et al. 1976:39; Reher 1970:51). An attempt was made to determine the seasonality of the Hartley site from the dentition by observing morphological aspects of mandibular eruption patterns and wear. Unfortunately, only three partially complete mandibles were recovered intact from the assemblage. In addition, only one of these mandibles belonged to an immature individual and was therefore useable for aging based on mandibular eruption. The second and third mandibles belonged to those of mature individuals, however, one mandible was unsuitable for this type of analysis due to taphonomic factors (the molars had been broken). It is presumed that the remainder of the mandibles had either been broken due to butchering or other taphonomic factors. The majority of these fragmented specimens consist of the ramus, the posterior coronoid process or the articular condyle, typical of what one would expect to find at a kill or processing site. Unfortunately, there were not even sufficient mandibular fragments to allow for reconstruction. The Hartley site assemblage contained no maxillary portions with socketed teeth. In addition, the majority of the teeth that were recovered were loose and fragmented and, therefore, not distinguishable between first and second molars.

The immature mandible (catalogue number 5691), although fragmented, was identified as belonging to the left side of the body and was aged based on tooth eruption. This particular specimen matched, both in terms of size and tooth eruption, a one-month old bison specimen housed in the University of Saskatchewan comparative collection (Figure 5.3). The other two mandibles that were recovered belonged to individuals who had reached maturity prior to death. One of the mandibles (catalogue number 5893) was from the right side of the body and was also complete (Figure 5.4). Unfortunately, this specimen was missing every tooth except the second and third molars which were broken, thereby limiting any sort of analysis based on enamel heights. The third mature mandible that was recovered (catalogue number 8979) was from the right side of the body and consisted of the mandibular body as well as all the teeth from the third premolar to the third molar (Figure 5.5). It is possible that this individual suffered from a form of generalized periodontitis as the alveolar bone has recessed and exposed the roots of the premolars and first molar. Discussion relating to this pathology can be found in chapter seven.



Figure 5.3 Mandible aged at one month old (5691)



Figure 5.4 Bison mandible recovered from the Hartley site (5893)



Figure 5.5 Bison mandible recovered from the Hartley site; note the generalized periodontitis (8979).

5.3.3 Discussion

Unfortunately, in the case of the faunal remains from the Wooded Hollow, the lack of foetal bone and intact mandible or maxillary dentition only allow for preliminary conclusions as to the time of year this part of the site was occupied. The lack of studies relating to epiphyseal fusion in North American bison makes the determination of age of immature individuals impossible. In terms of defining any sort of age categories based on tooth eruption and wear, only one of the three mandibles (catalogue number 8979) was suitable for an analysis detailing age groupings. Unfortunately a sample size of one individual is inadequate to make any solid conclusions. Two immature specimens and one immature mandible seem to suggest a spring occupation, however, to base any conclusions based on three specimens is un-scientific. It is, therefore, essential to attempt to define seasonality of this part of the site through an analysis of herd structure of the faunal remains in question.

5.4 Sex Composition of Bison Herds

5.4.1 Carpal and Tarsal Measurements

Carpal and tarsal bones provide an unexploited source of information at kill and campsites as they are often well preserved and frequently the most abundant elements in

bison bone assemblages (Morlan 1991). In the Horner II bone bed, for example, the calcaneus was the most abundant element (Todd 1987:135), at the Gowen I site, the talus was the most common element (Walker 1992:100), and Clarke's (1995:70) examination of the Hartley site assemblage also yielded approximately 250 carpal and tarsal elements complete enough to be measured. Carpal and tarsal measurements have proven to represent a source of information in determining the sex composition of bison herds (Morlan 1991:215). Previously, the most detailed studies of the age and sex composition of bison herds have been conducted on bones recovered from kill sites where there seems to be an abundance of skulls, mandibles, and limb bones. However, the effects of butchering, transport, marrow extraction, bone grease manufacture and carnivore ravaging make these types of studies impossible as they often reduce the larger known bones to mere unidentifiable fragments (Morlan 1991).

It is noted that although carpal and tarsal measurements have proven to be useful in determining the sex of the herd structure in question, assessment of age has proven difficult. This particular methodology does not make it possible to distinguish between immature and mature individuals by casual inspection. The only bone to have an epiphysis is the calcaneus, and in carpals and tarsals, it has been noted that ossification proceeds rather rapidly early in life (Morlan 1991). Therefore it should be noted that differences in size may reflect the maturity of the animal in question, as well as the sex. The bimodality noted in the following pages therefore demonstrates the distribution of mature bulls versus a mixture of adult cows and calves. In terms of the Hartley site assemblage, every measurement associated with each carpal and tarsal was taken twice with spreading callipers. If a deviation was noted between the first and second measurements, a third measurement was taken. In the case of these measurements, Morlan's (1991) methodology was followed. If the specimen in question was fragmented, the missing measurement was recorded as "n/a".

5.4.2 Carpal Measurements

Radial Carpal (*Os carpi radiale*)

The radial carpal sits on the medial end of the proximal row and articulates with the radius on the proximal side, the intermediate carpal on the lateral side and the fused

second and third carpal on the distal end. The length (L), width (W) and depth (D) were measured and noted for all complete specimens. These measurements can be found in Appendix A, Table A.1. Graphs of length versus width as well as length versus depth produced similar results to the graph below, however, depth versus width exhibited the best bimodal distribution. It was noted that a total of fifteen carpals demonstrated a fairly even distribution; seven of the carpals were clustered together representing the contingent of female/immature elements and an almost equal cluster of eight carpals were identified as an assortment of bulls (Figure 5.6). From the graph, it is noted that although only seven plots are associated with the male group, two carpals (catalogue numbers 7097 and 3153) had the exact same measurements. These carpals, one right and one left, likely represent one individual.

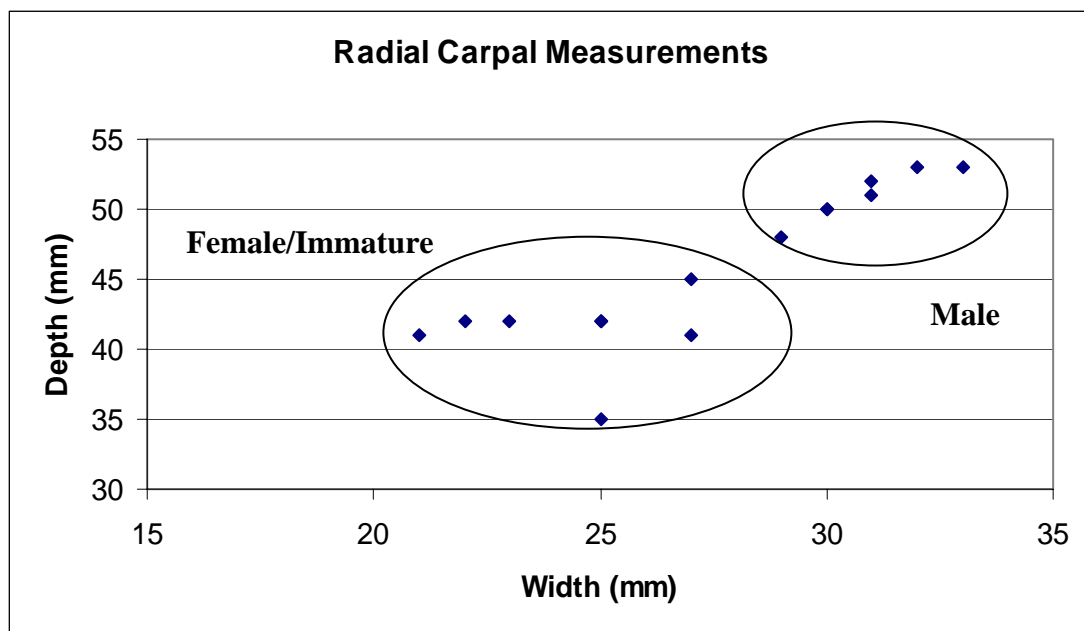


Figure 5.6 Bimodal plot of radial carpal measurements.

Internal Carpal (*Os carpi intermedium*)

The internal carpal, also known as the intermediate carpal, sits in the centre of the proximal row of carpals. It articulates with the radius on the proximal end, the radial carpal on the medial side and the ulnar carpal on the lateral side. On the distal end, the internal carpal articulates with both the fused second and third carpal and the unciform carpal (Morlan 1991:221). The best bimodal distribution was noted when width was

plotted against depth (Figure 5.7). All measurements can be found in Appendix A, Table A.2. In the case of the internal carpal, only seven specimens were complete enough to allow for measurements to be taken. As can be seen from Figure 5.7, six of the seven carpals likely belonged to females or immature individuals, whereas only one carpal likely belonged to a male.

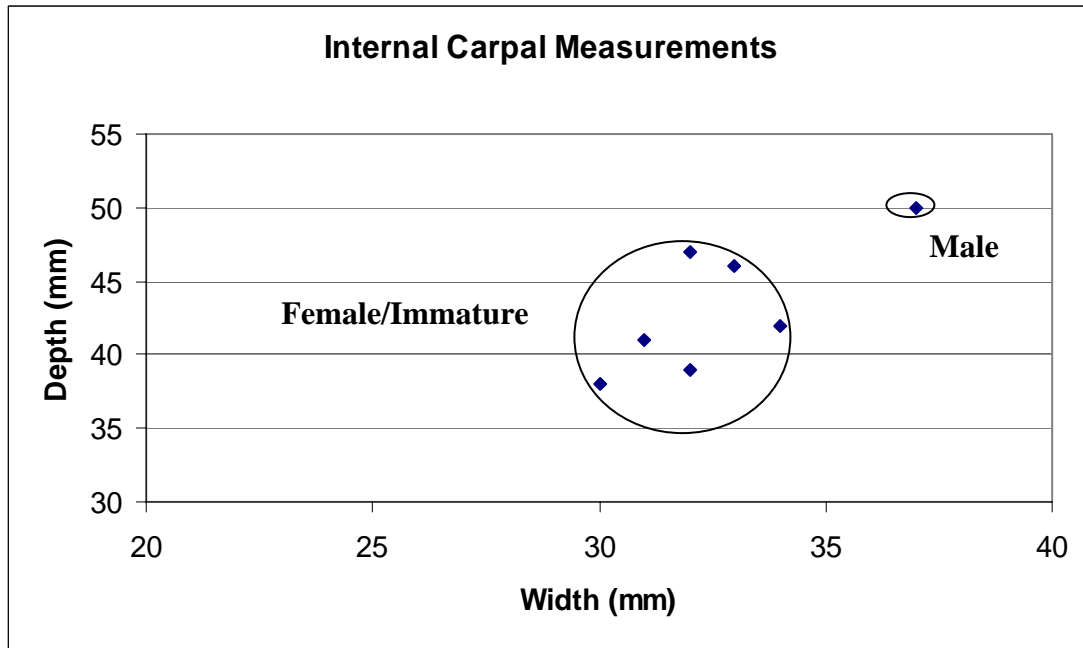


Figure 5.7 Bimodal plot of internal carpal measurements.

Ulnar Carpal (*Os carpi ulnare*)

The ulnar carpal is located at the lateral end of the proximal row. This carpal articulates with the ulna at the proximal end, the internal carpal on the medial side and the unciform carpal on the distal end. The posterior surface of the ulnar carpal forms the articulation for the accessory carpal (Morlan 1991:221). The measurements taken for the ulnar carpal can be found in Appendix A, Table A.3. In the Hartley site assemblage a total of eleven ulnar carpals were utilized for measurement, although two carpals had equal measurements (catalogue numbers 6011 and 2614). The bivariate plot that resulted from the measurements taken of depth (D) and anterior length (L) is not as clearly segregated as one would wish. Nevertheless, it appears as though five of the

carpals can be labelled as belonging to either female or immature individuals, whereas six likely belong to males (Figure 5.8).

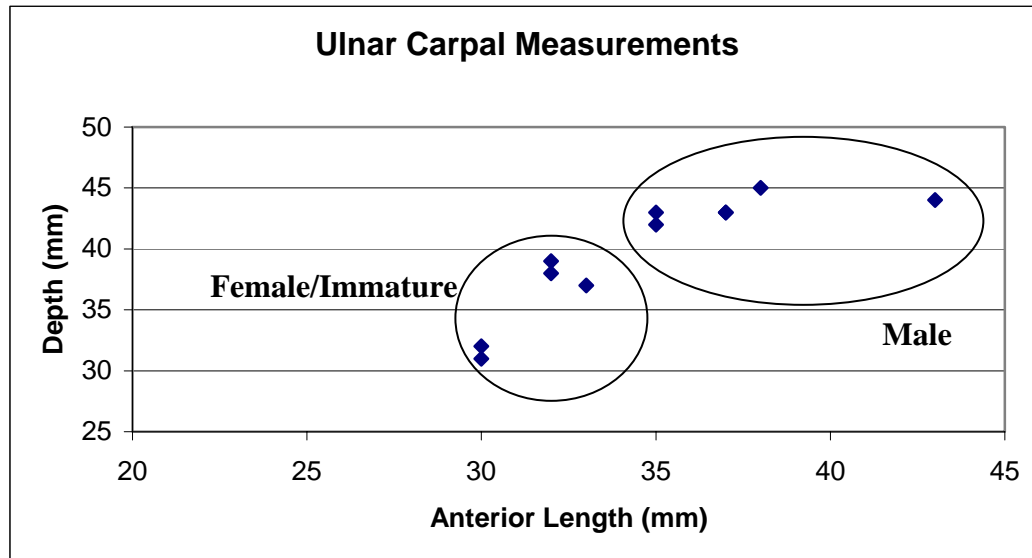


Figure 5.8 Bimodal plot of ulnar carpal measurements.

Fused Second and Third Carpal (*Os carpale II + III*)

The fused second and third carpal can be found in the distal row. This carpal articulates with the radial and intermediate carpals on the proximal end, the unciform carpal on the lateral side and the metacarpal on the distal end. In the Hartley site assemblage, 11 fused second and third carpals were measured according to their depth (D) and width (W). Measurements for these carpals can be found in Appendix A, Table A.4. Of the eleven carpals, it appears as though seven can be classified as female or immature individuals and four as mature males (Figure 5.9).

Unciform Carpal (*Os carpale IV*)

The unciform carpal (also known as carpal 4) is located at the lateral end of the distal row. It articulates with the internal and ulnar carpals on the proximal end, the fused second and third carpal on the medial side, and the metacarpal on the distal end (Morlan 1991). The clearest distribution was noted upon plotting depth (D) versus width (W).

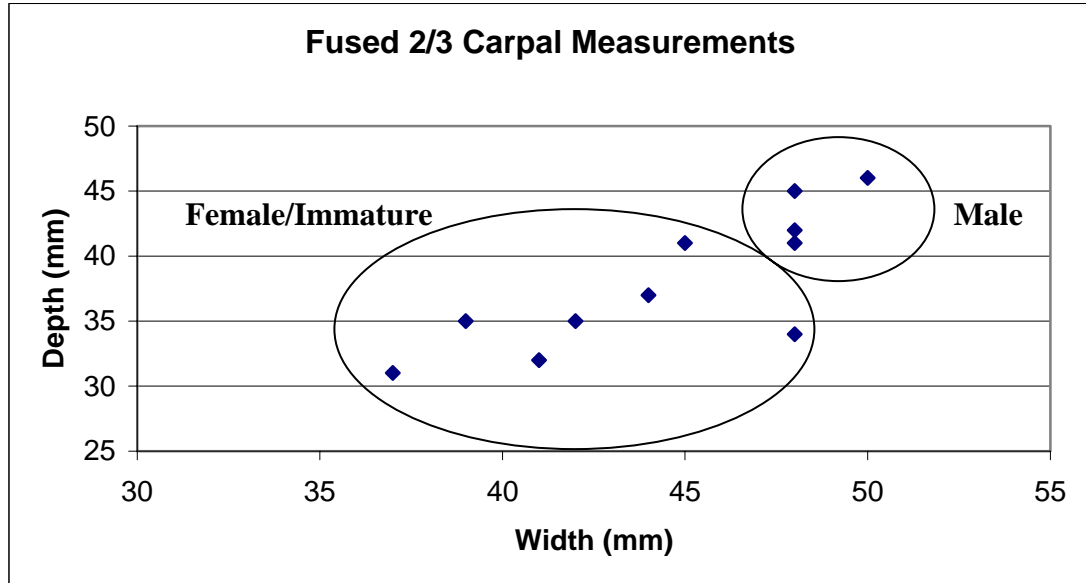


Figure 5.9 Bimodal plot of fused second and third carpal measurements.

A total of 19 complete unciform carpals were measured, producing a fairly even distribution of nine female and/or immature specimens and ten males. Although the graph clearly demonstrates measurements from fourteen individuals, various elements had equal measurements, thereby reducing the number of plots located on Figure 5.10 (See Appendix A, Table A.5).

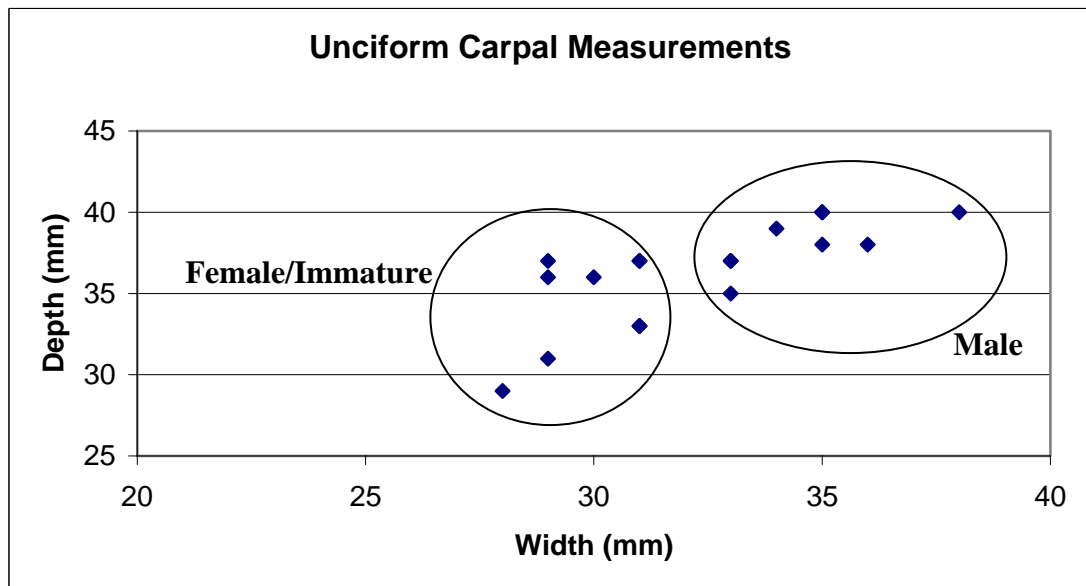


Figure 5.10 Bimodal plot of unciform carpal measurements.

Accessory Carpal

No measurements were recorded for the accessory carpal.

5.4.3 Tarsal Measurements

Talus (*Talus*)

The talus is one of the largest tarsals located in the proximal row on the medial side. On the proximal end, the talus articulates with the tibia, on the posterior and lateral sides with the calcaneus, on the lateral side with the lateral malleolus, and on the distal end with the fused central and fourth tarsal. The talus has two measurements that can be taken in each of the three dimensions (Morlan 1991:223). Lateral length (Ll), medial length (Lm), proximal width (Wp), distal width (Wd), lateral depth (Dl), and medial depth (Dm) were all measured and recorded (See Appendix A, Table A.6). Different combinations of each of these measurements were plotted on a graph with varying degrees of success. Only when medial length was plotted against lateral length was a reasonably good separation noted (Figure 5.11). Unfortunately, only five tali were complete enough to warrant measurement making this distribution even more difficult to assess. Of the five tali that were measured, only one likely belongs to a female or an immature individual whereas the other four likely came from male individuals.

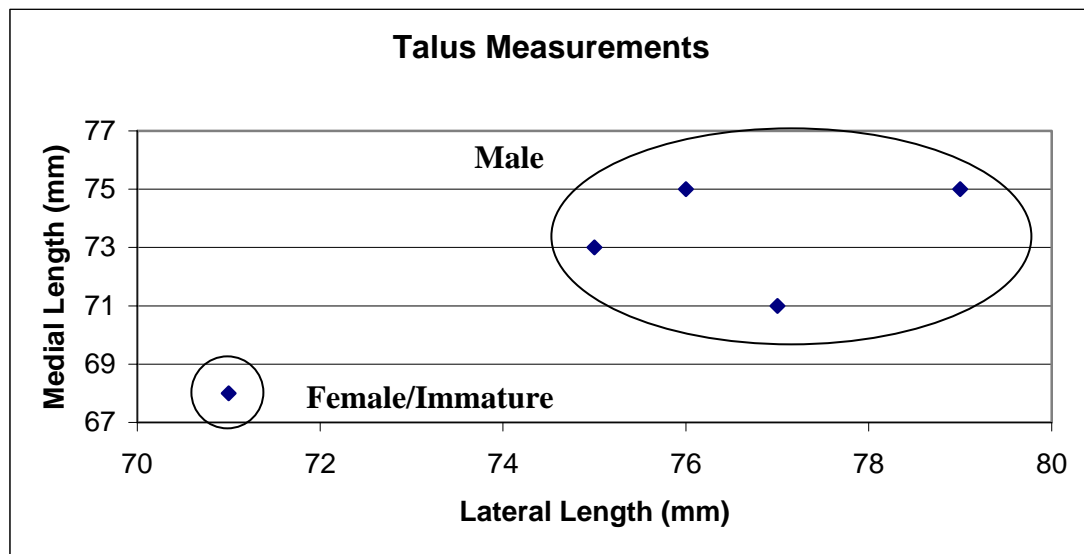


Figure 5.11 Bimodal plot of talus measurements.

Calcaneus (*Calcaneus*)

The calcaneus is the largest tarsal in the bison. It is the lateral tarsal in the proximal row and has a long posterior or proximal projection that is known as the tuber calcis (Morlan 1991:223). On the anterior and medial sides it articulates with the talus, on the distal end with the fused central and fourth tarsal, and on the anterior side with the lateral malleolus. It has been noted that in the European version of the bison (*Bison bonasus*) the epiphysis fuses at the end of the fourth year of life (Duffield 1973:133). Morlan (1991:223), however, calls attention to the fact that in some cases, fusion has been observed as occurring in the fifth year of life in bulls and sixth year of life in cows. The lack of consistency in the literature is disconcerting, however, these studies only have relevance if one assumes that *Bison bison* follow a similar schedule of epiphyseal fusion as *Bison bonasus* (Morlan 1991:223).

Only eight calcanei were complete enough to obtain measurements (See Appendix A, Table A.7). The graph of proximal width (Wp) versus proximal depth (Wd) demonstrated the best segregation between the sexes (Figure 5.12). Only one individual in the Hartley site assemblage was noted as not having a fused epiphysis and is noted on the graph with a square symbol. In total, three individuals were identified as female/immature and five specimens likely belonged to males.

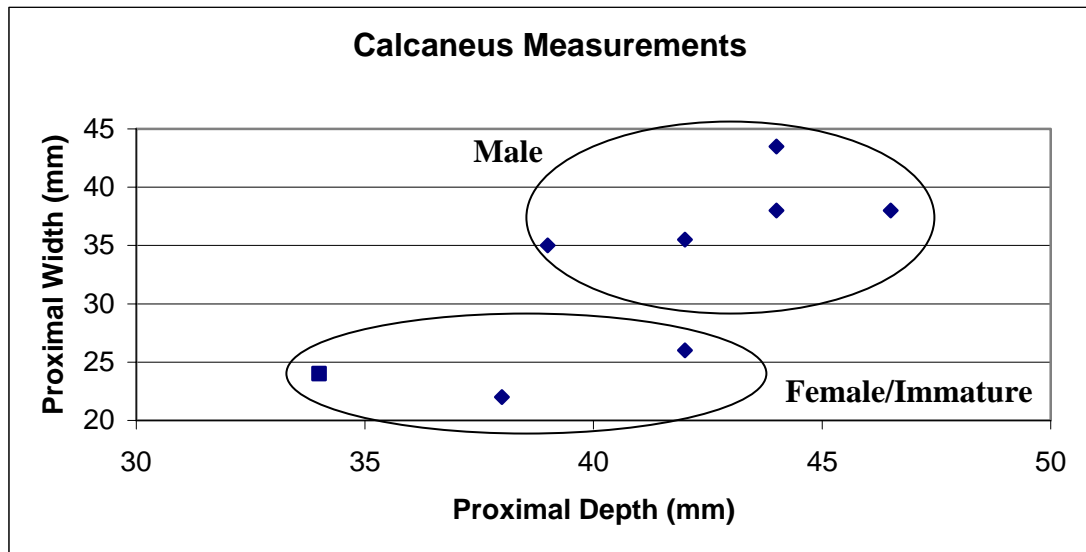


Figure 5.12 Bimodal plot of calcaneus measurements.

Fused Central and Fourth Tarsal (*Os centroquartale*)

The fused central and fourth tarsal occupies the middle row of tarsals and articulates with the talus on the proximal end, the calcaneus on the proximal and lateral sides, tarsal 1, the fused second and third tarsal and the metatarsal on the distal end (Morlan 1991). The graph of depth (D) versus length (L) demonstrated the best segregation between the sexes (Figure 5.13). An attempt was made to measure a total of 14 fused central and fourth tarsals, although only 12 of the 14 were complete enough for measurement (See Appendix A, Table A.8). The bimodal plot suggests that five of these tarsals belonged to female or immature individuals and the remaining seven likely belonged to males. It is noted that catalogue numbers 4046 and 8058, although both right elements, share the same measurements and are represented by one plot only in Figure 5.13.

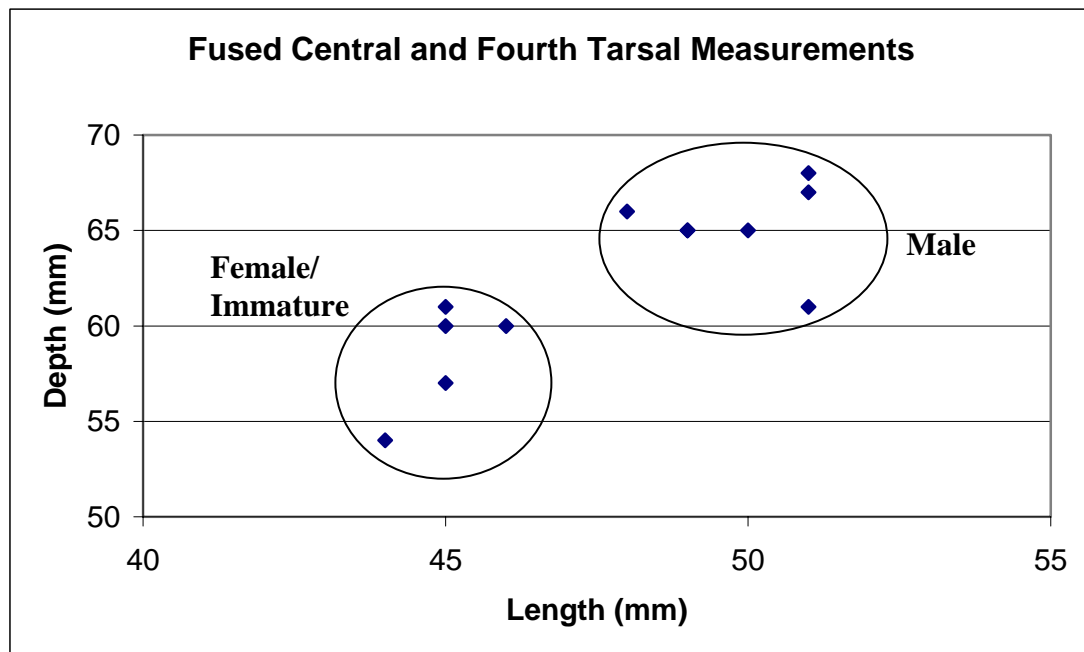


Figure 5.13 Bimodal plot of fused central and fourth tarsals.

Fused Second and Third Tarsal (*Os tarsale II + III*)

The fused second and third tarsal is located in the anterior end of the distal row of tarsals (Morlan 1991). It articulates with the fused central and fourth tarsal on the proximal end and the metatarsal on the distal end. A total of ten fused second and third

tarsals were obtained for measurement (See Appendix A; Table A.9). The segregation of female and immature individuals from male individuals was clearly noted when depth (D) was plotted against width (W) (Figure 5.14). Although only four male individuals are represented on the graph, two elements (catalogue numbers 7882 and 2292) share the same measurements. These two elements represent two separate individuals as they are both from the right side of the body. It can be seen that five individuals likely came from female or immature bison, and an additional five likely belonged to males.

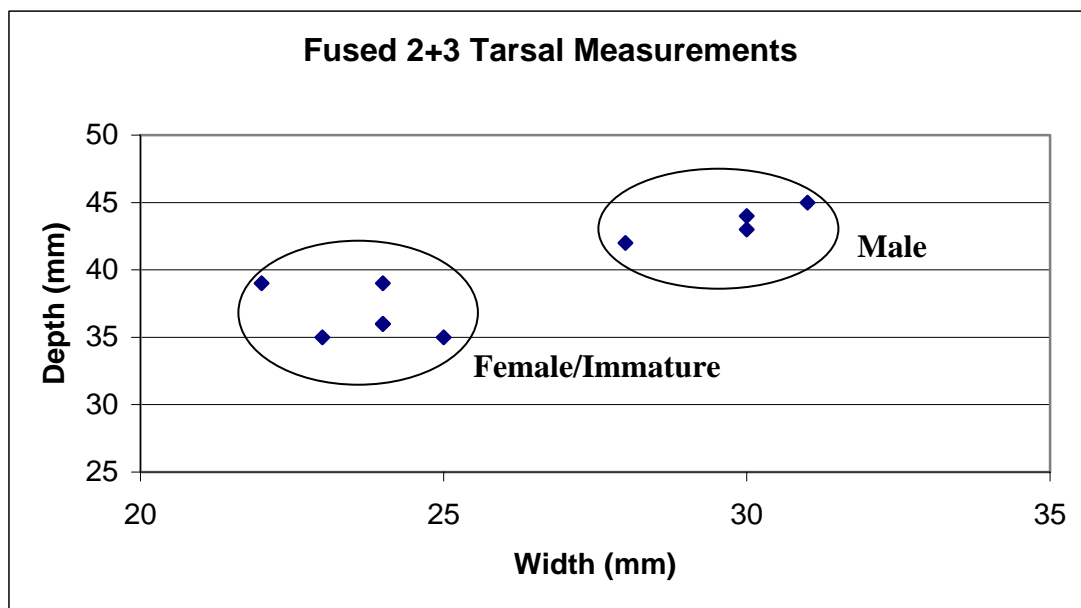


Figure 5.14 Bimodal plot of fused second and third tarsal measurements.

Lateral Malleolus (*Os malleolare*)

Although the lateral malleolus is technically not a tarsal, it is often found and presented with the tarsal assembly (Morlan 1991:225). On the proximal end it articulates with the tibia, with the talus on the medial side and the calcaneus on the distal end. In the Hartley site assemblage a total of nine lateral malleoli were complete enough for measurement (See Appendix A, Table A.10). A bimodal distribution was apparent upon plotting length (L) versus depth (D) (Figure 5.15). One can see that eight of the nine tarsals are grouped together and likely belonged to female or immature individuals, whereas only one likely belonged to a male.

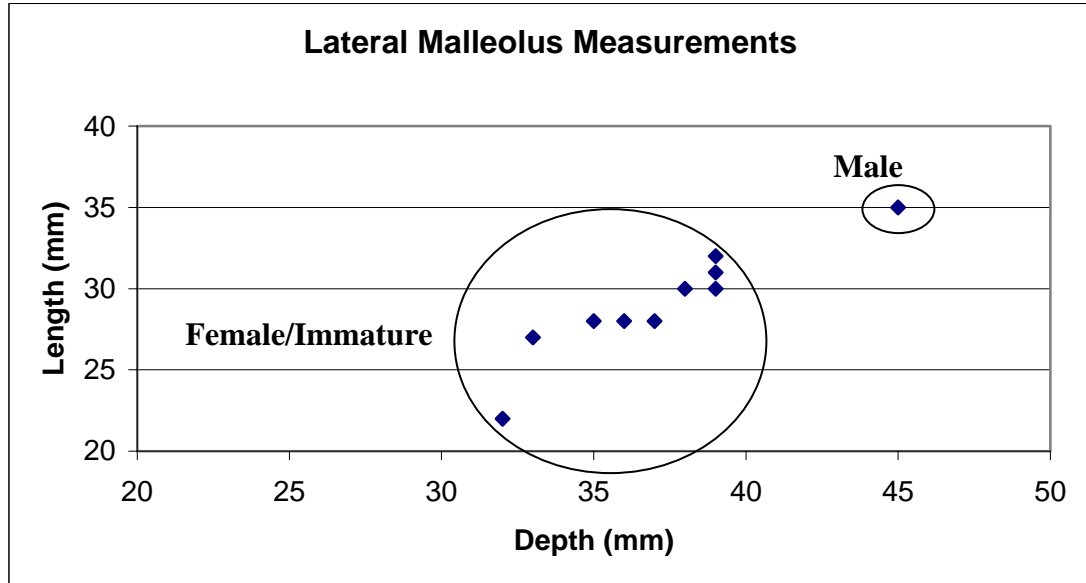


Figure 5.15 Bimodal plot of lateral malleolus measurements.

Tarsal 1

No measurements were recorded for tarsal 1.

5.4.4 Discussion

The bimodal distributions of carpal and tarsal measurements varied in their clarity and results. Each of the graphs presented above differed in terms of numbers of adult male individuals versus female and immature individuals. In most cases, a bimodal distribution was noted based on the measurements originally outlined by Morlan (1991). In some of the cases, however, a third cluster of individuals could have been recognized, likely representing a group of subadult bulls intermediate in size between females and mature males. Morlan (1991) notes that in such cases, until measurements are defined for the upper limits of adult female sizes, one must continue to cluster the immature male individuals within this grouping. In order for such a study to occur, a sample size large enough for statistical testing must be at hand.

When one analyzes the distributions obtained from all the carpal and tarsal measurements, there is a lack of consistency in terms of the apparent resulting herd structure. Ratios of female/immature to male elements range from 90%:10% for the lateral malleolus to 20%:80% for the talus (Table 5.5). In terms of the total numbers of

carpals and tarsals, approximately 54% of the elements were assigned to the female/immature category whereas 46% were assigned to the male category.

Table 5.5 Carpal and tarsal sexing results

Element	Utilized Measurements	Total	F/Imm. N	F/Imm. %	Male N	Male %
Radial Carpal	W/D	15	8	53.0	7	47.0
Internal Carpal	W/D	7	6	86.0	1	14.0
Ulnar Carpal	La/D	11	5	45.0	6	55.0
Fused 2/3 Carpal	W/D	11	7	64.0	4	36.0
Unciform Carpal	W/D	19	9	47.0	10	53.0
Talus	LI/Lm	5	1	20.0	4	80.0
Calcaneus	Dp/Wp	8	3	37.5	5	62.5
Fused C/4 Tarsal	L/D	12	5	42.0	7	58.0
Fused 2/3 Tarsal	W/D	10	5	50.0	5	50.0
Lateral Malleolus	D/L	10	9	90.0	1	10.0
Total		108	58	54.0	50	46.0

Overall, the total sample was fairly evenly distributed and representative of equal numbers of males and female/immature individuals. The almost equal distribution of carpal and tarsals between males and female/immature individuals suggests that this herd was composed of a both sexes as well as a variety of immature individuals killed during the rutting season. A second possibility for the apparent distribution is that the individuals may represent several small kill events that occurred at different times of the year.

5.4.5 Longbone Analysis

Longbones from the fore and hindlimbs of bison are also often used in sex determination (Speth 1983; Todd 1987). Studies of this kind were developed by comparing the results of archaeological fauna to limbs of modern known-sex *Bison bison* (Speth 1983:171; Todd 1987:156; Walde 2004b:103). The sexual dimorphism that is characteristic of most mammals is marked in the limb bones of modern bison with the mature males being considerably larger than the females. Once again, however, these techniques can only be applied on mature individuals; therefore, immature specimens are grouped together with the females resulting in groupings of mature bulls and immature calves and mature cows.

Often times, measurements such as rotational length or greatest length of the element can be used to determine the sex of bison recovered from an archaeological site, however, such measurements can only be used on bones that are either complete or nearly complete (Todd 1987). Unfortunately, as in the case of the Hartley site, limb bones, both upper and lower, are often broken by either human processing or by the actions of carnivores and other non-human agents (Binford 1978:48-64; Lyman 1994:193-219; Todd 1987:159).

Walde's (2004b) work on the development of discriminant function analysis has proven to be extremely useful in the case of sites where the longbones recovered from a site have been subjected to breakage due to cultural and environmental factors. The ultimate purpose of a discriminant function analysis is to discriminate between two groups of data that are each characterized by several different variables. In the case of sexing bison by way of a discriminant function analysis, the two groups of data outlined are those of the male group and those of the female/immature group. The different variables utilized are the longbone measurements originally outlined by Speth (1983).

Walde (2004b) has produced equations for the following six limb elements: humerus, radius, metacarpal, femur, tibia and metatarsal. Each set of equations was developed based on measurements taken on assemblages of known-sex bison (*Bison bison bison*) postcranial skeletal elements. The equation takes the following form:

$$G_x = C_{x_1}V_1 + C_{x_2}V_2 + \dots + C_{x_n}V_n + K$$

where G_x is the classification score for the group x (male or female), C is a classification coefficient, K is a constant, and V is a variable (Walde 2004b:103). The reason for the utilization of the same measurements, or variables (V), as proposed by Speth (1983) is because of their aptness to this type of analysis, in that the specimens do not need to be complete bones to be measured. In order for the discriminant function analysis to work, two separate equations (G_{male} and G_{female}) are run for each element in order to create male and female groups. The mathematical differences between the two groups establish the sex of each element. In order to be consistent, the female/immature group was always subtracted from the male group; therefore, negative values represent female/immature individuals where as positive values represent male individuals.

Measurements were taken on the fused proximal and/or distal ends of each of the six elements mentioned previously. No unfused specimens were utilized in this analysis. In addition, specimens with advanced stages of weathering or a high degree of fragmentation were also excluded. There were no measurable specimens for the proximal humerus, proximal or distal femur or proximal tibia. Measurements with callipers were taken as described by Speth (1983) to the nearest 0.1mm.

5.4.6 Forelimb

Because the distal humerus and proximal radius often have higher survival rates or recovery potential, it has been found that sexing of these portions is possible and often utilized at mass kill and processing sites (For examples see Clarke 1995; Todd 1987; Walde 2004b). In addition, the smaller longbones including the metacarpals and metatarsals have also been utilized in the determination of sex of individuals within an assemblage (Speth 1983; Walde 2004b). Unfortunately, in the case of the Wooded Hollow assemblage, very few forelimb elements were recovered.

In some cases, the discriminant function analyses allowed for various equations to be applied to each element. Walde (2004b:106) notes that equations in which more variables are utilized for sex determination increase the likelihood the element will be sexed correctly. In the case of the Hartley site assemblage, elements were sexed according to those equations for which the most number of variables (the most number of measurements) were taken.

Distal Humerus

The distal humerus is a denser portion of bone, thereby increasing the likelihood that it will survive (Todd 1987). Unfortunately, only a total of five elements were complete enough for measurements to be taken (Table 5.6). Of the five specimens, four were rights and two were lefts. As can be seen from Table 5.6, equation 2.8 was utilized wherever possible. This equation employed a total of six measurements per element, thereby increasing the chances that each element be sexed correctly. All of the humeri measured were fully fused, although they may not necessarily be derived from completely mature individuals. Although it is agreed that the distal end is the first to

become fully fused in the bison, variation exists in the literature as to the years in which the epiphyses fuse (Duffield 1973:133; Dyck and Morlan 1995:567; Empel and Roskosz 1963:372). Therefore, it is noted that while those individuals assigned within the male category are likely correct, those placed within the female category may only be referred to as female/immature.

Table 5.6 Distal humerus sexing measurements and results.

Cat. #	Side	I*	J*	K*	L*	M*	N*	O*	Eq. #	Male Eq.	Female Eq.	Diff.	Sex
3129	R	8.42	5.2	8.2	4.8	7.9	4.2	5.2	2.8	280.70	275.66	5.04	M
4699	R	N/A	4.9	7.7	4.6	7.5	3.7	4.1	2.4	158.90	161.93	-3.03	F/I
6508	L	9.3	5.85	9.18	5.8	9.4	4.1	4.7	2.8	336.55	329.78	6.77	M
6509	R	9.8	6.2	9.21	5.95	9.5	5.4	6.1	2.8	387.54	365.45	22.09	M
6355	R	9.7	6.5	N/A	N/A	N/A	N/A	N/A	2.7	177.16	169.68	7.48	M

* Measurements as presented in Speth (1983)

Proximal Radius

A total of four proximal radii were complete enough to be used in the discriminant function analysis proposed by Walde (2004b). Of the four specimens, two were lefts and two were rights (Table 5.7). In terms of fusion, the proximal epiphysis of the radius is the first epiphysis to fully fuse to the diaphysis, roughly at about two years of age (Dyck and Morlan 1995:571). The distal end, however, does not fuse until approximately age five for bulls and age six for cows (Duffield 1973; Dyck and Morlan 1995; Empel and Roskosz 1963).

Table 5.7 Proximal radius sexing measurements and results.

Cat. #	Side	A	B	C	D	E	F	Eq. #	Male	F/I	Diff.	Sex
4173	L	8.2	N/A	2.1	N/A	3.5	3.7	3.4	136.25	164.97	-28.72	F/I
4874	L	8.3	4.4	2.9	3.1	3.6	5.2	3.1	226.05	249.85	-23.80	F/I
7036	R	10	5.3	3.3	3.7	N/A	6.2	3.1	362.58	368.66	-6.08	F/I
2241	R	10	5.3	3	5.1	N/A	4.4	3.2	404.78	458.74	-53.96	F/I

All of the proximal radii used in this analysis had epiphyses that were completely fused; however, as noted above, because it is the first epiphysis to fuse, the proximal radius may not represent a fully mature individual. Therefore, all individuals within the female grouping are referred to as female/immature. Equation 3.1 was used wherever

possible for it utilized the most number of variables. All of the specimens utilized for measurement were placed within the female/immature category.

Distal Radius

A total of six distal radii, consisting of three rights and three lefts, were analyzed for determination of sex (Table 5.8). All specimens had completely fused epiphyses, decreasing the likelihood that immature individuals would be grouped together with the females. As such, the two evaluated groups consist of males and only females. An even distribution of three males and three females was calculated. In all but one case equation 4.1 was utilized to determine the sex of each specimen. One should also note that it is possible that some of the specimens utilized in measurement of the proximal and distal radius could have originally been from the same element.

Table 5.8 Distal radius sexing measurements and results.

Cat. #	Side	G	H	I	J	K	Eq. #	Male	Female	Diff.	Sex
2657	R	8.6	4.8	4.5	2.1	4.25	4.1	230.47	215.70	14.77	M
1698	L	6.5	3.8	3.7	1.8	3.6	4.1	111.37	117.11	-5.74	F
4469	R	7.5	4	3.9	2	2.9	4.1	157.38	168.29	-10.91	F
2382	L	8.3	4.6	4.3	3	3.7	4.1	187.93	182.39	5.54	M
2655	L	8.5	N/A	4.8	3.1	4.1	4.4	236.67	227.50	9.17	M
3331	R	7.1	4	3.6	2	3.5	4.1	128.13	132.65	-4.52	F

Proximal Metacarpal

Walde (2004b:107) notes that the proximal metacarpal lacks a true epiphysis, making it impossible to accurately assess animal maturity. Therefore, the discriminant function analysis defined by Wale (2004b) can only distinguish between a group of mature males and a group of adult females and immatures. Three bones from the left side and one from the right side were utilized for sex determination (Table 5.9). An even distribution of two mature males and two female/immature individuals was noted.

Table 5.9 Proximal metacarpal sexing measurements and results.

Cat. #	Side	A	B	C	Eq. #	Male	F/I	Diff.	Sex
9043	L	7.7	4.2	4.6	5.1	329.84	322.83	7.01	M
3210	L	6.3	3.5	3.6	5.1	214.52	222.91	-8.39	F/I
1917	R	6.9	3.7	4.2	5.1	257.47	259.86	-2.39	F/I
4015	L	7.4	4.6	4.7	5.1	340.74	333.68	7.06	M

Distal Metacarpal

According to Empel and Roskosz (1963:273), the distal end of the metacarpal fuses in the third year of life in *Bison bonasus*, however, based on the porosity of the bones recovered from the Sjøvold site, Dyck and Morlan (1995:571) suggested that this may occur much earlier in North American Bison (*Bison bison*). Walde (2004b) notes that sexual dimorphism in the distal metacarpal seems to be reflected more strongly in the proximal end. Unfortunately, only two specimens complete enough to be assessed were utilized in this analysis, represented by two lefts (Table 5.10). Both specimens were identified as male individuals, and it is noted that one of the specimens also retained its proximal end. In both cases, the specimens were identified as belonging to a male individual.

Table 5.10 Distal metacarpal sexing measurements and results.

Cat. #	Side	D	E	F	G	H	I	J	Eq. #	Male	Female	Diff.	Sex
9043	L	7.4	3.8	3.4	3.1	2.5	3.9	3.7	6.1	424.53	419.22	5.31	M
6349	L	7.3	3.7	3.4	3.2	2.6	3.9	3.6	6.1	408.81	404.23	4.58	M

5.4.7 Hindlimb

Numerous bones from the hindlimb can also be used to determine sex in an assemblage similar to that of the Hartley site. Walde (2004b) notes that the proximal and distal ends of the femur, tibia and metatarsal can be utilized for sex determination in North American *Bison bison*. Unfortunately, the only specimens that could be measured from the Hartley site assemblage included those from the distal tibia and proximal and distal metatarsal. Once again, the equations chosen were those in which more variables were utilized in order to determine sex.

Distal Tibia

In the tibia, the distal epiphysis fuses with the diaphysis in the middle of the fourth year. According to Duffield (1973:133), the proximal end does not fuse until a year and a half later, at the end of the fifth year. A total of eight distal tibiae were recovered, consisting of five rights and three lefts (Table 5.11). In all cases, equation 10.1 was applied to the specimens. In total, five of the specimens were identified as

belonging to female/immature individuals and the remaining three were identified as males. Unfortunately, no complete proximal tibiae were recovered.

Table 5.11 Distal tibia sexing measurements and results.

Cat. #	Side	H	I	J	K	L	Eq. #	Male	F/I	Diff.	Sex
3048	R	6.8	4.3	4.6	N/A	N/A	10.1	390.00	397.09	-7.09	F/I
7549	R	7.8	5.5	5.1	N/A	N/A	10.1	503.76	497.78	5.98	M
4920	L	6.8	5.3	4.6	3.8	4.8	10.1	384.62	392.29	-7.67	F/I
2400	R	7.9	5.6	4.9	5.2	6.1	10.1	485.22	481.23	3.99	M
2962	L	6.3	N/A	4.4	N/A	N/A	10.1	333.13	346.74	-13.61	F/I
5405	R	7	5.7	4.9	4.3	5.1	10.1	434.29	436.41	-2.12	F/I
7554	L	5.3	7.1	5.1	N/A	N/A	10.1	353.96	365.94	-11.98	F/I
6533	R	7.7	5.4	5.1	N/A	N/A	10.1	497.76	492.50	5.26	M

Proximal Metatarsal

As was the case with the proximal metacarpal, the proximal metatarsal also lacks a true epiphysis, therefore making it impossible to distinguish between immature males and adult females (Walde 2004b:107). Only one left specimen was complete enough to obtain the measurements required (Table 5.12). Equation 11.1 was applied and it was found that it likely belonged to a female/immature individual.

Table 5.12 Proximal metatarsal sexing measurements and results.

Cat. #	Side	A	B	C	Eq. #	Male	F/I	Diff.	Sex
2651	L	5.2	5.1	2.3	11.1	263.33	265.43	-2.10	F/I

Distal Metatarsal

According to Duffield (1973:133) the distal end of the metatarsal fuses to the diaphysis at the end of the fourth year of life. Although three left metatarsals were complete enough for some measurements to be taken, only two yielded those measurements needed for a discriminant function analysis (Table 5.13).

Table 5.13 Distal metatarsal sexing measurements and results.

Cat. #	Side	D	E	F	G	H	I	J	Eq. #	Male	F/I	Diff.	Sex
7005	L	5.8	2.2	2.3	2.4	2.7	3.4	3.5	12.2	291.77	310.16	-18.39	F/I
3831	L	5.3	2.6	N/A	2.5	N/A	3.3	N/A	N/A	?	?	?	?
6451	L	6	N/A	N/A	2.4	2.6	3.5	3.8	12.3	384.34	391.99	-7.65	F/I

In the first case, equation 12.2 was applied and demonstrated a female/immature individual. In the second case equation 12.3 also demonstrated a female/immature individual.

5.4.8 Discussion

The results of the longbone sexing data were varied, and it is noted that the sample size for each element was extremely small. In addition, some of the specimen groups were represented by mature individuals only (the distal radius and distal metapodials) whereas other groups may have contained some specimens that were not fully mature (the proximal radius and proximal metacarpal).

Similar to the results obtained from the carpal and tarsal data, the total sample was fairly evenly distributed and representative of almost equal numbers of males and female/immature individuals (Table 5.14). Ratios of female/immature individuals to male individuals vary from 0:100 all the way to 100:0. Overall, the total ratio of female/immature individuals to male individuals is 55%:42%. These ratios do not add up to 100% as one bone was indeterminate in terms of sex.

Table 5.14 Longbone sexing results.

Element	Total	F/Imm. N	F/Imm. %	Male N	Male %	Indet.	Indet. %
Distal Humerus	5	1	20.0	4	80.0	0	0.0
Proximal Radius	4	4	100.0	0	0.0	0	0.0
Distal Radius	6	3	50.0	3	50.0	0	0.0
Proximal Metacarpal	4	2	50.0	2	50.0	0	0.0
Distal Metacarpal	2	0	0.0	2	100.0	0	0.0
Distal Tibia	8	5	62.5	3	37.5	0	0.0
Proximal Metatarsal	1	1	100.0	0	0.0	0	0.0
Distal Metatarsal	3	2	67.0	0	0.0	1	33.0
Total	33	18	55.0	14	42.0	1	3.0

5.4.9 Phalanges

Phalanges have long been known to be useful in the determination of sex in bison. Early studies by Empel and Roskosz (1963) and Duffield (1973) were important in the development of phalangeal application to determine sex. Roberts (1982) developed a new technique for sexing Plains bison based on a study of first phalanges from individuals whose sex was known. Roberts (1982) chose the front phalanges rather than the rear phalanges in order to increase the likelihood of emphasizing the differences

between males and females. It is noted that sexual dimorphism was more likely to be expressed in the front phalanges than in the rear because the greater proportion of weight in bison is carried in the shoulder area, over the front feet. Therefore, the heavier-set bulls should demonstrate much larger first phalanges than females (Roberts 1982:4).

Roberts (1982:5) indicated that the reasons for choosing the first phalanges, as oppose to the second and third, were twofold. In Empel and Roskosz's (1963:293) study of European bison, it was found that the third phalanx was unsexable due to their lack of difference in size. From this information, Roberts (1982) assumed that the distal end of the second phalanx would therefore be less likely to express marked sexual differences, for it articulates with the proximal end of the third phalanx. In addition, there appeared to be a greater chance of finding a marked sexual difference in the first phalanx because the distal width of the metacarpal, which articulates with the proximal end of the first phalanx, has been found to show marked sexual difference between male and female bison (Roberts 1982:5). Secondly, the use of the first phalanges often shows more complete separation, or bimodality into two distinct groups, as oppose to the second phalanges (Roberts 1982:5). In a cluster-style analysis, a clear separation is imperative in order to allow for solid conclusions.

A discriminant function analysis was performed in which the length (L), greatest length (GL) and distal height (DH) for each first phalange was taken. These measurements were rounded to the nearest 0.1 millimetre and were inserted into the following discriminant function:

$$(GL \times 0.52067) + (DH \times 0.54678) - (L \times 0.29469)$$

Roberts (1982:90) concluded that when the value of the discriminant function was plotted in a cluster-style fashion against any of the three measurements (L, GL or DH), a clear bimodal distribution could be seen.

A total of 14 front first phalanges from the Hartley site assemblage were measured in terms of their length, greatest length and distal height. The values were plugged into the discriminant function equation as outlined above. Following the calculation of the equation, the obtained value was then plotted against length, greatest length and distal height respectively. These values can be found in Appendix A; Table

A.11. The clearest bimodal distribution was noted when the value of the discriminant function equation was plotted against distal height (Figure 5.16).

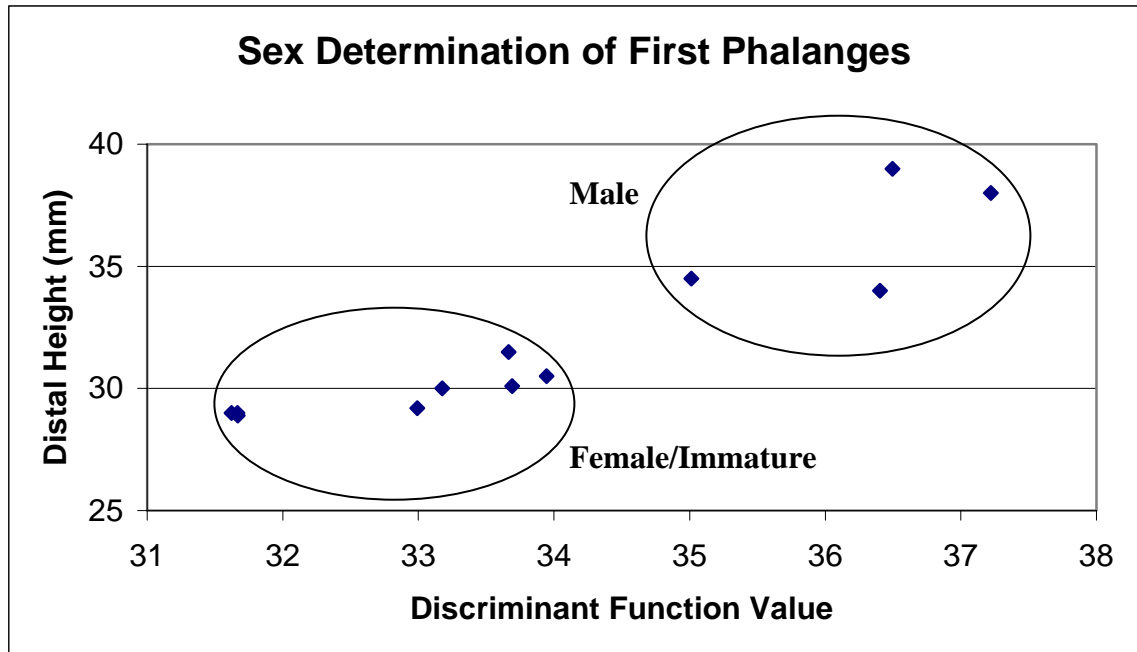


Figure 5.16 Bimodal plot of first front phalange measurements.

5.4.10 Discussion

Three lines of data have been utilized to obtain information regarding herd structure: (1) cluster analysis of carpals and tarsals; (2) discriminant function analysis of longbones; and (3) discriminant function and cluster analysis of the first front phalanges. All three of these lines of evidence suggest that the herd in question was composed of an almost equal ratio of female/immature individuals to male individuals. From the evidence presented above, one may attempt to infer seasonality. The time of year during which males and females congregate together is during the rut. Banfield (1974:406) suggests that the rutting period extends from early July to late September with a peak in mid-August while the gestation period of modern bison lasts between 270 and 300 days. If one assumes Banfield (1974) to be correct, parturition would then occur between mid-April and the beginning of June, peaking in May. Therefore, if an equal distribution of males and females is noted in an assemblage, as in the Hartley site assemblage presented above, it is likely that it is representative of a herd procured during the rut. A recent

publication by Walde (2006b) has demonstrated, however, that this may not be the case and further review of bison mating behaviour is needed.

Another possibility that needs consideration is that the Hartley site assemblage could be composed of individuals that were acquired over a period of time as opposed to one single event. Results obtained from the Tschetter site (Prentice 1983:36; Walker 1979:53) revealed that continuous use of a site can be inferred if either the herd structure or the bison mandibular tooth eruption and wear patterns are not consistent. Walker (1979) demonstrated that there was a variation in the definable age groupings based on the measurements obtained from the heights of the metaconid on the first molar. It was demonstrated that the values varied within each grouping of bison between increments of X.6 and X.7 years. Walker (1979) proposed based on this data that the Tschetter site probably represented continuous procurement events between November and late January. Although this site is identified as a single component site, it has been demonstrated that it was utilized over a period of time instead of representing one event. It is possible that the Hartley site assemblage could also be representative of various procurement events.

5.5 Summary

The Hartley site faunal assemblage is dominated by *Bison bison*. At least 17 individuals were identified based on the numbers obtained from the fused central and fourth tarsal. The majority of the assemblage is dominated by unidentifiable unburned bone suggesting that the bones were being processed to remove marrow. Aging and determination of seasonality proved difficult in this analysis as there was an inadequate sample of complete mandibles and identifiable molars. The complete lack of foetal remains also hindered any sort of conclusion with regards to procurement during the gestation period.

It is unfortunate that there is no clear separation of strata at the Hartley site, nor were any definable age groups outlined based on tooth eruption and wear. Inferences with regards to season of occupation are based solely on a very small number of immature elements as well as the herd structure. Cluster analysis of carpal and tarsals produced a bimodal distribution. Similar to these results, a discriminant function

analysis of available long bones also demonstrated bimodality. In both of these cases, an almost equal ratio of males to female/immature individuals was established. In addition, a cluster analysis of the front first phalanges confirmed that the herd likely consisted of both males and female/immature individuals. These conclusions are in opposition to the nursery herd that was demonstrated to have been present in the Brushy Depression to the south and instead suggest procurement during the rut, or at several different times of the year.

Chapter Six

The Hartley Site Non-Bison Faunal Assemblage

6.1 Introduction to the Hartley Site Non-Bison Faunal Assemblage

The Hartley site non-bison faunal assemblage is composed of at least 23 taxa of vertebrates. The specimens discussed in the following section were identified to the lowest taxonomic level possible. In some cases, the specimens were identified down to species, genus, family, and order. Some specimens could not be identified down to a specific taxonomic level and were therefore classified based on their size class only as originally defined by Dyck and Morlan (1995) and modified by Webster (1999).

6.2 Systematic Descriptions of Non-Bison Fauna

6.2.1 Class Mammalia

Order Carnivora, Family Canidae

Canis lupus

Material: NISP=75; see table 6.1 for a summary.

Distribution and habitat: Wolves are distributed widely across the planet. In Canada, wolves were once spread throughout the country with the exception of the Queen Charlotte Islands. North American wolves have been split into a large number of subspecies based on the slight differences in their, colour, skull shape and overall size (Banfield 1974:294). Wolves live in packs of four to seven individuals, although this number can vary between two and fourteen (Banfield 1974:290). Wolves tend to show little preference for particular habitats as they can be found on the arctic tundra, on the mountain-tops and on the plains as well as in coniferous and eastern deciduous forests (Banfield 1974:292). During the breeding season (late February to mid-March), wolves use dens in a variety of locations such as under a shelf of rock, in a cave, a hollow log, or even abandoned beaver lodges, badger dens or fox dens.

Table 6.1 Summary of *Canis lupus* counts

Element	NISP	MNE	MNI
Axial Skeleton			
Mandible	1	1	1
Incisor	3	3	2
Maxilla	1	1	1
Canine	3	3	1
Premolar	3	1	1
P ³	1	1	1
P ₃	3	2	2
P ⁴	1	1	1
P ₄	5	4	2
M ¹	1	1	1
M ₁	1	1	1
M ²	1	1	1
M ₂	1	1	1
M ³	1	1	1
Atlas	1	1	1
Axis	1	1	1
Cervical Vertebrae	1	1	1
Lumbar Vertebrae	1	1	1
Forelimb			
Scapula	2	2	2
Humerus	1	1	1
Ulna	3	2	2
Cuboid	2	2	2
Hindlimb			
Femur	1	1	1
Calcaneus	1	1	1
Astragalus	2	2	1
Navicular	1	1	1
4th Metatarsal	3	3	2
5th Metatarsal	2	2	2
Unidentifiable Metatarsal	2	1	1
Other Elements			
First Phalanx	3	3	1
Second Phalanx	6	6	1
Unidentifiable Metapodial	1	1	1
Miscellaneous Molars	13	-	-
Ribs	2	-	-
Total	75	-	-

Wolf packs occupy fixed home ranges around the den which may encompass between 100 to 260 square miles (Banfield 1974: 291). In the area, wolves travel along fixed runways which follow game trails, roads, rivers, lakes and portages. Packs often

patrol these routes at regular intervals with the hope of procuring food. Wolves are primarily hunters of big game including moose, caribou, wapiti, deer, sheep and bison. These animals will oftentimes return to their own kills and clean up the carcasses, but seldom touch other carcasses unless driven to do so by starvation (Banfield 1974:289-294).

Discussion: All specimens identified as *Canis lupus* were larger than the male wolf in the University of Saskatchewan comparative collection and represent at least two individuals. No cultural modifications in the form of cutmarks were noted and none of the specimens had been thermally altered. The majority of the specimens consist of teeth as well as bones from the hind and forelimbs (Figures 6.1 to 6.4). In terms of weathering, the specimens were only slightly weathered and root etching was classified from light to moderate. One specimen was noted as having a crenelated/scalloped edge (3771) and a second specimen displayed a puncture mark (4625), likely from a carnivore of some sort. Degree of polishing varied from being localized (3771, 4736, and 4877) to moderate (2673, 7566, and 8597) to extensive (4677).

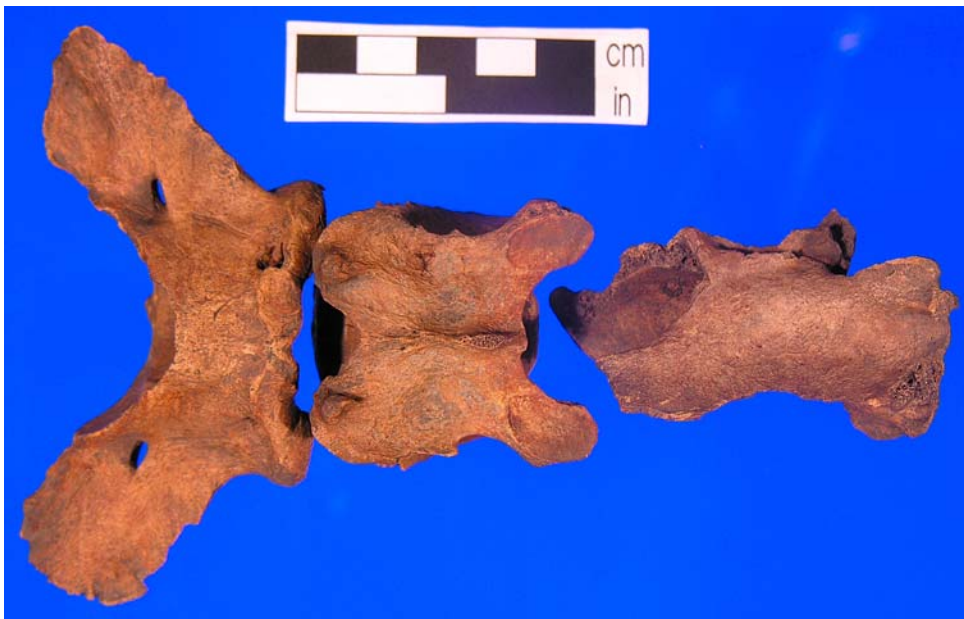


Figure 6.1 *Canis lupus* vertebrae remains recovered from the Hartley site.



Figure 6.2 *Canis lupus* metatarsal remains recovered from the Hartley site.



Figure 6.3 *Canis lupus* longbone remains recovered from the Hartley site.



Figure 6.4 *Canis lupus* carpal and tarsal remains recovered from the Hartley site.

***Vulpes sp.* (SC3)**

Material: NISP = 4; left M² (2761), right M₁ (3354), left M² (5900), left mandible (6827).

Discussion: The teeth and mandible identified were morphologically similar and of the same size as those of the *Vulpes* genus. None of the specimens were complete enough for identification to the species level. Specimens classified within this category were only slightly weathered and displayed a small amount of deterioration. Root etching was noted as light to moderate and only one specimen displayed any sort of moderate polishing (6827).

***Vulpes vulpes* (Red Fox)**

Material: NISP = 1; P₄ (3486).

Distribution and habitat: Red Foxes prefer semi-open country, such as agricultural areas, lakeshores, river valleys, natural clearings in forests, as well as the

alpine and arctic tundra. Only seldom are Red Foxes found in the heart of dense forests (Banfield 1974:300). In Canada, Red Foxes can be found from the west to east coasts, although they are rare on the southern plains of Alberta and southwestern Saskatchewan. There are currently nine recognized subspecies of Red Foxes in North America (Banfield 1974:301). Red Foxes, like many other carnivorous animals, found themselves unintended victims of intense poisoning campaigns directed against the Wolf, Coyote, and Black-tailed Prairie Dog in the first several decades after European migration to the province. Such poison campaigns were directed towards massive extinctions to make room for agricultural settlement (Fung 1999:142).

Discussion: The size and morphology of the dentition was the same as the Red Fox specimen housed in the University of Saskatchewan comparative collection. A minimum number of one individual is represented by the tooth and it displayed no signs of cultural modification or root etching.

***Vulpes velox* (Swift Fox)**

Material: NISP = 4; left scapula (6553), left M³ (8650), left M² (8651), left innominate (8652).

Distribution and habitat: The Swift Fox is very similar to the Kit Fox (*Vulpes macrotis*) and may only differ by level of subspecies (Banfield 1974:301). These animals are solitary except during the breeding season. They are primarily nocturnal and spend the daylight hours sleeping in their burrows. The dens of Swift Foxes are located in sandy soil on open, bald prairie, along fence rows, or occasionally in ploughed fields. Swift Foxes are typically found only in arid short-grass plains and shrubby deserts. This species, originally found in the arid plains of central North America from Texas to southern Canada, is now much more restricted in distribution (Banfield 1974:303). When the prairie region was first settled, Swift Foxes could be found from the Pembina Hills of Manitoba to the foothills of the Rockies. The Swift Fox was easily trapped and soon disappeared as the land came under cultivation. This species was considered to be extinct in Canada, however, has been reintroduced (Banfield 1974:303).

Discussion: All of these specimens were identified as belonging to a Swift Fox due to their similar size and morphology to the specimen housed at the University of Saskatchewan comparative collection. The specimens assigned to this species represent a minimum of one individual. Stages of weathering were insignificant in these specimens and root etching was consistently classified as light. No cultural modifications were noted in terms of cutmarks and the specimens showed no signs of thermal alteration.

Order Lagomorpha, Family Leporidae

Indeterminate Leporid (SC3)

Material: NISP = 4; left humerus shaft (5737), right humerus shaft (5738), left scapula (5739), left mandible (5740).

Discussion: These four specimens were assigned to the Rabbit family based on their comparable size and morphology. They could not be assigned to a specific species due to the high degree of fragmentation. None of the specimens show any sign of cultural modification and only light stages of weathering and root etching were recorded.

***Lepus sp.* (SC3)**

Material: NISP = 12; left mandible (1585), femur shaft (3920), left proximal tibia (4999), right ilium (5031), right ischium (5154), right radius shaft (6233), right humerus shaft (6260), right scapula (6261), left tibia shaft (6493), left mandible (6753), femur shaft (8934), distal humerus (9104).

Discussion: Based on the degree of fragmentation, these specimens were only identified as belonging to the *Lepus* genus. This identification was based on comparability in size. None of the specimens show any signs of cultural modification. Light root etching was noted on each specimen. No significant weathering was observed. Two specimens (6753 and 8934) showed signs of moderate to extensive polishing.

***Lepus townsendii* (White-tailed Jack Rabbit)**

Material: NISP = 1; first phalanx (5318).

Distribution and habitat: The White-tailed Jack Rabbit currently inhabits the northern Great Plains region of North America. Within Canada, this species is confined to the prairie regions of Manitoba, Saskatchewan, and a small pocket in the southern Okanagan valley of British Columbia (Banfield 1974:90). With the advance of agriculture in the northern prairies, the White-tailed Jack Rabbit is no longer confined to the arid short-grass plains in the extreme south.

Discussion: This specimen was identified as *Lepus townsendii* based on the overall size and morphology of the phalanx when compared to similar specimens at the University of Saskatchewan comparative collection. The specimen showed no signs of cultural modification. Only light root etching was noted on this specimen and signs of weathering were limited.

***Lepus americanus* (Snowshoe Hare)**

Material: NISP = 3; right scapula (4321), right proximal femur (8364), left scapula (8664).

Distribution and habitat: The Snowshoe Hare is known to inhabit forest regions, swamps and riverside thickets. In the prairie region in particular, this species is commonly found in aspen bluffs or copses, although it is also known to inhabit mixed deciduous and coniferous forests (Banfield 1974:83). The Snowshoe Hare occupies a broad belt across North American from Nova Scotia to Alaska. In Canada, this widespread species has been segregated into eleven geographical subspecies which differ slightly in terms of colour and size (Banfield 1974:84).

Discussion: These specimens were identified as *Lepus americanus* based on their similarity in morphology and size to the specimens housed at the University of Saskatchewan comparative collection. A minimum number of one individual is represented by these specimens. None of the specimens are burned or show any sort of cultural modification in the form of cutmarks. Only slight degrees of weathering, root etching and localized polishing were noted on one specimen (8364).

***Sylvilagus nuttallii* (Nuttall's Cottontail)**

Material: NISP = 3; left mandible (1602), left proximal ulna (3765), cervical vertebrae (9001).

Distribution and habitat: Nuttall's Cottontail is an inhabitant of the sagebrush plains of western North America. More specifically, this species can be found inhabiting coulees and river bottomlands where shelter is prevalent. In the evening, the Cottontail has been noted as venturing forth to feed on the open plains, but is wary of danger in the form of predators (Banfield 1974:79). The Cottontail is known to inhabit the western Great Plains region from Arizona to the southern Prairie Provinces (Banfield 1974:79). Within Canada, it has been hypothesized that this species has enlarged its Canadian distribution in the last century towards the north (Fung 1999:139). Presently, this species is found commonly on the third prairie steppe of southwestern Saskatchewan and southeastern Alberta.

Discussion: These specimens were identified as *Sylvilagus nuttallii* based on their similarity in overall morphology and size to the specimens housed at the University of Saskatchewan comparative collection. Only one individual is represented by these specimens. None of the specimens are burned or show any sort of cultural modification. Light root etching was noted only on the cervical vertebrae (9001) whereas the other two specimens were devoid of any sort of etching. Weathering was limited on these specimens.

Order Rodentia, Family Sciuridae

Spermophilus sp. (SC2)

Material: NISP = 34; see table 6.2 for a summary.

Table 6.2 Summary of *Spermophilus sp.* element counts

Element	NISP	MNE	MNI
Maxilla	6	6	3
Femur	5	5	3
Mandible	7	6	4
Humerus	9	4	4
Tibia	2	2	2
Innominate	2	2	2
Incisor	1	1	1
Lumbar Vertebrae	1	1	1

Axis	1	1	1
Total	34	34	-

Table 6.2 (continued) **Summary of *Spermophilus sp.* element counts**

Discussion: The majority of the specimens were highly fragmented therefore inhibiting any identification beyond the level of genus. All of the specimens recovered are stained in the same manner and have the same texture as the other elements in the assemblage suggesting that they are indeed cultural, as oppose to intrusive specimens. A minimum number of four individuals were represented in this assemblage as noted by the presence of the mandibular condyle on the mandible as well as the supracondylar foramen on the humerus. Weathering was limited on these specimens and no signs of cultural modification were noted. Root etching ranged from none to moderate, with most specimens recorded within the light category.

***Spermophilus richardsonii* (Richardson’s Ground Squirrel)**

Material: NISP = 2; right humerus (1937), right humerus (1352); right mandible (6588).

Distribution and habitat: Richardson’s Ground Squirrels can be found on the open prairie but prefer high rolling gravely and sandy soils in which to burrow. These sciurids tend to avoid wet lands and move quickly into cultivated fields. Although this species can be found on the central Plains of North America, they are most commonly found across the southern portions of the three Prairie Provinces (Banfield 1974:115-117).

Discussion: These specimens were almost complete and were assigned to this species on the basis of size and morphology compared to the specimens housed at the University of Saskatchewan comparative collection. A minimum number of two individuals is represented by these specimens. Neither of the humeri are burned nor show any signs of cultural modification. Both specimens are only slightly weathered and display signs of light root etching. These specimens are stained to the same degree as the rest of the Hartley site faunal assemblage, therefore inferring that they are not intrusive.

***Spermophilus tridecemlineatus* (Thirteen-lined Ground Squirrel)**

Specimens identified: NISP = 2; right humerus (3665), sacrum (5627).

Distribution and habitat: The Thirteen-lined Ground Squirrel is not known to inhabit the open grasslands to the same degree as other ground squirrels. Often times they are found in abandoned overgrown fields, shrubby areas, and poplar bluffs and are abundant in aspen parklands (Banfield 1974:123). The Thirteen-lined Ground Squirrel occupies a wide geographical range in the central Great Plains region of North America. Within Canada, three geographical subspecies have been recognized to date (Banfield 1974:125).

Discussion: Both specimens were identified to this species on the basis of overall morphology and size when compared to specimens housed at the University of Saskatchewan comparative collection. A minimum number of one individual is represented by these specimens. No burning or cultural modifications were observed on either of the bones and only light root etching was noted. These specimens were not heavily weathered and in terms of overall colour and staining, it is likely that they represent part of the original assemblage, as oppose to being intrusive.

Family Geomyidae

***Thomomys talpoides* (Northern Pocket Gopher)**

Specimens identified: NISP = 19; right and left mandible (8680), maxilla (8681), right humerus (8682), left humerus (8683).

Distribution and habitat: Pocket gophers are known to inhabit grasslands, cultivated fields, roadsides and riverbanks. This species tends to prefer a deeper, heavy, moist soil. The Northern Pocket Gopher can be found on the central plains and western mountain regions of North America. Within Canada, this species is limited to distribution across the Prairie Provinces from southwestern Manitoba to the Rocky Mountains of Alberta and mountain valleys of south-central British Columbia (Banfield 1974:150).

Discussion: These specimens were identified based on overall size and similar morphology to the Northern Pocket Gopher in the University of Saskatchewan comparative collection. These specimens represent at least one individual. Almost the

entire mandible and maxilla were recovered from the Hartley site, in addition to the right and left humeri. No cultural modifications, including burning, were noted. The specimens were only slightly weathered and the staining suggests that this individual formed a part of the cultural assemblage and is not intrusive.

Family Muridae

***Microtus pennsylvanicus* (Meadow Vole)**

Material: NISP = 5; left mandible (5155), maxilla (6576), left mandible (6577), left pubis (6578), left mandible (8340).

Distribution and habitat: The Meadow Vole prefers areas such as wet meadows, although they may inhabit any grassland habitat, salt marshes, abandoned fields, vacant lots, as well as protected areas of edges and openings in woods. Essentially, this species occupies areas in which there is a protective carpet of grasses, sedges or mosses (Banfield 1974:210). The Meadow Vole is widely distributed across North America from the Atlantic to the Pacific and from Georgia to Alaska. Within Canada, this species is found in all areas from Newfoundland to British Columbia. This species is divided into thirteen subspecies in Canada (Banfield 1974:211).

Discussion: All specimens were identified based on similarity to the overall size and morphology of the Meadow Vole skeletal elements in the University of Saskatchewan comparative collection. The specimens identified represent a minimum of three individuals. The light amount of staining and weathering along with the overall colouration, suggests that these specimens are intrusive or naturally occurring. No evidence of cultural modification, including burning, was noted. Root etching ranged from none to light.

Indeterminate Cricetine (SC1)

Material: NISP = 2; right mandible (2799), left humerus (2800).

Discussion: These specimens could only be identified down to the family level due to the high degree of fragmentation and they represent a minimum of one individual. Few signs of weathering were noted and only the humerus (2800) showed any root etching. No evidence of cultural modification, including burning, was noted on either of

the specimens. The lack of staining suggests that these specimens are intrusive or naturally occurring items in the assemblage.

Indeterminate Rodent (SC1/SC2)

Material: NISP = 3; right distal femur (6579), indeterminate cranial element (6580), right proximal tibia (6581).

Discussion: All of these specimens were identified as belonging to some sort of rodent, however, due to their highly fragmented nature a more detailed identification was not possible. These specimens represent a minimum of one individual. They exhibit few signs of weathering and only the femur (6579) and tibia (6581) showed any root etching. No evidence of cultural modification, including burning, was noted on any of the specimens. The amount of staining suggests that these specimens were part of the cultural assemblage, as opposed to being intrusive.

Miscellaneous Mammalian Remains

Indeterminate Very Large Mammal (SC6)

Material: NISP = 534; long bone shaft fragments and rib shaft fragments.

Discussion: Based on the overall size of the specimens, it is likely that most, or all, of these fragments belong to *Bison bison*,. The long bone and rib shaft fragments identified in the assemblage can only be classified based on their overall size as they display no identifiable attributes. Four hundred and eighty-five of the specimens are unburned and forty-nine display signs of thermal alteration, or burning. None of the elements were burned to the point that they showed signs of being calcined. One specimen (8716) exhibited evidence of chop marks, 38 of the specimens exhibited evidence of cut marks, and 7 specimens exhibited features characteristic of impact fractures. The majority of the longbones were fractured in a spiral manner. Spiral, or green fractures, can be considered to be the result of cultural activity. It has been noted that natural process such as trampling, freeze/thaw cycles, and post-depositional movement can produce spirally fractured bone, although trampling is considered to be the most likely source of this type of fracture (Agenbroad 1989:143). The presence of spirally fractured bone can, therefore, not always be interpreted as a product of human

cultural behaviour without the presence of additional cultural evidence to favour this interpretation. Due to the presence of large amounts of cultural material at the Hartley site, it is likely that the spiral fractures were a product of human handiwork.

Indeterminate Large to Very Large Mammal (SC5-SC6)

Material: NISP = 34; long bone shaft fragments and rib shaft fragments.

Discussion: These specimens were assigned to this class based on their overall size as the lack of diagnostic features inhibited identification to a more precise taxon. None of the specimens assigned to this size class showed any signs of thermal alteration. Three of the specimens exhibited signs of cultural modification in the form of cut marks (1911, 2402 and 4476). One specimen (6147) exhibited signs of rodent gnawing. Weathering was limited and root etching ranged from not present to moderate. One specimen (8755) exhibited signs of extensive abrasion.

Indeterminate Large Mammal (SC5)

Material: NISP = 6; mandibular body fragment (5274), long bone shaft fragment (5505), long bone shaft fragment (5972), rib shaft fragment (6620), long bone shaft fragment (7339).

Discussion: None of the specimens assigned to this size class showed any signs of thermal alteration. In addition, there was no evidence of cultural modification in the form of cut marks, although two of the specimens exhibited spiral fractures (5505 and 5972). Root etching ranged from not present to moderate and weathering was limited in all cases.

Indeterminate Medium to Large Mammal (SC4-SC5)

Material: NISP = 3; long bone shaft fragment (7286).

Discussion: This specimen did not exhibit any signs of thermal alteration. No evidence of cultural modification in the form of cut marks was noted. Breakage was catalogued as occurring in a transverse irregular direction. This specimen was weathered to stage three and showed no signs of root etching.

Indeterminate Medium Mammal (SC4)

Material: NISP = 1; mandibular body fragment (5660).

Discussion: This specimen did not exhibit any signs of thermal alteration. In terms of other taphonomic factors, the specimen was only slightly weathered and displayed only light amounts of root etching. There was also no evidence of cultural modification in the form of cut marks.

Indeterminate Small to Medium Mammal (SC3)

Material: NISP = 3; rib shaft fragment (7299), rib shaft fragment (7300).

Discussion: These specimens did not exhibit any signs of thermal alteration. Weathering was limited in each of the cases and both specimens only exhibited light amounts of root etching. There was no evidence of cultural modification in the form of cut marks.

Indeterminate Small Mammal (SC2)

Material: NISP = 11; right humerus shaft fragment (3423), proximal tibia fragment (3428), mandibular body fragment (4055), long bone shaft fragment (4955), rib shaft fragment (5445), left distal humerus fragment (5820), rib shaft fragment (7305), long bone shaft fragment (7306).

Discussion: Although many of the specimens listed above were identified to a particular element, the lack of diagnostics inhibited a further classification beyond that of a small mammal. Two of the specimens (3423 and 3428) were almost completely burned. Weathering was limited on each of the specimens and root etching ranged from not present to light. There was no evidence of cultural modification in the form of cut marks.

Indeterminate Micro-Mammal (SC1)

Material: NISP = 4; long bone shaft fragments (6574).

Discussion: The lack of diagnostic features on the long bone shaft fragments inhibited a classification beyond that of a micro-mammal. These specimens displayed

little amounts of weathering and root etching and no evidence of cultural modification was noted in the form of cut marks. This specimen also exhibited no thermal alterations.

6.2.2 Class Aves

Order Falconiformes, Family Falconidae

***Falco sp.* (SC5)**

Material: NISP = 1; left superior coracoid (5129).

Discussion: Overall morphology of this specimen suggested that it belonged to a member of the genus *Falco* when compared to other specimens in the University of Saskatchewan comparative collection. The fragmented nature of this specimen inhibited a more precise classification with regards to taxon. This specimen exhibited no thermal alterations or evidence of cultural modification in the form of cut marks. Weathering was limited and root etching was classified as light.

Order Anseriformes, Family Anatidae

***Anas sp.* (SC3)**

Material: NISP = 6; cervical vertebrae (1651), cervical vertebrae (1774), cervical vertebrae (1751), cervical vertebrae (1752), humerus (4626), cervical vertebrae (4799).

Discussion: The lack of a diagnostic element prohibited a more specific classification of these specimens as they were the same size and morphology of several species of the genus *Anas* in the University of Saskatchewan comparative collection. None of the specimens exhibited any sort of thermal alterations, nor did they exhibit the presence of any cultural modifications in the form of cut marks. Weathering was limited on these specimens and root etching was either not present or light (Figure 6.5).

***Anas platyrhynchos* (Mallard)**

Material: NISP = 3; left proximal coracoid (4229), right proximal coracoid (5039), left proximal tibia-tarsus (8692).

Distribution and Habitat: The Mallard is a common migratory bird in the western provinces although it may be found in North America, Europe, and Asia (Godfrey 1986:86).



Figure 6.5 *Anas sp.* vertebrae remains recovered from the Hartley site.

Mallards are adaptable ducks and can be found frequenting marshes, sloughs, onds, small and large lakes, rivers, and flooded land in both treeless and wooded country. This species tends to forage on land, especially in grainfields. Mallards prefer fresh to salt water and are unlikely to frequent coastal salt water areas, particularly in the winter (Godfrey 1986:86). In terms of migration, the Mallard tends to follow a route bordering the Mississippi River, although it has been noted that mallards may fly north prior to beginning the migration southwards (Fung 1999:153). The state of Arkansas is known to be the major wintering area for this species.

Discussion: These specimens were identified based on overall size and morphology. The Mallard in the University of Saskatchewan comparative collection was the only species which exhibited the same characteristics and overall size as these specimens. A minimum of one individual is represented and only one specimen (8692) exhibited thermal alteration. The specimens were only lightly weathered and stages of root etching were classified as light. No cultural modifications in the form of cut marks were noted.

***Anas clypeata* (Northern Shoveler)**

Material: NISP = 1; synsacrum (5532).

Distribution and Habitat: Within Canada, this species can be found in the Yukon, Northwest Territories and western provinces. In addition, some Northern Shovelers may be found in certain areas in Ontario, New Brunswick, Prince Edward Island, Nova Scotia, and even in some parts of Quebec (Godfrey 1986:98). During the breeding season, Northern Shovelers can be found in shallow, often muddy freshwater lakes, marshes, sloughs, and pot-holes, particularly those that offer adequate protection in terms of cover as well as adequate food resources (Godfrey 1986:98). The Northern Shoveler is noted as breeding in the province of Saskatchewan (Fung 1999:145).

Discussion: This specimen was identified based on its overall size and morphology. The Northern Shoveler in the University of Saskatchewan comparative collection was the only species which exhibited the same characteristics and overall size as this specimen. The specimen identified to this species represents a minimum of one individual. No signs of thermal alteration or cultural modification in the form of cut marks were noted. Weathering was limited and root etching was considered to be light.

Order Galliformes, Family Phasianidae

***Typanuchus phasianellus* (Sharp-tailed Grouse)**

Material: NISP = 2; cranium (7045), right carpo-metacarpus (8915).

Distribution and Habitat: The Sharp-tailed Grouse can be found in the Yukon, the Northwest Territories, and from British Columbia all the way to a small portion of eastern Quebec (Godfrey 1986:163). On the prairies, the Sharp-tailed Grouse inhabits grasslands, shrubby sandhills, coulees, creeks, and brushy patches. This species can also be found in the parklands, in grassland and grain-bearing lands or near brush or open woodlands. The coniferous forest is known to be a home for this species, often in areas dominated by openings made by forest fires as well as muskegs and bogs (Godfrey 1986:163). The Sharp-tailed Grouse is known to breed and winter in the province of Saskatchewan and can therefore be found at any and all times of the year (Fung 1999:147).

Discussion: These specimens were identified based on their overall size and morphology when compared to the Sharp-tailed Grouse at the University of Saskatchewan comparative collection. The minimum number of individuals represented

by these specimens is one. No signs of thermal alteration or cultural modification in the form of cut marks were noted. Weathering was limited on this specimen and root etching was considered to be light. Although the carpo-metacarpus exhibits weathering and staining similar to the rest of the assemblage, the cranium (7045) does not. It is likely that the cranium is intrusive and should not be considered to represent cultural material in this assemblage.

Order Charadriiformes, Family Scolopacidae

***Tringa flavipes* (Lesser Yellowlegs)**

Material: NISP = 1; left distal humerus (5820)

Distribution and Habitat: The Lesser Yellowlegs is common in the Yukon, northern British Columbia, central and northern Alberta, Saskatchewan and Manitoba, as well as central and northern Ontario (Godfrey 1986:201). Often times, the Lesser Yellowlegs can be found in association with the Greater Yellowlegs (*Tringa melanoleuca*). These birds tend to nest in open woodland and burntland in areas interspersed with muskegs, ponds and lakes. Wet areas are used for both feeding and rearing of the young (Godfrey 1986).

Discussion: This specimen (5820) represents a minimum of one individual and was identified to species based on the similarity in size and morphology to the Lesser Yellowlegs specimen in the University of Saskatchewan comparative collection. No signs of thermal alteration or cultural modification in the form of cut marks were noted. Weathering was limited on this specimen and root etching was considered to be light.

Indeterminate Small-Medium Bird (SC3)

Material: NISP = 5; long bone shaft fragment (1378), humerus shaft fragment (5145), long bone shaft fragment (5741), quadrate (9090).

Discussion: These specimens were classified based on size class due to the lack of identifiable attributes. In terms of overall size, these specimens likely came from a small to medium-sized bird such as a duck or grouse. The specimens represent a minimum of one individual. One specimen (5145) is not weathered or stained in the same manner as the rest of the assemblage, suggesting it is intrusive to the site. None of

the specimens exhibit any sort of cultural modification in the form of cut marks and, in addition, no signs of thermal alteration were noted. Root etching varied from not present to light.

6.2.3 Discussion

The Hartley site non-bison faunal assemblage contains a minimum of twenty-three taxa. In terms of avian remains, at least one genus of Falcons, two species and one genus of Anatids, and two species of Phasianids were recovered. The majority of the specimens represent cultural items whereas only a small number were found to be naturally occurring specimens.

The cranium from the Sharp-tailed Grouse (*Tympanuchus phasianellus*) was found to be weathered in an inconsistent manner when compared to the rest of the assemblage. The specimen was not stained to the same degree as the rest of the assemblage. The Sharp-tailed grouse is a naturally occurring species in the parkland area; it is therefore not surprising that it was found in association with the Hartley site assemblage. As well, the Meadow Vole, an indeterminate Cricetine and an indeterminate small to medium-sized bird were identified as being intrusive to the site. Meadow Voles are native to the area, suggesting it was killed or died by natural causes and came to be a part of the Hartley site deposits.

6.3 Seasonality

The presence of other non-bison fauna in the assemblage may be used to as indicators of the seasonality of the Wooded Hollow. A number of species which either hibernate or migrate out of the area during the winter months were identified. The specimens discussed above can be analyzed and classified into two categories: (1) those belonging within the Class Aves; and (2) those belonging within the Order Rodentia.

6.3.1 Class Aves

There are two main methods to infer seasonality based on the presence and analysis of avian fauna. The first method, proposed by Rick (1975), details the use of medullary bone in bird longbones, whereas the second methodology is to simply identify

species present in an assemblage and infer seasonality based on known migration routes. Both of these methodologies were attempted in this analysis.

Rick (1975:183-190) presents a methodology in which one is able to determine the season of occupation based on the presence of medullary bone in avian longbones. Medullary bone accumulates only in females during the breeding period. The reason that the medullary bone accumulates in females is that the bony growth is used as a calcium supplement for the production of egg shells. It is developed over a period of three to four weeks during the ovulating season (Gilbert et al. 1985:11). It is noted that the limited time frame of the medullary bone decreases the chances that it may be present in any given sample. If, however, medullary bone is present, it can be used to establish a refined time of seasonality. The presence of medullary bone indicates either spring or spring-summer occupation, depending on whether the birds lay more than one clutch of eggs (Gilbert et al. 1985: 11). It is important to note, however, that assumptions cannot be made if medullary bone is not found. The lack of such bone may simply imply that the specimen under question either belonged to a male individual or a non-breeding female. In addition, if the first set of eggs is lost, some birds may re-nest, thereby altering the time frame of the breeding season (Rick 1985:188-189).

The avian elements from the Hartley site that were deemed to belong to the cultural assemblage were inspected to see if medullary bone was present. Rick (1975:184) notes that all bones in the body store an amount of medullary bone, however, it is most visible in elements such as the femur, tibio-tarsus, and the ulna. The reason for this is that these elements have larger, more open medullary cavities. The majority of the avian elements recovered were complete elements and were, therefore, unsuitable for this type of analysis. Those specimens that were not complete were examined by both a hand-held lens and a dissecting microscope. Unfortunately, none of the bones exhibited medullary bone. It is therefore unlikely that the specimens consisted of females that were in the process of ovulating at the time of death.

Seasonality may also be inferred simply by the presence of certain avian fauna at an archaeological site. The time of occupation of a site can be based on known seasonal migration routes of various birds. In terms of the Northern Shoveler (*Anas clypeata*), this species of waterfowl has been noted as present throughout the province from early

April to early November in temporary wetlands, sewage lagoons and shallow lakes (Smith 2001:37). The Mallard (*Anas platyrhynchos*) is a common species found in Saskatchewan and is also known to be a spring and autumn migrant in the province, commonly found from late March to early November (Smith 2001:35). Despite the well-known and seemingly preferred migration routes of this bird, specimens belonging to this species have been found nesting in the Regina area during the winter months (Godfrey 1986:86) or in areas where open water persists throughout the year (Smith 2001).

Of particular importance to the avian fauna of the Hartley site is the Lesser Yellowlegs (*Tringa flavipes*). Interestingly, this species of bird is only found throughout the prairie ecozone from early April to early June and from mid-July to early October (Smith 2001:68). Only from early April to early October can this species be spotted in the boreal plain and northward. During migration, the Lesser Yellowlegs prefers shorelines of lakes, rivers and ponds.

6.3.2 Order Rodentia

Various ground squirrels were identified in the course of cataloguing this faunal assemblage. Of particular importance were those that were assigned to the genus *Spermophilus*. In the Hartley site assemblage, there were individuals who were classified to genus (*Spermophilus sp.*), as well as some that were classified to species (*Spermophilus richardsonii* and *Spermophilus tridecemlineatus*). The majority of the genus *Spermophilus* items were weathered in a consistent manner and showed the same degree of staining as the rest of the assemblage.

Ground squirrels generally hibernate roughly from the end of September to March when the temperature plunges below freezing (Banfield 1974:115). Richardson's Ground Squirrels may emerge earlier if the weather is mild, but may hibernate as late as mid-April if it is a prolonged winter season. Similarly, the Thirteen-lined Ground Squirrels tend to begin hibernation at the end of September, however, they usually reappear in early April, and the males often emerge roughly a week before the females (Banfield 1974:123).

6.3.3. Discussion

Both bird and rodent specimens alike were used to obtain information with regards to season of occupation at the Hartley site. Unfortunately, no medullary bone was noted in any of the avian elements discussed above and the lack of this type of evidence also cannot be used to infer seasonality. Therefore, determination of seasonality is based solely on species identified within the cultural assemblage. Of the avian fauna, the Mallard and the Northern Shoveler were identified and considered to be of importance. Both of these species are known as migratory birds within the province and can commonly be found in the spring, summer, and fall. Of particular importance, however, is the Yellow Lesserlegs as this specimen can further refine the seasonality of the Hartley site. Based on the presence of this one specimen, it can be said that the occupation of the Hartley site is limited to the time frame of early April to mid-June or from mid-July to October. The remaining mammalian fauna was also investigated to determine seasonality. Based on the presence of several identified specimens of *Spermophilus sp.*, *Spermophilus tridecemlineatus* and *Spermophilus richardsonii*, one can infer that the site was occupied between March and late September. When regarded as a whole, the non-bison taxa suggest that occupation occurred either between April and early June or mid-July to late September.

6.4 Summary

The Hartley site non-bison faunal assemblage contains a minimum of 23 taxa of vertebrates. The majority of these species are associated with the cultural assemblage, with the exception of one specimen each of Sharp-tailed Grouse (*Tympanuchus phasianellus*), Meadow Vole (*Microtus pennsylvanicus*), indeterminate Cricetine, and small to medium-sized bird. These intrusive specimens were eliminated from the cultural assemblage based on the texture and condition of the bones and were not given the same consideration as the remaining specimens. It is likely that these specimens became a part of the assemblage through natural processes such as predation.

Based on the presence of both avian and rodent faunal remains, it was determined that the Hartley site was occupied either in the spring or fall. This conclusion is similar to that reached regarding the bison remains. The conclusive herd

structure and the one-month old mandible discussed in chapter five suggest that the site was occupied either early in the fall or in the late spring. In addition, the lack of foetal bone suggests that this site was not occupied during the gestation period of the bison. The presence of avian and rodent remains also suggests occupation either in the spring or the fall, although the window is narrowed to the time frame of April to mid-June or mid-July to late September. Unfortunately, the lack of other useful vertebrate remains such as fish hinders any sort of conclusions that are more specific.

Chapter Seven

An Analysis of Taphonomic Factors and Butchering Practices at the Hartley Site

7.1 Introduction

Data pertaining to taphonomy often aids in the determination of activities, both of a human and non-human nature, which may have occurred at an archaeological site. In order to properly understand the processes that have had an effect on the faunal remains recovered from the Wooded Hollow region of the Hartley site, it is imperative to first discuss taphonomy and the role that taphonomic agents may have had in the overall state of the assemblage. An introduction to taphonomy and some of the terminology involved in this specialized type of research is first discussed. Following this, taphonomic factors are broken down into two distinct groups: those falling within the category of non-human agents and those in the category involving human alteration. Bone tools recovered from the Hartley site are considered in addition to a number of bone beads that were recovered during the excavations performed by the University of Saskatchewan field school. A short section detailing three identified pathologic specimens follows the analysis of bone tools.

The second half of this chapter is geared towards the butchering practices that may have been employed in the Wooded Hollow region of the Hartley site. A short discussion on utility indices begins this section followed with a more in-depth discussion of processing for the purpose of marrow extraction and processing for the purposes of grease extraction. A review of these practices and their archaeological visibility is pertinent to the analysis of possible activities that may have occurred in this region of the site. Lastly, with all the information assembled in this chapter, it is possible to assign a site type based on a variety of data relating to the presence and absence of certain fauna, the artifacts recovered at the site, as well as a variety of other supplementary factors. When all of this information is regarded as a whole, one is able to get an overall sense of the agents and processes that have affected this assemblage, and the types of activities that occurred here in the past.

7.2 Taphonomy

Current studies involving zooarchaeological research have focused on the role of taphonomy in faunal assemblages. Lyman (1994:1) defines taphonomy as "...the study of the transition, in all details, of organics from the biosphere into the lithosphere or geological record". Taphonomy is an important field to all archaeologists who study organic remains. For the zooarchaeologist, the main goals in analyzing prehistoric faunal remains are to prepare a complete taxonomic list of species present and to reconstruct subsistence patterns as well as paleoecological conditions (Lyman 1994). Taphonomic factors warrant consideration as they have a direct effect on the faunal assemblage, and therefore some of the main goals of zooarchaeological research. For the purposes of this thesis, the primary goal was to analyze the faunal remains recovered from the Wooded Hollow with the intention of reconstructing subsistence patterns. An attempt was made to quantify these remains in chapters five and six, and now it is possible to determine the economic importance of these remains, and how they may have been affected by human and non-human taphonomic agents and processes.

Gifford (1982:483-485) divides the goals of taphonomic research into two main types. In the first type of research the zooarchaeologists may attempt to "strip away" the taphonomic overprint caused by a variety of agents and processes. This allows the researcher to obtain accurate information and resolution on the faunal assemblage in question, and knowledge of the prehistoric biotic community. This goal is often geared towards those performing paleoecological studies, as opposed to zooarchaeological studies (Lyman 104:5). Conversely, in the second type of research, the analyst may attempt to determine the nature of the taphonomic overprint in order to be able to list the precise taphonomic mechanisms responsible for the current state of the assemblage, allowing for the creation of a "taphonomic history". The latter goal is more likely to provide information on the formation of, and conclusions regarding, the human behaviours that created the archaeological record in the first place. Furthermore, determination of the exact taphonomic history of a particular assemblage is often attempted as it sheds light on which taxa were exploited by humans and the relative proportions in which they were exploited (Lyman 1994:5-6). In order to adequately interpret the faunal remains recovered from an archaeological site, it is essential to

outline the likely human behaviours and non-human agents that have affected the faunal assemblage, both of which are crucial to understanding the current state of the assemblage in question. Terminology is discussed below, followed by a taphonomic analysis of the faunal remains recovered at the Hartley site.

7.2.1 Concepts and Terminology in the Study of Taphonomy

In order to adequately understand the role of taphonomy in reference to zooarchaeological studies, there are a number of terms that need to be identified. All terms and associated definitions in this section can be found in Lyman (1994:3-4). Firstly, the difference between a taphonomic agent and a taphonomic process needs clarification. A taphonomic agent is defined as "...the source of force applied to bones, the immediate physical cause of modification to animal carcasses and skeletal tissues", whereas a taphonomic process refers to "...the dynamic action of an agent on animal carcasses and skeletal tissues, such as downslope movement, gnawing, or fracturing". Examples of a taphonomic agent are gravity, a carnivore, or even a human. Examples of a taphonomic process could be something as simple as movement (due to gravity), gnawing (from a carnivore) or fracturing (by a human). Therefore, an agent refers to the source of the action, whereas the processes refer to the actual action relative to the agents listed above. Lastly, a taphonomic effect, or trace, is the "...static result of a taphonomic process acting on carcasses and skeletal tissues, the physical and/or chemical modification of a bone". Lyman (1994) notes that it is the taphonomic effects that are measured and/or identified, and only on the basis of this information do the magnitude of the effects of taphonomic processes and agents become apparent. Human and non-human agents and associated processes and effects are reviewed with regards to the Hartley site faunal assemblage in the following section.

7.2.2 The Effects of Non-Human Agents and Associated Processes

Non-human agents and associated processes can often times aid the zooarchaeologist in determining the taphonomic history of an assemblage. Various non-human agents and their associated processes and effects were identified while analyzing the faunal remains recovered from the Hartley site. These non-human agents, associated

processes and effects that were utilized in this analysis were largely first outlined by Todd (1987:122-123) in the analysis of the Horner II bone bed. Stages of weathering for small mammals, however, followed Andrews' (1990:11), and categorization and amount of root etching followed the categories outlined by Johnston (2005). Types of breakage were those outlined by Marshall (1989) and Todd (1987). These processes and effects were deemed appropriate for the type of research being performed at the Hartley site, as many of these agents have been known to act on archaeological assemblages in other regions of the Plains. Each agent, process, and effect is outlined and analyzed separately to observe the degree to which they may have affected the faunal remains recovered from the Hartley site.

7.2.2.1 Effects of Non-Human Agent #1

Agent: Elements of the Outdoors (temperature, moisture, wind, water, soil chemistry, insects, etc.)

Process: Weathering

Perhaps the most ubiquitous analyses performed on animal remains, whether they are human or non-human, are those relating to weathering. Weathering is defined as

...the process by which the original microscopic organic and inorganic components of a bone are separated from each other and destroyed by physical and chemical agents operating on the bone in situ, either on the surface or within the soil zone [Behrensmeyer 1978:153].

Whether or not a bone survives in the archaeological record depends on both the intensity and rate of various destructive processes, as well as the chance for permanent burial prior to total destruction (Behrensmeyer 1978:150). Once free of the overlying soft tissue, bones undergo rapid changes in appearance as they are exposed to the elements. In order to control for potential variation in the rate at which different skeletal elements weather, the analyst must record the maximum weathering state displayed over patches larger than 1 cm² on each bone specimen. The analyst also must, whenever possible, use the shafts of limb bones, flat surfaces of the jaws, pelvis, vertebrae, or ribs

instead of edges or areas where there is evidence of physical damage. It is also noted that small compact bones, such as the carpals, tarsals and phalanges, weather more slowly than do other elements in the same skeleton. Bones from different taxa, especially those of different body sizes, also weather at different rates (Behrensmeyer 1978:152; Gifford 1981:502; Lyman 1994:358). All of these factors are linked to the structural density of the bones in question, however, it is not yet known which skeletal elements weather the fastest.

Effect: Weathered Bone

The Hartley site faunal assemblage is mostly composed of unidentifiable unburned bone fragments (Table 5.1). As was mentioned previously, species and bone size likely has an effect on the rate at which skeletal elements weather. All skeletal elements, whether they were identified to a particular element, class of elements, or classified as unidentifiable fragments, were analyzed separately for stage of weathering. The associated species or higher taxonomy was also recorded. These steps were taken in order to be unbiased in the analysis and categorization of stage of weathering for each specimen. Once the analysis was completed, it was found that the Hartley site faunal assemblage was relatively unweathered. Following Todd's (1987) modified version of Behrensmeyer's (1978) weathering categories, it was found that the large mammal specimens, including *Bison bison*, were largely weathered to stage two (Table 7.1).

Table 7.1 Numbers of specimens and associated stage of weathering.

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
NISP	0	19	3,384	334	9	1	0

Stage two is characterized by limited surface weathering with some longitudinal cracking, whereas stage three is characterized by light surface flaking and deeper cracking (Todd 1987:123). A few specimens were weathered to stages one and three. Only a handful of bones were weathered between stages four and five and no bones were weathered to stage six (Table 7.1). The specimens from small mammals were limited to stage one. This stage is characterized by slight splitting of the bone parallel to fibre structure (Andrews 1990:11).

7.2.2.2 Effects of Non-Human Agent #2

Agent: Post-depositional Elements

Process: Deterioration

Lyman (1994) notes that bones weather in both the surface and subsurface contexts, however, in the research that has been conducted on weathering, it is found that it takes place on the surface of the ground. Little effort has been put into distinguishing weathering in surface and subsurface contexts. Todd (1987), however, noted in the Horner II faunal assemblage, that stages of deterioration may help classify the destruction of bone that occurs after an assemblage has been buried. Todd (1987) originally coded the stages of deterioration as ranging from zero to six. All stages refer to the state of the cortical bone, and for descriptions of these stages see Todd (1987:123). Bones identified as belonging to small mammals were excluded from this analysis in order to prevent any sort of bias when recording the stage of deterioration.

Effect: Deteriorated Cortical Bone

As was the case in the state of the Hartley site faunal assemblage in terms of stages of weathering, stages of deterioration were also at the low end of the spectrum. The majority of the specimens analyzed were categorized as having deteriorated to stage one (Table 7.2). This stage is characterized by no deterioration whatsoever; therefore the cortical bone surface was observed as completely in tact. The second most common stage of deterioration noted in the Hartley site faunal assemblage was stage two. Stage two is characterized by slight exfoliation of the bone cortical surface. A very small number of specimens were deteriorated to stages three, four, and five. Only two specimens exhibited deterioration to the point that the cortical bone was not present (stage six).

Table 7.2 Numbers of specimens and associated stage of deterioration.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
NISP	2,444	1,115	175	5	4	4

7.2.2.3 Effects of Non-Human Agent #3

Agent: Tree Roots and Fungi

Process: Etching

Root etching on faunal remains in an archaeological site can range from not present to heavy. Johnston’s (2005:78) quantification of the stages of root etching as **light**, **medium** and **heavy** was followed in this analysis. Light refers to bone that has at least one root etch, medium refers to etching that is present over 30% of the bone surface, and heavy refers to root etching that is severe enough to obscure the recognition of other modifications such as cut marks. Obviously, many of the bones also fell in the categories of light to medium, and medium to heavy.

Root etching occurs when the roots of plants excrete humic acid on bone surfaces. When associated with the growth and decay of roots comes into contact with bone surfaces, root etching occurs. In addition, etching may also be caused by acids secreted by a variety of species of fungi associated with decomposing plants (Lyman 1994:375). In this thesis, the term “root etching” will refer to the effects that both the plant and fungi produced as agents. The presence of root etching marks on bone indicates that the bone must have existed in a plant-supporting sedimentary environment for at least a part of its taphonomic history. Root etching can affect bones as they are buried as well as after they are buried. The exact kinds of plants and associated fungi that produce root etches and the depths to which they create these marks are still unknown (Lyman 1994).

Effect: Visible Root Etching

At the Hartley site, root etching was visible on the faunal remains in the form of wavy, “dendritic” patterns (Lyman 1994:376). These patterns formed as individual roots came into contact and etched bone surfaces. Of the observable fragments, specimens and elements, some of the faunal assemblage had at least been exposed to some light root etching processes (Table 7.3).

Table 7.3 Numbers of specimens and degree of observed root etching.

	None	Light	Light-Medium	Medium	Medium-Heavy	Heavy
NISP	613	2630	47	827	112	102

Surprisingly, however, many of the bones had no observable root etchings. Eight hundred and twenty-seven observed specimens had medium degrees of root etching and the numbers decreased significantly into the categories of medium-heavy and heavy.

These categories of root etching suggest that the Hartley site materials were not exposed to many plants or associated fungi while they were part of the archaeological deposit.

7.2.2.4 Effects of Non-Human Agent #4

Agent: Carnivore(s) and Rodent(s)

Process: Gnawing

Often times at a large kill, processing, or camp site, faunal remains exposed to the elements are also available to carnivores. According to Lyman (1994:325), bone-gnawing carnivores tend to break bones in one of two ways. First, carnivores may break bones by chewing and gnawing one of either epiphyseal ends of a long bone. This significantly weakens the structural strength of the bone and allows for the carnivore to access the diaphyseal, or shaft, portion. Once the structure of the bone is completely compromised, the diaphysis collapses into long rectilinear splinters. Gnawing marks can be noted in the form of furrows and punctures at the epiphyseal ends and scoring and pitting occur on the diaphysis, while the end of the diaphysis may be scalloped. The second way by which carnivores fracture bones involves simply chewing the complete bone by applying force directly along the diaphysis until the bone fractures. In this case, scoring and pitting of the diaphysis are common (Lyman 1994).

Effect: Punctures, Scoring, Pitting, Scalloped Edging

The faunal remains recovered from the Hartley site indicate that surrounding carnivores were either not present in great numbers in the region, or they did not have much of a chance to access the assemblage prior to burial. From Table 7.4, one can see that very few specimens displayed any types of gnawing that is characteristic of carnivores.

Table 7.4 Numbers of specimens and degree of carnivore/rodent gnawing.

	Crenulated/Scalloped	Pitting	Puncture	Puncture & Pitting	Scooping	Rodent
NISP	107	13	21	1	4	12

The majority of the specimens that were exposed to carnivores displayed a crenulated or scalloped edge. Pits and punctures were relatively uncommon as was scooping. Lastly, only 12 specimens exhibited a recognizable form of gnawing by some species of rodent.

7.2.3 Implications for the Hartley Site

Analysis of the Hartley site faunal assemblage has yielded information on the non-human agents that acted on the assemblage, the processes related to the agents, and the visible effects that were observed during analysis. Non-human agents and processes including weathering, deterioration, root etching, and carnivore actions have demonstrated that the Hartley site faunal assemblage is overall, in very good condition. One type of non-human process that was not addressed in this thesis was that of diagenesis. The physical and chemical composition of the material involved, including both the bones and surrounding sediment, the climate, and the depositional mode are known to affect an archaeological assemblage, however, this type of analysis goes beyond the scope of this thesis. It will be said, however, that diagenetic processes likely did have an effect on the Hartley site faunal assemblage, particularly in the form of mineralization. It was noted during the cataloguing process that the bones were very heavy and had likely been exposed to a variety of chemicals derived from the surrounding sediment, given the high water table in the dune basin.

The low stages of weathering outlined in the above-section demonstrate that the assemblage itself was likely buried quite quickly after deposition. In terms of carnivore and rodent gnawing, the data also suggest that the assemblage was either buried quite quickly after deposition or that few carnivores and rodents were present in the surrounding region. Root etching was noted on some of the faunal assemblage, however, the majority of the affected specimens displayed only light degrees of root etching. Therefore, the non-human agents, processes, and effects suggest fairly rapid burial following incorporations of the remains into the archaeological deposit. In order to perform an adequate taphonomic analysis, however, it is essential to consider humans as agents and how they may have effected the Wooded Hollow faunal assemblage.

7.2.4 The Effects of Humans as Agents and Associated Processes

Humans have the ability to affect an archaeological assemblage in a variety of ways. In terms of taphonomic processes and effects, it is of utmost importance to outline the activities thought to have taken place at an archaeological site in order to adequately understand what effect past peoples may have had on an assemblage. As was

mentioned in chapter five (this thesis), butchering practices in particular have a direct effect on the composition of the assemblage, both in terms of the ways in which elements were butchered, but also which elements were chosen for consumption. In reviewing a taphonomic history of an assemblage, particularly with reference to butchering patterns, it is noted that the agent (humans) and processes (butchering forces) do not change, however, the resulting observable effect does.

7.2.4.1 Effects of Humans as Agents #1

Agent: Human

Process: Butchering Forces

Humans have the ability to break bones in several ways. In order to be broken, force must first be applied to a bone. The available literature on butchering forces is quite extensive and is not addressed in this chapter (see for example Lyman 1994). For the purposes of this thesis, discussion of butchering forces will be limited to the resulting breakage patterns and observable cut marks noted during analysis.

Effect: Breakage Patterns

The Wooded Hollow faunal assemblage was to heavily processed by humans. By far, the most common form of breakage was that of “comminuted” (Table 7.5). The term comminuted was used to refer to bones that were broken beyond the point of identification to a specimen or element, and which were subsequently catalogued as fragments. It is likely, based on the thickness of the fragments, that the majority of the comminuted bone also came from large ungulates, if not bison, although it is not possible to prove this.

Table 7.5 Numbers of specimens and types of breakage.

Type of Breakage*	Spiral	Comm.	Trans. Regular	Trans. Irregular	Saw Tooth	Step	Impact Scars	Long.
NISP	688	163,872	48	1,175	10	6	1,127	1,438

* Abbreviations found on page xiii, this thesis

The second most common type of breakage in the assemblage was identified as “transverse irregular”. Following this category, a number of specimens had been broken longitudinally, or in a spiral fashion, and often times these bones exhibited impact scars.

These types of breakage patterns combined with the presence of impact fractures are often noted at archaeological sites where processing for the marrow extraction has occurred (Kooyman 2004:1989). A more detailed discussion of marrow extraction can be found in section 7.4.1, this chapter.

In addition to the bones that were broken, a total of 588 bones analyzed was assigned to the category of “complete” or “near complete”. Many of these elements, however, were carpals, tarsals, phalanges and teeth whereas the majority of the bones that were broken were elements belonging to the limbs. The evidence suggested by the breakage patterns and the types of bones broken suggest that breakage occurred on “green” longbones, processed while they were fresh. While cataloguing these items, it was noted that the fracture surfaces which were the same colour as the rest of the bone were likely archaeological, whereas those specimens that exhibited different colours were probably broken more recently.

7.2.4.2 Effects of Humans as Agents #2

Agent: Human

Process: Butchering Forces

In addition to applying force to break bones, humans also have the ability to create butchering marks in the form of cutmarks. Binford (1981) notes that form and placement of butchering marks will tell much about the types of butchering activities as well as to the types of tools utilized to produce the marks noted by the analyst. For the purposes of this thesis, it is likely that the cutmarks observed on the faunal remains were produced by stone tools, although metal implements cannot be ruled out as they have been noted in some Mortlach assemblages. Cutmarks found on bones will vary with the sequence or stage of processing reached prior to abandonment of the elements. Binford (1981:106) notes that the sequence of butchering almost always follows the same pattern of skinning, followed by dismemberment, followed by filleting for either consumption or storage, and lastly, marrow and grease processing. It is noted that the stage represented by filleting may also involve some secondary dismemberment. The above-mentioned sequence implies that the accumulation of cut marks will not only vary with the stage of processing but will therefore also vary diagnostically.

Effect: Cutmarks, Chop Marks, Grooves, Scraping

Analysis of the Wooded Hollow cut marks yielded some information on the butchering practices of the site occupants. In total, 216 specimens exhibited some form of alteration in the form of single cutmarks, chop marks, grooves, or scrape marks (parallel striations). The most common type of butchering mark were those classified as single cutmarks (Table 7.6). Cutmarks that were identified as scraping marks through their parallel striations were the next most common. Sixteen specimens exhibited recognizable grooves while only four specimens had butchering alterations in the form of chop marks.

Table 7.6 Number and type of observed butchering mark.

	Chop Marks	Single Cutmarks	Groove(s)	Scraping (Parallel Striations)
NISP	4	143	16	53

Overall, very few specimens were identified in the Wooded Hollow assemblage exhibiting any sort of recognizable butchering marks. In terms of a diagnostic analysis, placement of the cutmarks on many of the bones was often noted on longbone shaft fragments, rib shaft fragments and phalanges. Interestingly, only a handful of vertebrae exhibited butchering alterations in the form of cut marks. Scraping marks in the form of parallel striations were also noted on a number of longbones and rib shaft fragments. One mandible exhibited a deep groove on the ascending ramus and the majority of the other grooves were noted on longbone shaft fragments. Chop marks were found on one calcaneus, two specimens of unidentifiable bone, and one longbone shaft fragment. The presence of cut marks on the longbone shaft fragments, rib shaft fragments and phalanges does suggest that dismemberment, hide removal and filleting activities may have occurred in this part of the site.

7.2.4.3 Effects of Humans as Agents #3

Agent: Human

Process: Intentionally Modified Bone

According to Lyman (1994:338-339), tools are "...artifacts that exhibit use-wear that was created because the artifact was used by humans to perform some function".

Obviously, there are problems with such a definition as artifacts may be used to an insufficient degree to generate any sort of use wear, however, the only way in which we are able to recognize tools, specifically bone tools, is through the presence of use wear. In the interest of analyzing humans as agents with regards to the taphonomic history of the Hartley site, it is also essential to consider bone that was intentionally modified in the form of tools.

Effect: Culturally Modified Bone

A total of 10 possible bone tools were identified. A number of these tools are displayed below (Figures 7.1 to 7.4). Tools were identified and assigned to a particular category based on those originally outlined by Kehoe (1967:57-63) and Walker (1979:55-56). One bone awl, one scraping tool, two bone spatulas, and a number of knapping tools were either identified in the course of examining this assemblage, or during previous analyses. A number of possible bone expediency tools were also identified during the analysis phase of the project, however, it is difficult to say for certain whether or not these specimens were indeed used as tools. Lastly, a deflesher was identified during the last session of excavation at the Hartley site (by the Buena Vista Elementary School students).

Unfortunately, the two bone spatulas that were recovered during the field school excavations were not found. According to Walker (1979:57), bone spatulas consist of bone fragments which are flat to slightly concave. Trabeculae are first removed from the internal surface of the bone with the intention of producing a ladle-like surface. It is likely that in the course of cataloguing these materials these specimens were removed from the collection for further analysis or photography and were not replaced in the appropriate box. In addition to the bone spatulas, an identifiable scraping tool was also recovered during the field school excavations. Walker (1979:55) defines scraping tools by the heavy wear that occurs around the margins of the tools. Wear striations should appear to be perpendicular to the long axis of the tool assuming the lateral side of the object served as the working edge. On larger scrapers, the wear striations should run parallel to the long axis of the tool. The scraper that was recovered from the Hartley site was originally from the distal portion of the right humerus (Figure 7.1). It is

characterized by unifacial flaking on the distal end and a number of striations were noted running parallel to the long axis of the bone.



Figure 7.1 Unifacially flaked bone scraper (6888)

Bone tools including knappers and one awl were also recovered in the course of excavation. Knapping tools, also known as flakers, are thought to exhibit similar characteristics to awls and punches, with the exception that the objective, or working end, is more blunt and thick. Kehoe (1967:62) notes that the tips of flakers are often highly polished and scored by transverse cuts produced by chipping. These transverse cuts are definitely visible on the flakers identified at the Hartley site, as are the blunt ends (Figure 7.2). Walker (1979) noted in the analysis of the Tschetter site bone tools that some of the specimens appeared to have been ground or cut to produce a small facet or platform. It is speculated that this platform may have been created on these tools to facilitate flake removal. Other types of knapping tools that have been found at archaeological sites consist of antlers and ribs (Frison 1970:26).

According to Kehoe (1967:57) awls are defined by their gradually tapered sides and sharp, pointed tips. In terms of use, these tools are employed for the purposes of perforating leather or other materials.



Figure 7.2 Two knapping tools recovered from the Hartley site (8137 and 8138).

It is not uncommon to see bones such as metacarpals and metatarsals shaped into awls, as in the case with the specimen recovered from the Hartley site (Figure 7.3). In the analysis of the Tschetter site, Walker (1979) determined that the category which included awls, punches, and needles was the most common. Characteristics that are often seen in awls that aid in distinguishing them from knapping tools and flakers are the less rounded tips and overall size. Knappers tend to have tips that are slightly more pointed, and needles tend to be smaller than the awls. As Walker (1979) found through a microscopic analysis of needles, polishing in these tools may continue up the entire shaft and may not be confined to the tip area as in the awls. From the photograph, one can note that the lateral edges of the metacarpal are well polished and taper towards the midline of the bone. The pointed tip exhibited in Figure 7.3 exhibits a fair degree of polishing.

Defleshers have been found at a number of archaeological sites on the Northern Plains. Although they may be considered as a scraping tool, they differ from other scrapers in that they are often made from a long-bone of a large animal, frequently the metatarsal (Wilson 1983:27). Defleshers are formed by splitting or cutting a bone diagonally towards the distal end to form a flat end or bit.



Figure 7.3 Bone awl recovered from the Hartley site (8524).

This bit is serrated, while the proximal end may be removed or a hole may be drilled for the attachment of a looped thong or strap. The user would use this strap to secure their wrist and grasp the bone so that the bit was pointing towards their body. The loop essentially helped the user maintain the correct angle as the serrated edge was used to scrape flesh and fat or any other excess tissue from the hide once the hide has been left to decompose for a suitable amount of time (Steinbring 1966: 576; Wilson 1983:30). From Figure 7.4 it can be seen that it was the distal or serrated portion of the tool that was recovered during the excavations of the Hartley site. The specimen is likely part of either a metacarpal or metatarsal from a bison. Steinbring (1966:579) notes that metacarpals and metatarsals were often the bones of choice utilized for making these tools as they were of the choice size, weight and density. It has been noted through ethnographic research that a second specialized tool for hair removal would have been employed following the defleshing of the hide (Steinbring 1966:576).



Figure 7.4 Deflesher recovered during 2006 excavations (no catalogue number)

Although bone beads are not tools per se, it is appropriate to note the presence of these artifacts in this section. A number of possible bone beads were recovered during the excavations associated with the field school between 1988 and 1995 (Figures 7.5 and 7.6). In terms of overall size, these specimens match both the approximate circumference of both canid metapodials and rabbit longbones. Documentation exists for bone beads made from canid metapodials on the plains (see, for example Walker 1979). It is noted that some of the specimens displayed evidence of thermal alteration. It is not known whether thermal alteration occurred previous or subsequent to deposition. Bone beads are known to have been used for gaming pieces and notation devices in addition to items of decoration for clothing and jewellery (Walker 1979).

7.2.5 Implications for the Hartley Site

The taphonomic processes and associated effects where humans were the acting agent were reviewed in the above-section. From this analysis it was determined that the Hartley site faunal assemblage had been affected most greatly by humans in terms of processing activities.



Figure 7.5 Bone beads recovered from the Hartley site (9069).



Figure 7.6 Bone beads recovered from the Hartley site (9072).

As was demonstrated in chapter five the majority of the faunal remains recovered are unidentifiable, in terms of both numbers and weight. The most common category of breakage to which the analyzed specimens were assigned was that of “comminuted”. Spiral, longitudinal and in a transverse irregular breakage patterns were also recognized. A number of impact scars were also noted on several specimens. This information is quite clear in demonstrating that the faunal remains were strongly affected by human actions.

The analysis of bones displaying cutmarks demonstrated that a number of activities likely occurred in the Wooded Hollow region of the Hartley site. Various longbone shaft fragments, rib shaft fragments and phalanges were noted as having cutmarks. Placement of these cutmarks suggests that carcass dismemberment, hide removal, and filleting activities were occurring in this area. The recovery of various bone tools including one deflesher, one scraper and an awl also suggest hide processing activities were occurring here. The recovery of knapping tools suggests that some tool making or tool re-sharpening were also occurring. The taphonomic processes and effects observed to have been produced by humans demonstrate that the Wooded Hollow area of the Hartley site was characterized by a high amount of extremely processed bone and that a number of processing related activities likely occurred at the time of use. It is imperative, therefore, to further explore further the role that humans may have had in affecting the composition of the assemblage including a discussion on utility indices as well as activities geared towards marrow and grease extraction. First, however, discussion in the following section will be geared towards the identification of three distinct pathological specimens recovered in the course of analyzing these faunal remains.

7.3 Pathologic Specimens

As was noted in Chapter 5, one of the mandibles displayed characteristics of an individual who suffered from generalized periodontitis. In humans, generalized periodontitis usually affects all teeth and is characterized by a horizontal reduction in alveolar bone height (Aufderheide and Rodriguez-Martín 2003:401). The cause of periodontitis can be attributed to foreign bacteria or local trauma, however, the most

common cause of such a disease is severe attrition. When teeth become worn down to the point that the interproximal contact between teeth is no longer present, food can be forced down into the sulcus during mastication. After each meal, the sulcus is expanded by the retained organic matter due to the fact that the area has no self-cleansing method (Aufderheide and Rodríguez-Martín 2003:401). As the Hartley site is located within a sand dune environment, grit in the diet would not have been uncommon, thereby supporting the possibility that dental attrition could have caused periodontitis. Further support to this hypothesis is demonstrated in the case of this specimen by the fact that the teeth are worn down to a fair degree, which would have indeed allowed for food and grit to be accumulated in the sulcus (Figure 5.4).

A second pathology noted on a specimen recovered from the Wooded Hollow area of the Hartley site was a bone with a small area of necrosis on the postzygopophyseal portion of a cervical vertebra. This type of invagination, or area of necrosis, is noted in individuals who are suffering from osteochondritis dissecans (Figure 7.7). Osteochondritis dissecans is a benign, noninflammatory condition characterized by the production of small, focal epiphyseal areas of necrosis on the convex surfaces of diarthrodial joints.

Diarthrodial, or synovial joints, are joints whereby the opposing bony surfaces are covered with a layer of fibrocartilage and a joint containing synovial fluid. Production of these areas of necrosis results in the partial or complete detachment of a segment of the subchondral bone and articular cartilage (Aufderheide and Rodríguez-Martín 2003:81). In humans, this disease is characteristically found in young adults, however, it is not known whether or not it is limited to young bison. Carnivore gnawing was eliminated as the source of invagination, or area of necrosis, as it is obvious that the size, shape and irregularity of this invagination is not consistent with the punctures noted in other specimens from this assemblage.

The last pathology noted on a specimen from the Hartley site faunal assemblage was that of a localized periosteal reaction. Periostitis is not a disease itself, but rather is an inflammatory response to a disease which involves the deposition of periosteal bone around an area of infection.



Figure 7.7 Cervical vertebra displaying evidence of osteochondritis dissecans (8048).

Increased peripheral blood flow resulting in passive congestion and poor tissue perfusion stimulates surrounding connective tissues such as the periosteal membrane to deposit bone (Walker 1978:34-35). According to Walker (1978), ossifying periostitis that is found amongst humans is related to a number of conditions including leprosy, syphilis, various anemias, certain vitamin excesses and deficiencies, as well as respiratory diseases. In bison, however, it is likely that the periosteal deposition was a reaction to some sort of localized infection. Unfortunately, it is not possible to determine the exact pathology that caused this reaction.



Figure 7.8 Bone fragment displaying evidence of a periosteal reaction (7895).

7.4 Analysis of Economic Utility

The presence of bison bone at an archaeological site is thought to be due to its cultural introduction. This is true in the case of kill sites, processing sites, and habitation sites. It has been proven, however, that the absence of elements from an assemblage is also worthy of evaluation as reasons behind their absence may be due to a number of cultural in addition to natural factors. In order to properly understand the presence or absence of skeletal elements at an archaeological site, the analyst must understand the cultural reasons influencing why not certain elements are deserted at a kill site while others are taken away for the purposes of processing. One assumption that is made in devising hypotheses related to economic utility is that a person faced with a maximizing choice would select the element of high utility and remove that element from the kill area and would further process it at a secondary or tertiary location (Binford 1978; Brink and Dawe 1989).

Binford (1978) originally developed utility indices as a means of examining the economic importance of individual sheep and caribou elements. Given the necessary data on the distribution of usable meat on the skeletal anatomy of a particular species, it is possible to assign values to each part of its overall utility relative to other parts in terms of the food present on the animal. In devising utility indices, it is assumed that a

person faced with a maximizing choice would select the portion, or part, of an animal that provided the greatest proportion of useable meat compared to nonusable bone (Binford 1978:19). Since Binford's (1978) original study and publication of the Modified General Utility Index (MGUI), it is now known that a reverse utility curve can no longer be assumed to be evidence of purely cultural transport of elements, and several other factors, including both natural and cultural factors, must be considered. A series of body part utility models have since been formulated that indicate the relative value of different carcass units based upon their yield of one or more carcass products (for an overview of utility indices see Lyman 1992). Given the fragmented nature of the archaeological assemblage in question and the extremely small numbers of identifiable specimens, it would be completely redundant to perform an analysis of economic utility on these remains. This assemblage is almost completely dominated by unidentifiable comminuted bone fragments, and therefore, it is more useful at this point to present a discussion on the archaeological visibility of marrow and grease extraction.

7.4.1 Processing for the Purposes of Marrow Extraction

The Wooded Hollow exhibits many characteristics of a marrow processing activity area. Marrow processing has received a considerable amount of attention in the archaeological literature over the years. Marrow is extremely important for those whose diets are largely derived from meat. It is present within the central cavity of bones, particularly leg bones (Kooyman 2004; Speth 1983). A number of processes where marrow extraction was the primary goal have been described in the ethnographic literature. A bone may be placed in suspension between two anvils and struck in the middle, it could be held freehand and struck, or placed on one anvil and struck, or placed longitudinally and split, similar to a piece of wood (Binford 1981; Kooyman 2004). This variation in bone breakage technique is related to the generalized structure of mammalian bones, the structural properties of each specific element, as well as to the decision by the individual who was performing the action of breaking the bones (Kooyman 2004).

Although bone marrow does contain a number of nutrients, fat is the most common substance and main value. Fat derived from bone marrow was likely an

extremely important resource to the Precontact Plains Adapted peoples as it performed the function of supplying the large amount of energy needed to survive in this type of environment. According to Speth (1983:148), dietary fat is an essential source of fatty acids; it provides a vehicle for fat soluble vitamins (such as A, D, E and K); it is important for the development of cell membranes; fat-rich foods are often high in protein; and lastly, fat has a tendency to make foods taste better.

Aside from non-human taphonomic agents, the activity of marrow processing allows the archaeologist to explain why bones found at an archaeological site are broken. Marrow removal from bone that yields meat normally takes place after the removal of the meat for consumption or storage (Binford 1981:106). It has been noted through ethnographic observations of processing animals (specifically caribou) for marrow that in addition to the broken shaft fragments, a number of bone splinters and chips are also produced. Kooyman (2004:188) notes that various ethnographic accounts of marrow extraction describe the breakage of long bones to maximally expose the marrow cavity and hence facilitate marrow removal. Spiral fractures, although first thought to have been associated with marrow processing, has received much attention since Bonnichenen's (1979) research into this form of bone breakage. Much criticism erupted when other non-human taphonomic agents, such as trampling, were omitted as possible reasons for the cause of spiral fractures. Since then, it has been found that almost all green (fresh) bone fractures spirally, whether as a result of non-human agents or human actions. Therefore, bone broken for the purposes of marrow extraction will exhibit some degree of spirally fractured bone in addition to the small chip and splintered bone known to accompany bone breakage.

Binford (1978:155) notes through Nunamiut research that when bones are processed for marrow, small chips (less than 1.3 cm in length) are often concentrated in the location where the actual cracking of the bones was carried out. Binford (1978) observed that marrow was almost always consumed during the night hours around the inside hearth or stove. Despite the best efforts of the group to keep this area clean, numerous small chips remain in fair numbers around these locations, whereas the larger chips (splinters) and articular ends are commonly removed to the dump. In addition to Binford's (1978) observations on the Nunamiut, it has been noted elsewhere in the

literature that bone breakage for the purposes of marrow extraction leaves other indicators in the form of bone fragments and impact fractures.

Enloe (1993) devised a research methodology in which a number of attributes from three samples of known Nunamiut derivation were analyzed in search of diagnostic criteria for recognizing characteristics of material remains that might indicate the process responsible for their creation. The search was geared towards the identification of criteria for discriminating between bone splinters that were the result of intentional, specialized processing of raw bones for their marrow, versus those that were created as a result of meat and incidental marrow consumption. It was found that a difference did exist in terms of element representation, fragment length, and length variation between the two processes. In the case of sites utilized for mass marrow consumption, more metapodial fragments and unidentified element fragments relative to upper limb bones were recovered compared to immediate consumption middens. In addition, the fragments from mass-processing locations appeared to be longer and of a more uniform length overall compared to those from consumption middens (Enloe 1993:93). Upper limb elements were considered to consist of the humerus, radius, femur and tibia. At the Hartley site, fragment length was not measured, however, in terms of overall NISPs, metapodial fragments were less numerous to upper limb fragments, however a large number of unidentified limb fragments were recovered (Table 5.3). This suggests that it is likely that processing for the purposes of marrow extraction was occurring at this site.

An additional study geared towards the identification of marrow extraction in archaeological sites is based on a model constructed by Kooyman (2004). He studied a faunal assemblage from a historic Métis settlement in the Cypress Hills of Alberta, and based on bone fragments with a high incidence of long spiral fractures (spiral fractures with a length of six centimetres or more) determined that marrow extraction activities were occurring. Kooyman (2004) notes that in order for a sufficiently large cavity to be opened for marrow extraction, it is likely that more than one blow had to be employed, although one blow may be sufficient in some cases. Bones utilized for marrow extraction should therefore be characterized by one to three impact marks for each element and a sufficiently large opening towards the cavity of the bone. Numerous

impact scars were also noted on single elements, thereby suggesting that marrow extraction was occurring at the Hartley site.

7.4.2 Processing for the Purposes of Grease Extraction

Extraction of grease was another activity employed by the Plains adapted people for the purposes of subsistence. Bonnicksen and Will (1980:11) note that grease extraction can often be recognized in the archaeological record through the identification of large numbers of extremely fragmented bones. Grease extraction is most efficient when bones are in this form as it maximizes the surface area exposure; therefore, when the bones are boiled, the maximum amount of grease can be extracted (Emerson 1990:186). Bone grease is the most concentrated in the articular ends of longbones and has been noted as a minor but dependable and nutritious fat supply that was an important dietary item, especially during times of stress (Brink 1997:259). Breakage of bones for the purposes of bone grease extraction has been noted in the literature as the process that follows breakage of the bone for marrow extraction.

In addition to a highly fragmented assemblage, an indicator of bone grease extraction is through the presence of impact scars on various specimens in a faunal assemblage (Table 7.3). As Kooyman (2004) notes, each element would require several break-causing impact blows to fragment a bone into several pieces. It is likely that the number of impact scars noted in Table 7.3 is much lower than the actual percentage of impact scars that were identifiable in the faunal assemblage. Unfortunately, the majority of the unidentifiable bone fragments collected in quadrant bags were not evaluated for the presence of impact scars. It is safe to assume, however, that a number of these fragments exhibited impact scars and that processing for the purposes of grease production did occur at this site.

7.4.3 Implications for the Hartley Site

The review of the techniques utilized for marrow and grease extraction presented in the above-sections is fundamental to the understanding of the bone breakage patterns recognized at the Hartley site. In chapter five, it was demonstrated that the assemblage is characterized largely by unidentifiable bone fragments, both in terms of NISPs and

representation by weight (Table 5.1). It is likely that the inhabitants of the Hartley site were utilizing bison, the most dominant species in the assemblage, to the fullest extent. It has been demonstrated through the analysis of butchering practices, specifically breakage patterns, that activities revolving around, the extraction of marrow and grease were occurring. Although no features were identified in the course of excavating various units in the Wooded Hollow, a large number of fire broken rock (FBR) pieces were obtained over the various years of excavation. It is therefore likely that boiling pits were employed somewhere by the site's inhabitants.

7.5 Site Type Determination

In an attempt to ease the ability for an archaeologist to determine the type of site being studied, Sivertsen (1980) published a model whereby the site type was determined through a series of questions regarding the presence or absence of a number of lines of data, including their interrelationships. The above-sections have been devoted to the roles of non-human and human agents and their associated effects on the Wooded Hollow assemblage. Further to this, a discussion of processing related to marrow and grease extraction was included. Having considered these factors, one can be more comfortable in the analysis of site type.

Sivertson (1980) devised a model whereby an analyst is able to determine the function of a site based on the presence and absence of certain features, artifacts, and ecofacts as well as their interrelationship to site activity areas. It is assumed in this study that certain archaeological indicators will reflect past site activities and that these activities may be evident in the spatial patterning of artifacts at the site or they may be reflected in the frequencies or presence and absence of artifacts (Sivertson 1980:427). Although this model was originally devised to be used in differentiating between Paleo-Indian kill, butchering, processing, and camp sites, it is nevertheless applicable to all time frames as the criteria are very general.

In this model, Sivertson (1980) devised a set of ten criteria thought to be useful to site type determination. These criteria were largely developed out of ethnoarchaeological work conducted by Binford (1978) and Yellen (1977) and focus on both faunal and lithic materials. For a complete list of the criteria, refer to Sivertson

(1980:427). A lithic analysis has yet to be completed in the Wooded Hollow section of the Hartley site, so criteria pertaining to these categories, specifically the types of tools and lithic debris, were estimated based on the knowledge of the author. Bone tools discussed in this chapter, however, were of use. Despite these limitations, it seems clear that the Wooded Hollow section of the Hartley site demonstrated characteristics of both a kill locus and a butchery/special processing locus. The presence of a number of low utility elements, the presence of a large number of projectile points, as well as a topographic setting indicative of a bison pound are characteristic of a kill locus. On the other hand, however, the domination of one species (bison) in the faunal assemblage, the fragmentary state of the bones, and the presence of bone tools such as a deflesher and a scraper, are indicative of a butchery or special processing locus. Interestingly, Clarke (1995:186) determined that the Brushy Depression exhibited the characteristics of a camp, multiple activity or terminal processing locus. Further analysis of the lithic remains from the Wooded Hollow would greatly increase our understanding of the activities that took place in this section of the site.

7.6 Summary

Taphonomic characteristics and butchering patterns observed on the faunal remains from the Wooded Hollow section of the Hartley site provide evidence that this assemblage was likely buried very quickly after a number of bison were procured and heavily processed. A review of the taphonomic processes revealed that the assemblage was largely affected by humans. Weathering, root etching, and carnivore action were very limited on the faunal remains analyzed for this thesis, suggesting that burial occurred quickly after these specimens were deposited. Stages of deterioration demonstrated that bone degrading processes did not occur to a large degree after deposition. On the other hand an analysis of taphonomic processes where people are acting as the agent demonstrates that humans had a much more profound effect on the overall state of the faunal remains in this assemblage. Heavy processing activities were likely occurring at this site as demonstrated by the numbers of comminuted fragments of bone. Spiral, longitudinal, and transverse irregular fractures were also noted in the analysis of specimens within this assemblage, as were a number of impact scars. Further

to this analysis, a number of bone tools and possible pathologic specimens were identified.

The second half of this chapter was devoted to the analysis of the butchering activities that occurred in this region of the site. An introduction to the applicability of utility indices revealed that this assemblage had far too few identifiable specimens to produce viable results. Therefore, a more in-depth review of the visible characteristics related to processing for the purposes of marrow and grease extraction was performed. The fragmented nature of the bone and fracture patterns noted on many specimens in the assemblage also suggested that this area may have been used for both marrow and grease production. Further to this, a model proposed by Sivertson (1980) in which site type determination can be revealed by a simple determination of the presence or absence of artifacts, ecofacts and features was applied to the faunal remains recovered from the Wooded Hollow. According to these remains, it is likely that the Wooded Hollow region was used as a kill locus and butchery/special processing locus. As this analysis has indicated that the Wooded Hollow section of the Hartley site was likely used as a kill and processing site, further investigations as to why this region was chosen for these activities warrants consideration. The following chapter is therefore devoted to the analysis of the archaeological phenomenon associated with the exploitation of sandhill environments, particularly for the purposes of habitation and bison procurement.

Chapter Eight

The Use of Sandhill Environments in the Late Precontact Period

8.1 Introduction

Studies relating to the exploitation of sandhill environments by Plains adapted peoples, particularly in the Late Precontact Period, are becoming a major area of focus in archaeological research. It has been documented that the Northern Plains subdivision of the Great Plains was dominated by grasslands occupied by herds of bison that were exploited by Plains adapted peoples at all times of the year. Within the grasslands ecosystems, regional variants including such subsystems as the foothills of Alberta and Wyoming, and sandhill systems of Saskatchewan were heavily exploited for the purposes of habitation and large-scale bison procurement (Figure 8.1). Sandhill environments have been shown to have relatively stable areas, or islands, of resources that supplemented the resources available in the greater grasslands ecosystem. An examination of the faunal remains at habitation as well as kill or processing sites in sandhill environments is performed. These sites are of particular interest in terms of overall similarities and differences when compared to the faunal analyses documented from the Wooded Hollow region of the Hartley site. This chapter examines several different examples of archaeological sites in sandhill environments, with particular reference to habitation and large scale bison procurement. Investigation into procurement activities requires a review of the various methods such as impounding (the bison pound) as well as surrounding. Studies relating to impounding and surrounding have revealed that these activities were dependent on a large number of factors including seasonality, topographic features, and available ecological resources, all of which are examined in the following sections. Special attention is also paid to the bison seasonal round as proximity to the herds themselves was essential to the process of communal hunting.



Figure 8.1 Sandhill systems located on the Great Plains of North America.

8.2 Bison Procurement Methods

Bison procurement methods in the Late Precontact can be described as falling into one of the following three categories: impounding (buffalo pounds or corrals),

driving bison over a precipice (buffalo jumps), driving buffalo into an arroyo, and surrounding on foot. Only after the horse was introduced did pursuit on horseback become a method of procuring large numbers of bison (Verbicky-Todd 1984:33). A brief overview of bison pounding, bison surrounding, and the importance of the seasonal round on bison procurement are discussed below. Buffalo jumps were omitted from this overview as this method of bison procurement is not relevant this thesis.

8.2.1 Bison Pounds

Bison pounding throughout the Late Precontact, Protohistoric and Historic Periods was an important activity for the Plains adapted peoples enabling them to procure large amounts of food, tools, and clothing. Bison pounds are also commonly referred to in the literature as corrals, pens, and drives, however, for the purposes of this thesis they will be referred to as bison pounds or corrals. Impounding procedures were fairly complex and several variables warranted consideration prior to procuring a herd or several herds of bison. Seasonality, physical components, and topographic features all played a role in the success of procuring bison in this manner. Each of these factors is considered in the following sections of this thesis.

8.2.1.1 Seasonality of Bison Pounds

It has been noted in the historic and ethnographic literature that pounds were almost exclusively described as being a fall or winter activity, however, some references suggest that impounding in the spring and summer did take place occasionally (Frison 1978:236; Verbicky-Todd 1984:34-36). Typically, fall or winter impounding activities were conducted after the bison had migrated to the river valleys, parklands and foothills seeking shelter during the cold months.

Vickers and Peck (2004) suggest that fall and winter camps and associated kill sites were oriented towards locations that would provide substantial amounts of wood for both fuel and pound construction. Although highly mobile at other times of the year, the Plains adapted peoples are thought to have been more settled during the winter months. Due to the extremely harsh surrounding prairie climate, it is surmised that areas in which adequate cover could be obtained in terms of shelter, as well as those that

provided a resource base to support the wintering population, were sought out and exploited (Vickers and Peck 2004:98-99). Further to this discussion, Vickers and Peck (2004) suggest that as procurement sites are primarily fall and winter events, the locations of pounds should be correlated with the locations of fall and winter campsites. Although this is the case in a number of sites (see for examples Hjerstad 1996; Prentice 1983; Ramsay 1991), there are also a some sites for which the seasonality determined for pound sites is not confined to the fall or winter months (for examples see Chapter 5 this thesis; Hamilton and Nicholson 1999; Koch 1995).

8.2.1.2 Physical Components of Bison Pounds

As was noted in the previous section, wood played a critical role in the building of the bison pound. A bison corral is constructed of tree trunks and brush cut from the immediate area (Verbicky-Todd 1984:39). The ethnographic literature provides detailed accounts of particular areas that were chosen for impounding because of their close geographical relationship to wooded areas. It has been described in the ethnographic literature that the Plains adapted peoples would seek out small groves of trees surrounded by plains, and in this grove of trees, a yard would be made by cutting down small trees and interweaving them with brush to construct a pound (Verbicky-Todd 1984:56). In some cases, stones, skins attached to poles, mud or any other substance that could be found to fill in the corral walls, was utilized in order to make the pound structure appear sturdy. Once inside the pound, the bison would not run into the walls if they looked sturdy. Instead, they would run around within the structure looking for a clear space through which they could pass. The bison would only rush against a barrier if they could see through the wall to the outside (Frison 1978:231; Verbicky-Todd 1984:40).

It has been noted in the ethnographic record that pound structures varied in terms of their shape and size. In terms of shape, bison pounds were most frequently said to be round, although square and rectangular shapes were also noted. Occasionally, some bison pounds were enlarged by adding appendages or multi-corral pounds were built by constructing two corrals, one of which would open into the other (Verbicky-Todd 1984:40). Noted dimensions of the height of bison pounds vary from about 1.2 metres

to 2.44 metres, and the enclosing area ranged from about half an acre to one and a half acres, depending on the number of bison being corralled (Verbicky-Todd 1984:41; Vickers and Peck 2004:100). Alexander Henry the elder commented in the late 1700's that the "...common size of the pounds used by the Assiniboine was from 60 to 100 yards in circumference and five feet in height" (Verbicky-Todd 1984:41).

Verbicky-Todd (1984) notes the importance of fences extending out of the pound entrance and drivelines. Typically, if a pound was constructed on a slope or on level prairie, fences, made of the same material as the pound were extended out from the entrance of the structure ranging from one hundred feet to one and a half miles. Extending from these wings was what is commonly referred to as drive lines. Drive lines are described as lines of stakes or piles of material consisting of buffalo chips, dirt, or sometimes stones, arranged at regular intervals in lines coming from the wings of the pound entrance. Normally described as V-shaped, drive lanes served the purpose of triggering the bison to travel toward the corral. In some cases, if drive lines were not used, people were stationed in rows diverging from the pound, encouraging the bison to move towards the appropriate location.

It can be seen that the physical components of the bison pound were limited by the surrounding available resources. The material and number of people involved in the hunt were obviously limiting factors in this activity. The basic components of the bison pound, however, consist of a drive lane bounded by either rows of objects or people, and a corral or pen large enough to enclose the hunted herd (Verbicky-Todd 1984:43). The other factor that is critically associated with the construction and success of a bison pound is the surrounding topographic features.

8.2.1.3 Topographic Features and Bison Pounds

The location of bison pounds on the Northern Plains was very much linked to an area's topographic features. Verbicky-Todd (1984:37) notes that bison pounds were typically built on one of three types of terrain: (1) on or at the base of a natural slope; (2) on level ground; or (3) beneath a precipice high enough to keep the bison from escaping back out of the pound, but not high or steep enough to kill or incapacitate most of the herd. Pounds were also known to be constructed between two hills where the valley

bottom served as a natural funnel through which the bison were driven. In order for bison to be impounded, it was essential to drive them in the right direction without allowing them to see the pound structure until they were just about to enter the trap (Verbicky-Todd 1984:38). The purpose in choosing a pound location was to find an area in which the pound could not be seen until the bison were either in the enclosure, or it was too late to escape (Arthur 1975:78). It has also been noted in the ethnographic record that pounds were usually situated on the south or east side of a gently sloping hill for timber was plentiful for pound construction, whereas the north and west sides were often open country (Arthur 1975:77).

8.2.2 Bison Surrounds

A second commonly used method for the large scale procurement of bison was the surround. Prior to the introduction of the horse, the bison surround was executed on foot by a group of people who stealthily formed a circle around a herd. By slowly closing in upon the herd, the bison began to mill around the gradually contracting circle, and as they advanced, the Plains adapted peoples shot the animals with bows and arrows (Verbicky-Todd 1984:133). This type of communal hunting procedure involved the efforts of many individuals working together in what has been described as a “military fashion” (Verbicky-Todd 1984:134). Essentially, in order for a surround to operate, the number of people involved could have been somewhere between 80 and 100 including men, women and children. A group of this size was thought to have been able to kill anywhere from 100 to 500 bison in the course of an hour (Verbicky-Todd 1984:136). In order for the surround to be successful, the people worked under the direction of leaders who had been called on by the Chief to maintain peace and order among members, as well as to direct and oversee activities such as surrounding. These individuals were known either as “camp police” or “soldiers” (Forbis 1978:3; Verbicky-Todd 1984:137).

Bison surrounding activities changed significantly once the horse was introduced on the Plains (Verbicky-Todd 1984:140). Originally, the introduction of the horse changed the way in which the Plains adapted peoples procured bison as they would surround the herds, in a similar fashion to that of the human surround. Once horses became more commonplace, the surround was easily executed by hunters mounted on

horseback, and as a consequence of the speed of the animals, the hunt became a much quicker, more efficient method of hunting (Verbicky-Todd 1984:134). Again, the surround on horseback was a communal effort policed in a military fashion by the camp soldiers. Eventually the Plains adapted peoples abandoned the surround on horseback for the more favourable method of chasing the herds.

8.2.2.1 Seasonality of Bison Surrounds

Unlike the preference for the winter months, it has been noted that bison surrounds were often executed during the warmer season. A number of factors need consideration when discussing the seasonality of a bison surround. First and foremost, it has been noted several times in the ethnographic literature that in order to successfully conduct a surround, much time must be taken in order to not disturb the targeted herd of bison (Verbicky-Todd 1984). In addition, concealing oneself in the landscape is much easier during the summer months as grass, trees, and riverbanks offer better places to hide than the white barren landscape that is characteristic of the winter months. Many historic accounts of the bison surround, although they do not say so specifically, make reference to bison where a "...cloud of dust was raised" or being killed upon "the green and enamelled turf" (Verbicky-Todd 1984:139). Such references lead one to believe that these events took place in the warmer months of the year. Although not as much attention is paid to the season during which bison surrounds were executed, it is likely that they occurred during the warmer spring and summer months, even into the fall.

8.2.2.2 Topographic Features and Weather Conditions

Similar to the bison pound, topographic features were essential to the success of the bison surround, although in this case, it appears as though the weather, particularly wind conditions, were more pertinent. Arthur (1975:66) notes that in order for a surround to be successful, certain favourable conditions were required. This meant that the general nature of the terrain, weather, and surface condition of the ground had to be adequate in order for the bison to be procured. Verbicky-Todd (1984:137) notes that in order to successfully approach the herd, topographic features such as breaks and ravines, and hills and hollows were all necessary in keeping the Plains adapted peoples out of

sight. Although sight was an important factor in concealing the presence of the hunting party, Soper (1941:399) notes that of all the senses, the sense of smell is the most strongly expressed in the bison and therefore deserved the most attention. Soper (1941) also notes that the bison does, on occasion, rely on its sense of hearing, and very rarely on its vision. Sight is the poorest of all the senses in the bison, and only when scent and sound are obscured will the animal stare impassively into the distance and become particularly indecisive. For this reason, wind strength and wind direction were foremost in importance when it came to executing the surround. Days when no wind was blowing were sought out for this type of activity.

In order for a surround to be successful, the bison herd in question had to be in an appropriate position, that is, a herd that was far enough away so that the shouts and shots of the hunters would not be heard by the other herds of bison in the surrounding area. In addition, if a herd was on an inappropriate landform such as a hill the hunters would wait until the herd moved to a more favourable location such as a narrow valley or low-lying watering hole (Arthur 1975; Verbicky-Todd 1984). When approaching a herd of bison on foot, the Plains adapted peoples were careful to stay both out of sight of the animals, but also out of smelling range. It has been noted that a bison herd could smell a hunter at a distance of up to three to five kilometres, even if the hunter could not be seen (Verbicky-Todd 1984:135). To begin, the hunters would form a very large circle, as far as possible from the herd, and then they would begin to slowly draw themselves around the herd at approximately the distance of a mile. If there was a breeze blowing, the hunters would compensate by planning the trap so that the windward side took shape last. That way, if the bison scented the hunters on the windward end of the surround, they would flee in the opposite direction only to be met by the other side of the hunting party, or “human corral” (Verbicky-Todd 1984:135). In meeting with the hunters, the bison would then turn and run back towards the windward side only to find that the circle would have closed. At that point the bison would begin running about in a circle, completely surrounded by the hunting party. Once entrapped in the human corral, the bison would be attacked in a matter of minutes by a slough of arrows. If, by chance, some individuals in the herd did escape, they may or may not

have been pursued depending on whether other herds were located in the surrounding area (Verbicky-Todd 1984).

8.2.3. Implications for the Hartley site

The Wooded Hollow section of the Hartley site could have functioned as either a bison pound or bison surround for a number of reasons. Although it has been noted that the seasonality of pounding may have differed from that of surrounding, it is possible that this site could have functioned in either case. It was noted above that pounding events were often employed during the fall and winter months, whereas surrounding events were limited to the warmer season. Essentially, either scenario fits with the approximate seasonality of the Wooded Hollow section of the Hartley site.

In terms of topography, the Wooded Hollow section is conducive to both a pound and surround situation. The Wooded Hollow section of the Hartley site is located within a dune environment characterized by a clump of aspen trees that are growing within a depression at the base of a stabilized sand dune. If this area was utilized in a pound situation, it is possible that the gently sloping edges of the aspen grove could have blocked the view of the corral structure from the bison while the steeply sided south edge prohibited the animals from escaping once they were entrapped. In addition, the availability of the aspen trees and surrounding shrubbery, would have aided in the construction of a bison corral necessary for the success of the hunt. In a surround situation, it is possible that the hunting party could have surprised the herd while they were in the midst of watering or feeding within the Wooded Hollow. Being in the midst of a hollow of aspen trees, it would have been less likely that the herd could have seen or heard the approaching hunting party, bearing in mind that the weather, specifically the wind speed and direction had to be appropriate. Although it is not possible at this point to determine specifically which type of communal hunting technique was employed in the Wooded Hollow section at the Hartley site, it appears that either a pound or surround would have been possible considering seasonality, topographic features and available ecological resources.

Much of the literature concerning bison procurement in the Late Precontact Period is centred on the fact that the Plains adapted peoples were known to obtain

hundreds of bison at each kill event. As was shown in chapter 5, this is not the case as the minimum number of individuals recovered from the excavated units in the Wooded Hollow section at the Hartley site was shown to be 17. Although this number only represents a portion of the site excavated, it is unlikely that the total number of animals procured would have been in numbers ranging in the hundreds. In the Wooded Hollow section, it seems as though bison procurement was limited to a smaller number or group of individuals. This does not necessarily mean, however, that a pound or surround type situation was not employed to procure the bison. From the information gathered above, however, it does seem more likely that the numbers of bison involved and the effort required point towards the use of the area as a surround.

8.3 Bison Procurement and the Seasonal Round

In order to review the demographic relationships between human bands and herds of bison, it is essential to review bison behaviour in terms of the seasonal round. It is noted in the literature that the bison was hunted during all seasons and almost every part of the animal was used, whether it was to eat, make clothing, tools, or cooking utensils (Verbicky-Todd 1984:4). For the Plains adapted peoples, the bison was an important resource, and for a number of years it was thought that the heavy dependence on this species necessitated that people had to lead, at least in part, a nomadic lifestyle. In archaeological research, it has been thought that this lifestyle was based upon the movements of the bison herds upon which the Plains adapted peoples were so dependent. A review of the debate regarding the movements of bison herds is necessary in order to understand the demographic relationship between human bands in the Late Precontact with their environment, specifically in relation to large scale bison procurement.

The question of migratory versus non-migratory bison movement from the northern grasslands into the parkland and boreal forest environments has yet to be resolved. The first publications regarding bison migration on the Northern Plains essentially took the form of two opposing hypotheses. Various studies have emerged since then, however, it is pertinent to mention these first publications in order to gain an adequate understanding of the thoughts on the bison seasonal movements and how it

may or may not affect archaeological site distribution. Gordon (1979) and Morgan (1980) were one of the first to suggest that bison herds migrated regularly between the aspen parkland and southern boreal forest during the winter times, and southerly grassland environments in the spring in response to the need for and availability of superior forage. Conversely, the second hypothesis suggested by Hanson (1984) postulated that the bison did not migrate, but rather engaged in nothing more than erratic seasonal movements. Since these two studies, many more scholars have attempted to clarify this debate. In studying historical accounts of bison herd location and recent ecological data, Epp (1988) has suggested yet another hypothesis indicating that only some Plains bison migrate. Epp (1988) has suggested that bison display a dual dispersion practice whereby some populations migrate to the protected regions in the northern extension of the Northern Plains, whereas other smaller sedentary populations stayed in the southern grasslands.

Malainey and Sheriff (1996) have put forth hypotheses on bison migration patterns on the Northern Plains. By once again analyzing archaeological sites on the Northern Plains as well as historic accounts of the location of bison herds, it was concluded that large populations of bison were found to be present in abundance on what was thought to be the uninhabitable regions of the northern grasslands during the winter months. Furthermore, Malainey and Sheriff (1996) suggest that the hunter-gatherer populations that inhabited both parkland and forested environments may have left these sheltered areas during the winter to take advantage of the herds of bison on the northern edge of the grasslands. It is indicated that the abundance of resources such as vegetation, trees, and herds of bison in areas such as river valleys, on the grassland environments were similar to the resources found within the parkland. Meyer and Epp (1990) suggest that the parklands should perhaps even be viewed as ecological extensions of the more southerly grasslands. Owing to the presence of such resources, it is argued that it was not necessary for the Plains adapted peoples to abandon the grassland regions during the winter months in search of the large herds of bison (Malainey and Sheriff 1996:349).

8.3.1 Implications for the Hartley site

Whether bison were migratory or non-migratory animals has been thought to have implications for settlement patterns during both Precontact and Historic times. Both Epp (1988) and Malainey and Sheriff (1996) make strong arguments against the notion of mass bison migration into the protected parkland and boreal forest areas and complete abandonment of the northern grassland region. As the Hartley site is located within the Moist Mixed Grassland Ecoregion of the Prairie Ecozone, it fits nicely into the hypotheses proposed by Epp (1988) and Malainey and Sheriff (1996) in terms of season of use for large scale bison procurement and settlement. However, as was alluded to previously, in any of the seasons, whether winter, late spring, or early fall, it is possible that the location of bison herds were secondary considerations in addition to the availability of other resources. In the following section of this chapter, it is questioned whether it was a combination of environmental diversity and stability in grassland and sandhill environments that were the factors that truly influenced settlement patterns within this, and similar regions, on the northern plains, or conversely whether another scenario can be uncovered.

8.4 Exploration of the Interaction and Role of Grassland and Sandhill Environments in Relation to Settlement and Bison Procurement

Recent archaeological research directed at sites dating to the Late Precontact Period has been focused on the use and exploitation of sandhill environments for the purposes of settlement and large scale bison procurement. The Hartley site is located within the Moose Woods Sandhills, an area of stabilized sand dunes within the Moist Mixed Grassland Ecoregion of the Prairie Ecozone straddling the South Saskatchewan River (Acton et al. 1998:151). A more detailed description of the geology, climate, hydrology, local flora and local fauna of this region can be found in chapter 2. Many archaeologists have researched the role of sandhill environments, particularly in the way they affect the locations of habitation sites from the Middle Precontact Period to the Late Precontact Period (for examples see Dyck 1977; Evans 2006; Koch and Bozell 2003; Neal 2006; Ramsay 1991; Vickers and Peck 2004). Researchers have attributed this settlement strategy to the fact that there is an abundance and variety of resources in the ‘ecotones’ that exist between sandhill and grassland environments, particularly in

wetland areas or 'ecological islands' (Epp 1984; Hamilton and Nicholson 1999). It is interesting to note that although many of these studies have focused on the locations of large camp and associated kill and processing sites, few have paid attention to whether there are any emerging trends in terms of season of use, or whether the subsistence strategies are truly demonstrative of varied resource procurement. The goal of the following sections in this chapter is to discuss the role of grassland and sandhill environments, particularly with reference to settlement and bison kill sites, and to evaluate these sites for trends in seasonality and faunal resource procurement.

8.4.1. Grassland Environments on the Northern Plains

The Prairie Ecozone in Canada is made up of grassland, aspen parkland, and montane forest regions, all of which cover one-third of southern Saskatchewan, extending from the boundary with the United States northward to the Boreal Plain Ecozone (Acton et al. 1998). Within Saskatchewan, grassland environments are classified into two distinct ecoregions: The moist mixed grassland ecoregion and the mixed grassland ecoregion. Differences between the two ecoregions is noted in both the faunal and floral species that prevail in each area, however, it is the presence of aspen bluffs occurring in association with local wetlands that sets the moist mixed grassland ecoregion apart from the mixed grassland ecoregion (Acton et al. 1998).

Despite the current classification scheme proposed by Acton et al. (1998), the grassland regions of North America appeared to many historic observers to be an uninterrupted, monotonous sea of grass (Licht 1997:2; Neal 2006:147). This was despite the fact that prior to European settlement, this region may have been one of the richest ecosystems in the world. Ecologists currently divide the prairies into three zones running east to west: tallgrass, mixed-grass and shortgrass prairie. Collectively referred to as the Great Plains, these areas primarily differ based on the amount of rain that falls each year (Licht 1997:2-5). The grasslands are also very susceptible to a variety of extremes: severely hot and dry summers, and consequently grass fires and droughts, severe winters including blizzards, the consistent presence of a wind, as well as a variety of other weather-related factors (Potyondi 1995:15-19).

The geomorphology and sedimentology of the Great Plains grasslands is varied and landforms and associated soils in this region can often be attributed to glacial action. Pleistocene glacial deposits cover the entire province with the exception of some areas of the southern plateau (Fung 1999:86; Storer 1989:17). The surficial deposits in the grasslands are typically characterized by glacial till and stratified drift. Southern Saskatchewan is characterized by a number of geographical features including glacial moraines, kettles or pits, as well as ancient glacial spillways and lakes. Stone-free glaciolacustrine silts and clays that were once deposited in these lakes are now the underlying sediments in some of the best agricultural land in the province (Fung 1999). Those areas that were not exposed to the deposition of lake sediments or sandy gravel ridges are characterized primarily by underlying glacial tills. Sinuous sand and gravel ridges, or eskers, formed by underlying glacial rivers and streams, are typically composed of this material, although they tend to be more commonly found in the northern portion of the province (Fung 1999).

When the glaciers began melting, huge volumes of sediment and meltwater from the retreating ice sheets began carving deep channels in the till and underlying bedrock, forming river valleys such as the South Saskatchewan and Qu'Appelle (Storer 1989). These river valleys have provided, and continue to provide, the major dependable sources of water for all life forms, including an array of mammalian, avian, fish and botanical species. In addition to these major river valleys, the province is characterized by a variety of knob-and-kettle topography. When the glaciers retreated, blocks of ice that were calved off were buried in moraines. As the ice melted, the overlying moraine deposits began collapsing, resulting in depressions in the landscape, while at the same time being surrounded by low hills (Fung 1999; Storer 1989). The topographical relief prevalent in this type of situation created the numerous shallow wetlands that dot the landscape from Alberta to Manitoba, as well as in the Dakotas and Minnesota (Licht 1997:9). Upon forming, these small depressions became rainfall and snowmelt traps and provided the type of environment that was essential to the survival of countless waterfowl and other wetland dependent species (Licht 1997). These wetland regions also supported groves of aspen trees, which exhibited habitats similar to those of the river valleys (Neal 2006:151).

8.4.2 Sandhill Environments on the Northern Plains

The sandhill environments that are typical of the Northern Plains were the last geomorphological feature to have formed following the retreat of the glaciers. Unlike the glacial till that covers the majority of the province, the sandhills were created through post-glacial wind redistribution of the sands, silts and clays that were originally deposited as deltas where meltwater channels entered glacial lakes (Acton et al. 1998; Fung 1999). In terms of overall geomorphology, sandhills are primarily altered by wind action, as opposed to any effects of precipitation and runoff. As Epp and Townley-Smith (1980:5) note "...precipitation percolates through the sand to the water table before it has a chance to accumulate on the surface; therefore, there is very little surface runoff, and the landform generally is not shaped or affected by streams". Sandhill environments tend to demonstrate a wide range in terms of landform types, as well as associated vegetation cover. The landforms themselves can range from highly stable low-lying and highly elevated dunes to extremely unstable dunes in which no vegetation has grown. In Epp and Townley-Smith's study of the Great Sandhills of Saskatchewan, ten types of dunes were outlined based on the overall shape of the landforms (1980:15). With regards to the Moose Woods Sandhills region, some dunes have stabilized as a result of vegetation growth. The regions that are poorly stabilized are characterized by grasses, whereas the regions that are stable tend to support shrub-like plants such as the juniper shrub, in addition to aspen trees. Aspen trees are typically found only in areas where the water table is near the surface (Acton et al. 1998:151). Consequently, it is noted that while sandhill landforms can be stable, they are essentially an active landform for which stability is determined by levels of moisture. Dry conditions can effectively deplete any vegetation cover, allowing for the displacement of the once-stable sand deposits and resulting in movement (Townley-Smith 1980a).

Sandhill environments can support similar plant, mammalian and avian species as those seen within the greater grasslands ecosystem. It is noted that sandhill environments are a more specialized territory and can therefore support species that are commonly found in arid sandy regions, moister wetland and parkland areas, as well as those species that are unique to the sandhills themselves. For a detailed list of fauna and flora in the Great Sandhills see Epp and Waker (1980:75-84) and Townley-Smith

(1980b:31-72). An important component for species diversity in the sandhills is found within the wetland environments. As was the case for the formation of the Wooded Hollow at the Hartley site, Hamilton and Nicholson (1999:9) note that wetlands are essentially stable underground aquifers, with the pothole lake or slough encompassed by rings of aquatic and arboreal vegetation, surrounded by mixed grass prairie. Furthermore, Hamilton and Nicholson (1999) have noted that the presence of wetland areas in sandhill environments creates a cycle of protection and growth in these otherwise dry and unstable surfaces. Essentially, wetlands harbouring woody vegetation can create windbreaks, which then foster the formation of linear sand dunes. These dunes, in turn, form protective barriers for other dunes and the woody vegetation which protect the wetland area at the core of the environment. The net effect of these wetland areas is the formation of an isolated and relatively stable forest-wetland ecologically stable niche surrounded by mixed prairie. Hamilton and Nicholson (1999:9) have classified these sandhills and associated wetlands of the Plains as “ecological islands”. These islands are thought to provide a stable and diverse resource base for humans and animals alike, adding to the richness of the greater grasslands and sandhill environments.

8.4.3 Exploitation of Sandhill Environments for Purposes of Settlement and Bison Procurement

It has been hypothesized that the concentration of archaeological sites in sandhill environments can be attributed to the high variety of plant and animal life associated with the ecological interaction between the surrounding grassland and prairie environments. Epp and Johnson (1980) and Epp (1983) were the first to perform a detailed study of the settlement patterns in sandhill environments with particular emphasis on the role of the interaction between sandhill and grassland environments on the northern plains. These studies hypothesized, and to a certain degree, demonstrated, that settlement in sandhill environments may be related to distance to the encompassing resources typical of grassland environments as well as the resources located within particular areas of sandhill environments. Further publications by Epp (1984:325) suggest that settlement in these regions is related to a concept known as the “edge effect”.

Epp (1984:323) suggested that the Plains adapted people hunter-gatherers chose, above all, settlement locations that displayed the characteristics of “landform-based edges” where near proximity of a maximum variety and stability of resources from more than one ecotone could be utilized. In this publication, it was assumed that past peoples behaved selectively with regard to their surrounding environments and chose sites for habitation in a non-random manner; non-random simply meaning that areas were chosen that were the best suited for the people involved. The same assumption is employed in this thesis; that areas chosen for settlement and bison procurement were also non-random. Epp (1984) used site location information based on the available literature, archaeological impact assessment reports, and records from the Royal Saskatchewan Museum of Natural History in Regina as his data set with the purpose of analyzing archaeological site distribution on the grasslands, aspen parkland and boreal forest. The regional focus was confined to Saskatchewan from the Atlantic climatic period to early historic times (*ca.* 4000 to 300 BP), covering the latter portion of the Middle Precontact and all of the Late Precontact periods (Epp 1984:324).

Epp (1984) suggested that boundaries of ecosystems are often defined by plant communities, and that these plant communities are influenced by both climate and landform. Epp (1984:325) noted that an ecological interface occurs where two or more zones meet and often times, in these areas of overlap, characteristics of the two or more zones are noted. Epp (1984) refers to these overlapping areas as ecotones. In addition to the ecotones, a second important concept in Epp’s (1984) study was the concept of the edge effect. Simply stated, the edge effect implies that biological diversity, and stability, tends to be the greatest in zones of ecological overlap in two types of edges: inherent edges and induced edges. Inherent edges, or edges caused by a landscape feature of long-term duration, are the type of edges that are of interest to the archaeologist, as they are more permanent. This is in opposition to the induced edge whereby there is a “meeting of successional stages of vegetative conditions within a plant community” (Epp 1984:325). The stages of vegetation can be changed by events such as fire, disease, erosion or intensive grazing. By analyzing site distribution data based on inherent edges, interpretations can be made based on the specific landform features themselves and their associated flora and fauna.

Epp (1984) analyzed site distribution data from the boreal forest, aspen parkland and plains grasslands in order to determine whether there was evidence of a Precontact settlement-environment relationship. He noted that sites in the aspen parkland were rare. A different success rate was noted in the plains grasslands, however, this may be simply due to the fact that more work has been done in this region, and site visibility in this area is generally superior (Epp 1984:329). In this publication, it is noted that many of the archaeological sites found within the grassland environment are located within anomalous environments, such as sand dune or river system environments. Although Epp (1984) does admit that more information needs to be compiled, it is concluded, based on the survey of sites in various dune and alluvial environments that inherent edges tended to be attractive habitation areas, specifically those used for temporary hunting purposes. Epp (1984:332) attributes this to the fact that these areas were in proximity to the greatest variety and stability of resources. Although the study alludes to resource variety and stability, no actual paleobotanical or faunal remains were used to support this statement.

In addition to the study of ecological edges, Epp's study of bison migration suggests that the settlement patterns noted in the grassland environments of the northern plains is linked to what he terms "wooded, anomalous environments" (1988:316). With the exception of alluvial environments in the greater grassland ecosystem there were likely very few other places that offered attractive settlement locales to the Plains adapted peoples during the harsh times of year. In this paper, it is suggested that these environments provided primary settlement locations, especially during the winter months, as a combination of resources including small non-migratory bison herds, wood, shelter, water, berries, as well as other resources were readily available. Hamilton and Nicholson (1999:22) support this hypothesis and further suggest that these areas, termed as 'ecological islands' provided a seasonally shifting resource base that was capable of sustaining a relatively large population within a relatively small area, not just during the winter months but at all times of the year.

It is possible, however, that environments that offered protection from the elements and necessary resources were sought out throughout the year, not only the winter months. It is therefore imperative to determine whether attraction to these areas

was based on the availability of these “clumped”, stable, and varied resources. It is also imperative to determine whether resources in these ecotonal regions or ecological islands in sandhill environments were purely utilized as winter sites or whether warm season sites can also be found. In addition, an analysis of the faunal remains from a variety of sandhill sites may demonstrate whether people in Late Precontact times were solely procuring bison or whether a more broad-based foraging strategy was utilized. Lastly, if sites from all seasons are found, it is imperative to compare the subsistence strategies to determine whether seasonality played a role in the species of animals exploited.

8.4.3.1 Seasonality and Faunal Assemblage Diversity of Archaeological sites in Sandhill Environments

Although a variety of studies (Epp 1984; 1986; 1988; Epp and Johnson 1980; Hamilton and Nicholson 1999) have demonstrated that archaeological site location is likely related to the ‘edge effect’ caused by the variety of resources in sandhills, particularly the wetland areas (ecological islands) of these environments, actual concrete evidence of resource procurement is missing. It is necessary to determine whether or not the archaeological record demonstrates subsistence strategies characterized by numerous resources and whether or not these sites are found to demonstrate trends in terms of season of use. It is essential to keep in mind that human modification of the landscape in the last few centuries may have obscured the total number of sites and location of sites within these wetland areas or ‘ecological islands’ in dune environments (Hamilton and Nicholson 1999). In addition, the decline of groundwater levels within dune environments has been noted, and would have certainly had a dramatic effect on the formation of, as well as the retention of ‘ecological islands’ within these environments. The archaeological sites discussed below are intact sites dating to the Late Precontact Period, however, due to human modification of the landscape they only represent a fraction of the sites chosen for settlement in these regions. It should be noted that in the future, the generation of ecological maps based on historic data may prove to be suitable for addressing settlement of ‘ecological island’ and ‘ecotone’ locations within and between sandhill and grassland environments. Sites were chosen based on Neal’s (2006)

observations and analyses of archaeological sites in sandhill environments, and are presented in no apparent order (Figure 8.1). It is also noted that intrusive faunal remains described in the original reports were not included in this analysis as they have no bearing on the subsistence systems in question. The following section is committed to analyzing settlement and bison procurement sites with reference to seasonality as well as determining whether the faunal assemblages reflect a varied or limited subsistence strategy in terms of species utilized.

Lauder Sandhills

One of the most recent surveys of Late Precontact sites in dune environments was that performed by Hamilton and Nicholson (1999:12-13) whereby 11 archaeological sites were added to the total number of records at the provincial inventory. Hamilton and Nicholson (1999) note that the number of sites added since beginning the survey may represent a conservative number as survey work has not yet been completed in the main body of the Lauder Sandhills (Figure 8.1). In total, the main body is thought to encompass roughly 4,400 hectares of stabilized sandhills environments interspersed with these wetland 'ecological islands' (Hamilton and Nicholson 1999:13). By transforming topographic information into a Digital Elevation Model and utilizing information from vegetation studies, it was found that the majority of the sites dating to the Late Precontact (specifically those recognized as Vickers Focus sites) displayed a definite spatial relationship with the former wetland areas of the Lauder Sandhills.

Of particular interest in the Lauder Sandhills are the Jackson and Vera sites, located on the periphery of the grasslands and sandhill environments. A more detailed analysis was performed at each of these sites, including inferences regarding season of use. The faunal remains recovered indicated that the Jackson site was occupied over a series of winter months between November and March. The Vera site, however, was suggested as being occupied sometime between the months of April and May (Playford and Nicholson 2006:412-413). Seasonality at both sites was determined based on bison tooth eruption and wear schedules, foetal bone assessment, as well as the presence of seasonally restricted non-bison species. Surprisingly, it was found that although the two sites differed in terms of season of use, the faunal assemblages were remarkably similar

in that they were both dominated by bison. Although there were almost four times as many specimens at the Jackson site as compared to the Vera assemblage the minimum number of individuals (MNI) for this site is actually less than at the Vera site. This may indicate that heavier processing activities were occurring at the Jackson site (Playford and Nicholson 2006:413).

In contrast to the popular belief that sites occupied by the same group at differing seasons would have had noticeably different faunal assemblages, the Jackson and Vera sites were found to have remarkable similarities in terms of the secondary species utilized. There is evidence at both the Jackson and Vera sites of consumption of other mammals, however, the importance of these species when compared to that of the bison is small (Playford and Nicholson 2006:419). Of the non-bison fauna, large canids, elk, foxes, beavers, various leporids and ground squirrels were noted. Various birds of different size classes, including the sharp-tailed grouse were recovered from the assemblage in addition to amphibian, reptile and fish remains (Playford and Nicholson 2006:412). Measurements taken on carpal and tarsal bones as outlined by Morlan (1991) suggested further that the herd was comprised of both males and females. The numbers and measurements from the carpals and tarsals can be found in Playford's (2001) thesis, and the data indicates that animals from both nursery and bull herds were being sought out and killed.

The Bradshaw site, a third site known to date to the Late Precontact Period on the edge of the Lauder sandhills (Figure 8.1) has also been analyzed for the purpose of defining subsistence activities in this region (Nicholson and Hamilton 2001:63). This site is suggested as being a summer occupation based upon the recovery of a small number of beaver remains and duck-sized bones, although no analysis seems to have occurred on bison eruption and wear patterns, foetal bone, or defining herd structure. Essentially, the argument made for the determination of seasonality is based upon the assumption that open water would have been needed for the procurement of both the beaver and duck-sized birds. Nicholson and Hamilton (2001) further suggest that vegetal resources were likely utilized at this site, although no discussion is given as to the recovery or analysis of such paleobotanical remains. It is difficult to ascertain the exact numbers and types of species utilized at this site and whether or not the faunal

assemblage is dominated primarily by bison remains. Further examination of the faunal remains is needed to determine the extent to which this site displays similar or different trends with regards to other sites located in sandhill environments that have been categorized as settlement or bison procurement sites in the Late Precontact.

Moose Woods Sandhills

The Hartley site (FaNp-19), located within the Moose Wood Sandhills (Figure 8.1) has received a considerable amount of attention over the years at the University of Saskatchewan (for examples see Clarke 1995; Farrow 2004; Meyer 1989; 1995). The section identified as the Brushy Depression was classified as a camp and processing site based on the recovery of faunal remains, lithic debris, potsherds, and the presence of several features including two large hearths. Seasonality based on mandibular tooth eruption and mandibular wear patterns revealed that this site was a late fall/early winter occupation as measurements indicated increments of X.6 years, or roughly the month of December. Metric and non-metric analyses of foetal elements suggested that the site was occupied for a longer period of time, roughly from December to late March (Clarke 1995:55). A minimum of 28 individuals were represented in the bison remains recovered from the excavations in the Brushy Depression. It was also determined that 97% of the faunal remains were of *Bison bison* (Clarke 1995:32). This is in contrast to the bison faunal assemblage recovered from the Wooded Hollow that had a minimum of 17 individuals and was proven as being occupied from late spring to early fall (chapter five this thesis).

At least 22 non-bison taxa were identified in the faunal assemblage from the Brushy Depression. Interestingly, this part of the site differed from the Wooded Hollow in terms of species identified. At least one wolf and one coyote were recovered from the collection. Bones of a variety of species of fox, one badger, various rabbits, at least two beavers, various rodents and a number of birds were identified (Clarke 1995). It is interesting to note that two species of fish were recovered from the Brushy Depression including the Northern Pike and an unspecified freshwater fish (Class Osteichthyes), although they only represent a minimum of two individuals (Clarke 1995:33).

The Bill Richards site is located in the immediate vicinity of the Hartley site, further to the north on Preston Avenue on the periphery of the Moose Woods Sandhills (Figure 8.1). Several sessions of excavation and survey have occurred at this site. Enns-Kavanagh and Whatley (2005:1.4) determined that faunal remains and artifacts recovered over the years demonstrated that the site likely represented a Late Precontact processing site of predominantly Mortlach affiliation. These previous studies demonstrated that a minimum number of three bison individuals had been processed at this site, and in addition, the faunal remains had been highly processed and the majority were either burned or calcined. The most recent excavations demonstrated that the faunal assemblage was dominated by bison or other unidentifiable ungulates. The Bill Richards site was found to have multiple occupation events and ranges of 73%, 88% and 89% of the faunal remains recovered were represented by *Bison bison*. Canid remains, rodent remains, and avian elements were also recovered, it is not specified as to whether the rodent remains are indeed cultural (Enns-Kavanagh and Whatley 2005:3.27). Minimum numbers of individuals in each of the occupation layers ranged from one to three.

Enns-Kavanagh and Whatley (2005:4.3) suggest that the faunal, lithic, and ceramic remains also indicated that this site was utilized as a processing site. The distance of the site area to a reliable water source (the South Saskatchewan River) seemed to suggest that the site was once utilized by small groups of hunter-gatherers who were taking advantage of the water in seasonal sloughs during the early spring as they hunted small numbers of bison. No mention is made as to the identification of any foetal remains, implying that they were not recovered. It is not clear as to why a seasonality of winter to spring was suggested in this report as there was no analysis on mandibular eruption or wear patterns (likely due to the small sample size of the faunal assemblage). In addition, recovered rodent remains were identified as *Spermophilus richardsonii*, however, no mention is made of the hibernation patterns of this species or as to whether this was the primary reason of the assignment of a spring occupation. It is the opinion of the author, therefore, that analysis of seasonality is incomplete and only tentative.

The Fitzgerald site (ElNp-8) is located on the edge of the same dune complex as the Hartley site (the Moose Wood Sandhills) and has shed light on the subsistence system employed by Besant hunter-gatherers (Figure 8.1). The Fitzgerald site was identified as a bison kill and processing site based on the faunal remains recovered from over 73 square metres of cultural deposits (Hjermstad 1996:46). A minimum of 49 individuals were represented and, if correlated against the estimated size of the complete kill area, Hjermstad (1996:122) suggested that there may have been upwards of 800 animals slaughtered in the communal hunting operations. Seasonality was determined through mandibular eruption and wear, and categories between X.5 and X.7 year increments were determined, meaning that the bison were procured between late October and early December, assuming a peak calving period in early May (Hjermstad 1996:145-146). Unfortunately, there was no mention or analysis of faunal remains identified as non-bison taxa from the Fitzgerald site. It is therefore assumed that all faunal remains recovered from this site belonged to *Bison bison*. Obviously, a kill and primary processing site would be less likely to have a very diverse faunal assemblage. The Fitzgerald site, however, does prove that in the Late Precontact, bison procurement was an extremely important subsistence activity and one that was not limited to the winter months.

Dunfermline Sandhills

The Tschetter site (FbNr-1), located on the edge of the Dunfermline sandhills, is one of the longest-known Late Precontact bison kill sites in the Saskatoon region (Figure 8.1). A detailed analysis of the faunal remains recovered from this site was performed by Walker (1979) and included inferences of seasonality as well as a complete list of species present in the assemblage. In terms of seasonality, Walker (1979) attempted to define age groups by mandibular eruption and wear. Based on the analysis of the tooth eruption patterns, 13 immature mandibular dentitions and the tooth wear patterns of 27 mature specimens, Walker (1979:52-53) was able to distinguish discrete groupings of X.6 and X.7 increments. This fluctuation, or variation, of the age groupings suggested that the Tschetter site represented a continuous procurement event, or events, that

occurred between early November and late January. Interestingly, no foetal remains were recovered from this site (Dr. Ernie Walker, personal communication 2007).

In terms of species utilized at the Tschetter site, it was determined that 99% of the assemblage represented the remains of *Bison bison* (Walker 1979:51). The non-bison faunal remains were recovered and identified to the most specific taxonomic level possible. Non-bison fauna that were identified included dog, wolf, unidentified canid, two mustelids, one rabbit, and an unidentifiable bird. A ground squirrel was identified, however, it was not considered to be part of the cultural assemblage. It was noted that the presence of the mustelids was unconventional as these species begin to hibernate at the onset of cold weather in late October or November (Walker 1979:55).

The Rousell site, also located in the Dunfermline sandhills, was originally identified in the summer of 1969 and test excavations were carried out in 1971. Two Oxbow projectile points were found on the grid road that intersected the site, however, further test excavations produced four Avonlea projectile points (Dyck 1972:7). The faunal remains from this site consist of only bison and a minimum number of three individuals were identified based on the presence of vertebral elements (Dyck 1972:5). No mention was made as to the presence of foetal bones or possibilities in terms of seasonality. The site was thought to be a kill and processing site, more specifically a pound or surround, from the faunal and lithic materials recovered. The presence of bone tools, such as flesher-like tools and pointed, polished splinters proved difficult in the interpretation of the site as they are often associated with hide-working activities. If, however, the site functioned as a kill and processing site, it is possible that they were a part of the butchering tool kit (Dyck 1972).

Douglas Park Sandhills

Two theses have recently been defended where the primary research goal was to identify and analyze certain aspects of the archaeological sites located within the Douglas Park sandhills (Evans 2006; Neal 2006). Evan's (2006) research project was geared towards a Geographic Information System (GIS) approach to investigate the relationship between archaeological site location and environmental elements on the Northern Plains landscape. It was found that a strong relationship existed between site

location in dune environments and these areas of diverse resources (Evans 2006:92). Neal (2006), however, was more concerned with two sites in particular, EgNn-9 and EgNo-23, and how these sites demonstrated similarities in subsistence strategies to other sites also in grassland and sandhill environments. Both of these sites are located on the periphery of the Douglas Park sandhills (Figure 8.1). Although both of these studies were not limited to sites dating to the Late Precontact period, EgNn-9 and EgNo-23 were both demonstrated as having Late Precontact components through the recovery of diagnostic projectile points (Neal 2006:ii). EgNn-9 was identified as a possible campsite based on the presence of the faunal remains, lithic debris, and the presence of various hearths including fire broken rock (FBR). Faunal remains dating to components in the Late Precontact period consisted of bison, both male, female and immature and unidentified artiodactyl. The majority of the specimens were broken and burned to such a degree that identification of element, class of elements, species or higher taxonomic classification was not possible (Neal 2006:64-68).

EgNo-23 was found to be the more extensive site, as a bison kill was unearthed upon top soil stripping of the proposed natural gas pipeline. Unfortunately, the materials dated to the McKean series, therefore, making an analysis of these materials inappropriate for this thesis (Webster 2004; Neal 2006). The faunal remains recovered from the upper levels of this site were dated to the Late Precontact period and included a large amount of unidentifiable bone, tooth and enamel fragments. The identifiable specimens consisted of a number of bison and unidentified artiodactyl bones. The Late Precontact components of EgNo-23 were thought to represent a campsite based on the presence of faunal remains, lithic debris including FBR, and features (Neal 2006:140). Unfortunately, the upper levels dating to the Late Precontact period at EgNn-9 and EgNo-23 did not provide enough faunal specimens for the determination of seasonality. Both sites were utilized repeatedly during the Middle and Late Precontact periods, demonstrating the importance of the Douglas Park Sandhills to the Plains adapted people hunter-gatherer groups. It seems as though bison was by far the most dominant species acquired for the purposes of subsistence. EgNn-9 was identified as a campsite, whereas EgNo-23 was identified as a bison kill and campsite.

The Melhagen site (EgNn-1) is also located on the edge of the Douglas Park Sandhills and fortunately, analyses were performed with the intention of determining seasonality and, to a certain degree, listing the non-bison species present (Figure 8.1). By analyzing tooth eruption and wear patterns, Ramsay (1991:169) determined that the site represented either a continuously used bison pound that extended from the fall of one year into the spring of the next, or that it could also possibly be representative of multiple kill events that occurred during different seasons of different years. The Melhagen site bison faunal remains suggest that the most intensive hunting occurred in the fall and several smaller kill events took place throughout the winter and into the spring. Interestingly, no foetal remains were recovered at this site, however, Ramsay (1991:164) attributes this to favourable selection and removal from the site as well as to taphonomic factors. The Melhagen site represents a large kill event as a minimum number of 173 individuals were recovered (Ramsay 1991:197). It was stated that these individuals represent much less than the original assemblage, as it was estimated that less than 25% of the site has been excavated (Ramsay 1991:2).

Unfortunately, the analysis of the non-bison taxa recovered from the Melhagen site is not very detailed and data pertaining to these other species is limited to mere mention as quantitative units are not discussed. The following species were identified in the assemblage: mule deer, unidentified mustelid, falcon, domestic dog, and at least three swift foxes (Ramsay 1991:208-215). In addition, much of the original assemblage that was excavated by the Saskatoon Archaeological Society prior to Ramsay's involvement was destroyed as a result of water damage due to flooding of improper storage facilities. It is likely that the faunal assemblage may have been more diverse in terms of overall species identified had the whole collection survived (Ramsay 1991).

In an attempt to recover paleobotanical remains from a variety of soil samples, Ramsay (1991) performed a detailed flotation study. Although a variety of seeds, shells and charcoal were recovered, some faunal remains were also obtained. Unfortunately, the samples of faunal material that were identified in the Melhagen flotation sample were extremely small fragmented pieces that were "generally unidentifiable" (Ramsay 1991:23). It would be interesting to compare the results of the paleobotanical remains recovered from this site to other sites dating to the Late Precontact Period in sandhill

environments to determine the extent to which vegetation contributed to subsistence. This type of analysis goes beyond the scope of this thesis.

Nebraska Sandhills

The McIntosh site, a Central Plains tradition settlement located near Enders Lake in the Nebraska sandhills has also proven to be useful in the study of bison procurement and seasonality in these types of environments. As the Central Plains tradition dates to ca. A.D. 1300-1450, it falls within the Late Precontact period on the Northern Plains. The McIntosh site itself is located on a gently sloping sand dune face along the southeast shore of Enders Lake in the north-central Sandhill region of Nebraska (Koch 1995:39-40). It is noted that the position of the McIntosh site relative to the lake renders this site somewhat distinctive when compared to the other archaeological sites in sandhill environments. This is in particular reference to distribution relative to permanent water sources and therefore aquatic resources. Based on the faunal remains recovered from this site, it was determined that the site was likely occupied from the spring to the fall. This assessment was based on select small mammal, bird and fish remains and their known hibernation and migration schedules. In particular, fish vertebrae were analyzed for their “annuli”. Annuli appear as dark, narrow, translucent bands alternating with broad, white opaque bands. It is known that the darker bands represent periods of arrested or slowed growth during the cooler seasons, while the wider lighter-coloured bands represent rapid periods of growth during the warm season (Koch 1995:49). The season during which the fish died can therefore be estimated through an analysis of these annuli.

In terms of overall species diversity at the McIntosh site, mammals were particularly low in abundance. Fish represented the largest percentage in terms of minimum numbers of individuals in the assemblage, followed by birds and small mammals. Interestingly, reptiles, amphibians and bison represented relatively few of the total number of individuals recovered (Koch 1995:43-44). It is essential to note, however, that even though there were many more fish consumed at this site, the mammalian fauna were still estimated to have contributed the largest proportion of available meat, specifically the meat that would have been available from the bison, deer

and antelope (Koch 1995:46). Other species of interest recovered at this site include various rabbits, squirrels, foxes, mustelids, and birds. No canid remains were recovered. It seems at this site that the secondary sources were much more important in the overall subsistence system employed by the hunter-gatherers who inhabited the area. It is hypothesized that this difference exists because of the lake that is immediately adjacent to the site.

Great Sandhills and Harris Sandhills

Various studies performed in sandhill environments were geared towards the location and classification of archaeological sites within these regions. Examples of such research include the studies by Epp (1986) and Epp and Johnson (1980) of archaeological site distribution in both the Harris Sandhills and Great Sandhills of Saskatchewan (Figure 8.1). In both of these studies, the research design was focused on the identification of sites in the sandhill region in relation to the greater grassland environment. Less attention was paid to indicators of seasonality or the diversity of the faunal assemblages at the larger kill and campsites. In both cases, however, Epp (1983; 1986) and Epp and Johnson (1980) indicated that campsites and bison procurement (kill) sites were present. It is noted in both studies that settlement within the sandhill environments is related to the easily accessible plant and animal resources of both the grassland and sandhill environments (Epp 1986; Epp and Johnson 1980).

In a land management study of the Great Sandhills, a total of 58 sites were located, all of which date to Precontact times. Unfortunately, not all sites were dated to a particular time period during the Precontact era, although recovered diagnostics suggest that most sites contained components dating to the Late Precontact. Of these 58 sites, 45 were identified as habitation sites and 13 were identified as hunting losses (Epp 1983:191-192). In terms of site location, Epp (1983:192) discovered that three distinct peripheral site concentrations could be identified, with very few sites more than 7 km from the sandhill boundary. These concentrations were divided into two separate geographical locations; those in the northern extremities and those in the southern extremities. It was noted that those sites in the northern extremities were located within 50 km of the South Saskatchewan River, a distance that likely could have been travelled

in two days. It was suggested that the cluster of sites in the north were likely utilized by Plains adapted peoples hunter-gatherer that may have had kinship ties with other populations south of the South Saskatchewan River. The explanation for the southern cluster of sites was linked to the two major water bodies in the region: Crane Lake and Big Stick Lake (Epp and Johnson 1980:129). The archaeological site concentrations are attributed to the availability and high variety of plant and animal life associated with the ecotone, or ecological interface between the prairie and sandhill environments in addition to the close permanent water supplies. It is suggested that settlement of these areas was linked to maximized short-term resource availability and long-term resource stability thereby minimizing energy expenditure during resource acquisition (Epp and Johnson 1980).

Although a pattern does emerge that links settlement in these regions to available resources, Epp and Johnson's (1980) focus was to simply survey and identify sites in Great Sandhills. Therefore, as no excavations were carried out, no artifacts were recovered which could be used to identify seasonality. If there were indeed links to resource availability and variety, one would expect to see a number of different species being utilized for subsistence. Seasonality was suggested on the basis of likelihood of resource procurement as bison and antelope were likely most abundant in these regions during the winter. By simply using deductive reasoning, it is suggested in this study that these sites were occupied during the colder months (Epp and Johnson 1980).

Similar to the situation in the Great Sandhills, a total of 43 sites were recorded in the Harris Sandhills, 36 of which had culturally diagnostic materials. 35 of the sites were identified as probable habitation sites, six were identified as hunting losses and two sites were classified as kill sites. Interestingly, all but seven of these sites were located in the northwest periphery of the sandhills, leading one to believe that settlement may also have been based on resource availability and variety (Epp 1983). This is in opposition to the rougher and more heavily forested southern and eastern parts of the dune complex, where virtually no sites were found. The Harris Sandhills present a situation in which sites tend to be concentrated in areas of sheltered but low dunes and ridges between two major water sources, Eagle Creek on the northwest side and Crystal Beach Lake on the southeast side. Settlement in the northwestern areas of the sandhills

is attributed to the high variety of resources such as wood, berries and other vegetal resources, ready access to a stream and lake and associated waterfowl, as well as access to the nearby grasslands where bison would have been present for procurement. Lack of sites found in the south and eastern parts of the sandhill region is attributed to the more rugged and forested habitats, which Epp (1983:194) suggests was less ideal for habitation. Seasonality is not suggested at any of the sites in the study of the Harris Sandhills.

In the case of both the Great Sandhills and Harris Sandhills, a detailed faunal and paleobotanical analysis could not be performed as these studies were geared towards identification of site location. Epp (1983) and Epp and Johnson (1980) do make valid arguments for the variety, stability and procurement of resources in both these regions, and it is suggested that the topography and ecology in both of these regions has changed little from the Late Precontact to today (Epp 1983:188). It is the opinion of the author, however, that without any information on faunal or paleobotanical resource procurement, settlement strategies based on resource procurement cannot be inferred, nor can any argument be made in terms of season of use.

Manitou Sandhills

A similar situation occurred in the Manitou Sandhills where various archaeological resources were identified for the purposes of the development of a resource management plan (Manitou Sandhills Integrated Resource Management Plan 1996:4). Although no specific archaeological surveys were performed in order to identify potential conflicts with development, 37 known archaeological sites had previously been recorded in the area. In addition, none of the sites were cited as dating to certain time periods during Precontact or Historic times. A search of the provincial Heritage Branch site inventory database would certainly provide more detail on the numbers and types of archaeological sites found within this region, however, such a search goes beyond the scope of this thesis.

8.4.4 Implications for the Hartley site

An examination of a number of sites from various sandhill environments on the Northern Plains has revealed that these areas were being sought out at all times of the year for purposes of habitation and large scale bison procurement. Reasoning behind these settlement patterns has been linked to the ‘edge effect’ proposed by Epp (1984) and the ‘ecological island’ phenomenon outlined by Hamilton and Nicholson (1999). While it might be true that there is an abundance and variety of faunal and botanical resources in these regions, an analysis of the faunal remains of archaeological sites in dune environments in the Late Precontact Period suggests that the hunter-gatherer groups were not utilizing or searching out animals except bison. Also, there does not seem to even be a difference in faunal resource procurement relating to the season of use.

Playford and Nicholson (2006:418) hypothesized that different resources would have been utilized in the winter and summer months, thereby leaving a “seasonally specific signature”. This does not seem to be the case, as the sites explored in the section above are similar to the Hartley site with respect to seasonal diversity, or lack thereof, in the faunal assemblage. It is noted that, with the exception of the McIntosh site in which a number of species of fish were procured, there was a heavy reliance on bison, regardless of the season of use. Table 8.1 represents specific species or classes of animals that were noted in the faunal assemblages of the various sites discussed above. It is noted that the majority of the animals listed in this table are thought to be seasonal indicators, although one can see that foetal bone is not always present in winter or spring sites, and fish, mustelids, and birds are not common in spring and fall sites.

The mammalian remains identified at the Jackson and Vera sites are remarkably similar to those recovered from the Hartley site in terms of the heavy processing of bison remains, and in addition, the lack of fish remains (Table 8.1). Although Clarke (1995) recovered some fish remains in the Brushy Depression region of the Hartley site, no fish remains were recovered in the Wooded Hollow. Fish, however, could be avoided due to the negative effects of lipid malabsorption, although this is unlikely as the probable season of use was late spring to early fall.

Table 8.1 Typical faunal resources recovered at the above-mentioned sites

Site	Time	Type*	B*	Ftl	C	R	Fx	Sq	Br	Av	D	Gr	F	M
Hartley (BD)	Winter/Spring	C	√	√	√	√	√	√	√	√	√	√	√	√
Hartley (WH)	Spring to Fall	K/P	√		√	√	√	√		√	√	√		
Jackson	Winter/Spring	K/P	√	√	√	√	√	√	√	√		√		
Vera	Spring/Summer	P	√	√	√	√	√	√	√	√		√	√	
Bradshaw Bill	Summer	C	√						√	√	√			
Richard's	?	P	√		√		√	√						
Fitzgerald	Fall	K/P	√											
EgNn-9	?	C	√											
EgNp-23	?	C	√											
Tschetter	Fall to Winter	K/P	√		√	√	√			√				√
Rousell	?	K/P	√											
Melhagen	Fall to Spring	K/P	√		√		√			√				√
McIntosh	Summer	C	√			√	√	√		√	√	√	√	√
Great Sandhills	?	K/C	√											
Harris Sandhills	?	K/C	√											

*Abbreviations found on page xiii, this thesis.

Lipid malabsorption occurs when a prolonged diet of lean red meat is quickly replaced by fish and the body is unable to absorb the fatty acids (Malainey et al. 2001:141). This type of illness can simply be avoided by consuming foetal and newborn specimens belonging to large game animals, and, if present, stored carbohydrate-rich foods throughout the year.

The Fitzgerald site, the Tschetter site, the Rousell site, the Bill Richards site, and the Bradshaw site also yielded faunal assemblages that were dominated by bison, although it is noted that only test excavations occurred at the Rousell site, thereby limiting the available data on recovered faunal remains (Table 8.1). Determination of seasonality at these sites ranged from winter, spring, summer and fall, and in none of these cases does a broad spectrum food procurement strategy seem apparent. It is, however, imperative to keep in mind that these analyses were geared towards a comparative analysis of the faunal remains recovered at archaeological sites in dune

environments in the Late Precontact period, and the role of plant foods was largely ignored. It is noted, however, that fine screen procedures were employed during the excavations of the Brushy Depression. The use of fine screen or flotation devices to recover paleobotanical remains would definitely broaden the scope of resource procurement in the Late Precontact Period in sandhill environments.

Regardless of the vegetal contribution to the diet of the hunter-gatherer occupants bison seems to be the primary food resource in the majority of the sites discussed above. The question then becomes: Why is there such a reliance on bison resources even in sites located on the periphery of grasslands and sandhill environments in the Late Precontact Period? The answer may be as simple as that suggested by Playford and Nicholson (2006): bison were available and people in the Late Precontact had the technology and knowledge to sustain themselves almost exclusively on this preferred animal resource. The specific migratory behaviour exhibited by bison may remain uncertain, however, the evidence presented above suggests that these animals were utilized, almost exclusively on the Northern Plains during the Late Precontact Period in sandhill environments. Since these people had the knowledge and technology to procure bison, it may have been more efficient in terms of energy expenditure to procure bison on this scale rather than to constantly forage for plant foods and non-bison fauna.

8.4.5 Exploitation and Settlement of Sandhill Environments: A Combination of Factors?

The above-sections have been geared towards a number of factors that may have influenced the choice in settlement in, and utilization of, sandhill environments during the Late Precontact Period. A review of large scale bison procurement activities has demonstrated that the Hartley site, among all of the other sites discussed, was in an excellent location in terms of the topographic features and available ecological resources (wood) for pounding and surrounding bison. In addition, the campsite located in the Brushy Depression, was likely chosen because of the shelter and firewood provided by these wooded 'ecological islands' in the dune environment. Regardless of the diversity,

or lack thereof, in the faunal assemblages reviewed above, it is apparent that the Late Precontact Period inhabitants of the Northern Plains were occupying these environments for purposes of settlement and bison procurement.

It is critical to note that the use of sandhill environments for the purposes of habitation and large scale bison procurement is not even limited to the Late Precontact Period. As Neal (2006) noted, both EgNn-9 and EgNo-23 have earlier components dating to Pelican Lake and McKean times. In addition, work in the Dunfermline sandhills has proven that a variety of activity was also occurring in this area from the Middle Precontact to Late Precontact Periods. The Harder site, for example, is an Oxbow complex occupation, located in a shallow dune depression on the northern edge of the Dunfermline Sandhills (Dyck 1977:16). The dominant vegetation in the area consists of poplar and aspen trees, similar to those seen in the Moose Wood Sandhills. Faunal remains at this site were largely dominated by bison, however, the remains of moose, canid (including wolf and coyote), swift fox, white-tailed jack rabbit and marten were also identified. The bison remains represented a minimum of eight individuals, based on the first phalanges (Dyck 1977:39).

In the Dunfermline sandhills, the Carruthers site also contains occupations dating to the Middle Precontact Period. The Oxbow materials consisted of one broken and two complete projectile points which confirmed the presence of this Middle Precontact Period single occupational site.

Regardless of the diversity of faunal remains at the sites dating to either the Middle or Late Precontact Periods, it is obvious that sandhill environments were being sought out for the purposes of settlement and bison procurement. One must keep in mind that while bison availability may have been a major consideration in settlement location choice on the Northern Plains, it is also likely that a variety of other factors played a key role. As was outlined in the first section of this chapter, topographic features, availability of ecological resources such as wood, as well as the optimal settlement locations in terms of shelter, are likely the primary reasons there is such a concentration of sites in sandhill environments on the Northern Plains. The term 'ecological island' is therefore applicable in the sense that these areas offered shelter during the winter months, wood for fire and pound construction at all times of the year,

as well as the appropriate topographic features for pound execution. Although the faunal remains from several sites do not demonstrate a broad based subsistence strategy, settlement and bison procurement in these regions was nevertheless linked to these 'ecological islands'.

8.5 Summary

The archaeological record on the Northern Plains indicates that sandhill environments were being sought out in the Late Precontact, especially for settlement and bison procurement. A review of bison procurement strategies described in the ethnographic and historic literature has suggested that the Hartley site would have had the optimal topography and available ecological resources for the execution of either a bison pound or a bison surround, in addition to providing a well-sheltered area during the winter time. A review of the literature on the bison seasonal round, or migration behaviour, has indicated that some herds of bison remained on the northern grasslands throughout the year, thereby influencing the settlement and procurement strategies of the Plains adapted peoples.

The archaeological sites reviewed in the above-sections were found on well-drained, sandy soils adjacent to prairie potholes, or 'ecological islands' supported by high water tables. Some of the sites are located near major streams and/or lakes and others are located at some distance. Immediate vegetative cover seems to be dominated by aspen bluffs surrounded by nearby marshes. All sites are located on the peripheries of dune and grassland environments, in so-called 'ecotones' as originally described by Epp (1984). All sites, or regions, were reviewed for information pertaining to season of use and no trends emerged.

Although many of these sites are located near or within these 'ecological islands', or in ecotones between two adjacent environments it is obvious that resources would have been plentiful. Interestingly, there does not seem to be much utilization of various non-bison species to supplement the diet. Bison seems, to be the primary food animal greatly dominating any secondary resource. One must note, however, that faunal remains were not recovered from the Great Sandhills, Harris Sandhills and Manitou Sandhill, thereby limiting the type of conclusions made with regards to resource

procurement in these areas. Playford and Nicholson (2006) suggest that heavy emphasis on bison utilization is linked to knowledge of, available technology, and preference for this particular mammal. Migration also plays a key role in bison utilization in these environments. Although there is still a debate regarding the patterns of bison migration, it can be said on the basis of historical documentation and archaeological faunal analyses that at least some herds of bison were available on the northern grasslands during the winter months. Future research geared towards analysis of the settlement and exploitation of resources in sandhill environments should perhaps consider a comparison of paleobotanical remains in addition to the analysis of faunal remains recovered from these archaeological sites. Although a clear picture has been portrayed in terms of animal species utilized at these sites, the role of plant resources cannot be underestimated.

A review of a number of sites located in sandhill environments has indicated that the Plains adapted peoples were seeking out these environments for the purposes of bison procurement and habitation. Sites located in these environments also indicate that this phenomenon was not limited to the Late Precontact Period and these regions were obviously sought out throughout the Middle Precontact Period as well. It is likely that throughout Precontact times, the combination of migratory behaviour and availability of bison, the location of sites in ecotones between grassland and sandhill environments particularly in these 'ecological islands', in addition to the topographic and ecological resources (wood) available for bison procurement and shelter led the Plains adapted peoples to periodically settle in these regions.

Chapter Nine

Summary and Conclusions

9.1 Introduction

The Hartley site is a multicomponent kill, processing, and habitation site within the limits of the city of Saskatoon and analysis of the faunal remains from this site has yielded much information. Although many previous years of research have occurred at this site, conducted by avocational, consulting and academic parties, much additional knowledge has been gained through the analysis of the materials recovered from the Wooded Hollow section of the Hartley site. The faunal remains recovered from the Hartley site were analyzed in detail in chapters five, six, and seven of this thesis. The goals of the analysis were to create a complete list of taxonomic species for the purposes of determining the subsistence patterns, season of use, and taphonomic factors, both of a human and non-human nature, that may have had an effect on the assemblage. Lastly, the major goal of this thesis was to introduce and analyze the role played by sandhill environments with particular reference to activities related to large scale bison procurement and settlement, both of which have been documented on the Northern Plains during the Late Precontact Period.

9.2 Results of Faunal Analyses

The results of the basic faunal analyses demonstrated that bison was, by far, the most common species present in the assemblage. However, 23 other taxa were identified in the assemblage. It was also noted that the majority of the assemblage was unidentifiable in terms of both skeletal elements and species. Specimens that were not identifiable to any sort of taxonomic level were assigned to a size class if possible. Surprisingly, the minimum number of individuals (MNI) calculated by the identification of anatomical landmarks suggested that only 17 individuals were represented in the assemblage analyzed.

Although this number only represents a portion of the animals that were killed and/or processed in the area, it is not what one would expect at a large scale bison procurement and processing site.

Analyses of bison tooth eruption and wear schedules were not helpful in the determination of age groupings and therefore season of use. As only three partially complete mandibles were recovered, determination of seasonality was not possible by these means. The recovery of very few identifiable immature specimens also did not aid in this task, although one immature mandible and two identified bison bone specimens were aged by comparison to bison of known ages. These few specimens were extremely immature and were suggestive of a spring occupation. Interestingly, the lack of any foetal bone also prohibited the assignment of seasonality based on measurements for which the gestational stages of growth and development are known. Clarke's (1995) analysis of the faunal remains from the Brushy Depression, identified the presence of numerous foetal remains, suggesting that it was occupied during the winter and possibly spring seasons. It is suggested that the lack of foetal bone in the Wooded Hollow is not due to preservation factors, and rather that this region of the site was not used during the gestational months of the bison.

In an attempt to determine herd structure through various means of cluster and discriminant function analyses, it was demonstrated that almost equal numbers of males and female/immature individuals were represented at the site. Based on known studies of bison reproductive behaviour, the apparent herd structure suggests that the animals were procured during the rut, or the fall. The information pertaining to the one juvenile mandible, few specimens of immature individuals, and the herd structure suggest that the Wooded Hollow may have been used continuously from the spring into the fall months.

Non-bison species that were recovered from the Wooded Hollow also suggested that the site may have been occupied either in the spring or fall. The presence of migratory waterfowl, specifically the Lesser Yellowlegs (*Tringa flavipes*), in conjunction with the known hibernation patterns of certain rodents (*Spermophilus richardsonii* and *Spermophilus tridecemlineatus*) also suggest occupation either between April and mid-June or mid-July to late September. The

non-bison species identified in this chapter were not recovered in large numbers, evidence that the main animal resource exploited at this site was bison.

An analysis of the taphonomic processes and effects in terms of non-human agents and humans acting as agents revealed that the assemblage was affected mostly by human processes. Analysis of non-human agents and associated processes demonstrated that the assemblage was likely buried quite quickly after the site was vacated. Stages of weathering and deterioration are very low and exposure to carnivores does not seem to have played a large role in the overall state of the assemblage. Conversely, where humans were the acting agents, the breakage patterns clearly demonstrate that the inhabitants of this site were exploiting all resources related to bison that were available for consumption. Although few butchering marks were noted in the form of single cut marks, chop marks, or parallel striations, much of the assemblage is dominated by unidentifiable pieces of comminuted bone. As a result of the overall state of the assemblage, attention was paid to the archaeological visibility of processing for the purposes of marrow and grease extraction. The breakage patterns of the bones, specifically the overwhelming amount of comminuted bone fragments, suggest that both marrow extraction and grease processing activities were occurring at this site. Although no associated features in the form of boiling pits were found, it is likely that these activities were occurring in or adjacent to this part of the site. Sivertson's (1980) site type determination model was applied to the cultural remains recovered in the Wooded Hollow and confirmed that the overall state of the assemblage was characteristic of kill and processing activities. Associated bone tools suggest that various processing activities, including hide processing, were also occurring here.

9.3 The Role of Sandhill and Grassland Environments at the Hartley Site

One of the main goals of this thesis was to compare the location of the Hartley site and associated faunal assemblage to other sites found in similar environments on the Northern Plains. As it was determined that this site was likely used as a bison kill and processing site, a review of bison procurement methods, particularly with reference to pounding and surrounding was attempted. The review

of these methods demonstrated that a number of factors were essential to the execution and success of bison procurement. Available ecological resources such as wood, adequate topographic conditions, and seasonality all played a role in the success of these procurement strategies. In noting these conditions, it was discovered that the Hartley site, located in a sandhill environment with an abundance of wood, would have been conducive to a pound situation. Ethnohistoric accounts of bison pounding and surrounding events occurring in the fall and winter, although not necessarily limited to these months, correspond to the earlier conclusion that the Hartley site was used into the fall. In terms of location in a treed bluff, the Hartley site also nicely fits the model of either a pound or surround. If the region was indeed used as a pound, the slight drop in topography would have obscured the view of the incoming bison. It is also possible that the animals were procured in a surround type fashion where they were surprised by a 'human corral' while seeking either shelter or water.

Further review of the literature regarding availability of ecological resources on the Northern Plains suggested that the location of the Hartley site may have also been tied to the surrounding grassland environment. Epp's (1984) work on the availability of resources in 'ecotones' that exist between overlapping environments suggested that settlement location is tightly linked to these regions. It is suggested that these areas were conducive to settlement as they offered the most convenient locations in terms of proximity to the greatest variety and stability of resources. Hamilton and Nicholson (1999) support Epp's (1984) hypothesis, however, they coin the term 'ecological islands' for the regions in which there is a seasonally shifting resource base able to sustain a relatively large population within a fairly small area. Within sandhill environments, these 'ecological islands' are often found in the small depressed wetland regions supported by high water tables that are conducive to the habitat preferences of a diverse array of plant and animal species.

As archaeologists are becoming increasingly interested on the role of sandhill and grassland environments on the Northern Plains, it was deemed necessary to compare the results of the faunal analysis obtained from the Hartley site to other sites occupied during the Late Precontact Period in similar geographical settings. A

review of sites found in seven different sandhill environments across the Northern Plains suggested that the phenomenon of settlement and large scale bison procurement in these regions is not limited to Saskatchewan. Of the sites that were reviewed, it was noted that no trends emerged in terms of seasonality. Surprisingly, it was found that the faunal resource bases were not as varied as one would expect. In almost all of the sites, with the exception of the McIntosh site, there is a definite predominance in the use of bison as the primary animal resource. The reason behind this reliance is not yet understood, however, suggestions have been made ranging from knowledge and available technology to procure this resource to simple preference for this species.

The faunal assemblages analyzed at various sites in these dune environments did not demonstrate large amounts of variability in terms of species utilized and it is important to keep in mind that sandhill environments, particularly the edges, were being settled for the purposes of habitation and large scale bison procurement. As Epp (1984) originally suggested, choices in terms of settlement are not only linked to variety of resources, they are also linked to stability. As these 'ecological islands' are often found in areas with higher water tables, it is likely that they are more stable in terms of plant and animal life. The location of the Hartley site demonstrates that grassland resources (primarily bison) were being heavily exploited, however, the role of available ecological resources (wood) and the undulating topographic setting characteristic of the sandhill environments were also likely weighed when choosing to settle and exploit the resources within the region. It is therefore proposed that a combination of factors, primarily the availability of bison, wood, and topography conducive to bison procurement likely led to the occupation of this region and the use of the site as both a habitation and large scale bison kill and processing site.

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Appendix A
Bison Carpal, Tarsal and Phalange Measurements

Table A.1 Radial carpal measurements

Catalogue Number	Side	Width	Depth	Length	Sex
200302789	R	31	52	35	Male
200302606	R	23	42	30	F/Imm
200303155	R	21	41	31	F/Imm
200303154	R	25	42	32	F/Imm
200303153	R	30	50	33	Male
200303781	L	25	35	30	F/Imm
200303908	L	25	42	28	F/Imm
200304048	L	32	53	37	Male
200305179	L	27	41	29	F/Imm
200307011	L	22	42	31	F/Imm
200307097	L	30	50	33	Male
200307098	R	27	45	32	F/Imm
200307438	R	29	48	31	Male
200308941	R	31	51	38	Male
200309047	L	33	53	34	Male

Table A.2 Internal carpal measurements

Catalogue Number	Side	W	D	L	Sex
200301541	R	33	46	31	F/Imm
200301561	L	32	39	32	F/Imm
200302446	R	34	42	29	F/Imm
200303251	R	30	38	28	F/Imm
200303415	R	31	41	29	F/Imm
200307833	L	32	47	24	F/Imm
200309046	L	37	50	33	Male

Table A.3 Ulnar Carpal Measurements

Catalogue Number	Side	La	D	Lp	Sex
200301683	L	43	44	36	Male
200302614	R	37	43	42	Male
200303649	L	32	38	41	F/Imm
200304780	L	38	45	46	Male
200306011	R	37	43	44	Male
200306441	L	32	39	37	F/Imm
200306700	R	33	37	35	F/Imm
200307095	L	35	42	45	Male
200307100	L	30	31	40	F/Imm
200307437	R	30	32	37	F/Imm
200308856	L	35	43	45	Male

Table A.4 Fused Second and Third Carpal Measurements

Catalogue Number	Side	W	D	Sex
200301553	R	44	37	F/Imm
200302955	L	48	42	Male
200302351	R	42	35	F/Imm
200302435	R	48	41	Male
200302010	L	39	35	F/Imm
200302665	L	48	34	F/Imm
200302634	R	37	31	F/Imm
200304380	R	41	32	F/Imm
200305250	L	45	41	F/Imm
200308942	R	50	46	Male
200309049	L	48	45	Male

Table A.5 Unciform Carpal Measurements

Catalogue number	Side	L	W	D	L	Sex
200301322	L	30	33	35	30	Male
200302243	L	28	29	36	28	F/Imm
200302627	R	24	31	37	24	F/Imm
200303393	L	28	35	40	28	Male
200303613	R	24	28	29	24	F/Imm
200303906	R	27	29	37	27	F/Imm
200304047	L	28	31	37	28	F/Imm
200304131	L	31	38	40	31	Male
200304362	R	26	31	33	26	F/Imm
200304875	L	28	36	38	28	Male
200305264	L	27	29	31	27	F/Imm
200305412	R	28	35	38	28	Male
200305572	L	28	33	37	28	Male
200306871	R	27	33	37	27	Male
200307044	R	26	30	36	26	F/Imm
200307807	L	30	31	33	30	F/Imm
200308881	L	27	35	40	27	Male
200308943	R	28	35	40	28	Male
200309048	L	28	34	39	28	Male

Table A.6 Talus Measurements

Catalogue Number	Side	Dm	DI	Wp	Lm	Wd	LI	Sex
200303221	L	42*	41*	55	71	49	77	Male
200304972	L	36*	38*	51	68	47	71	F/Imm
200306438	R	45	42	57	75	56	79	Male
200306439	R	46	43	52	75	55	76	Male
200308076	R	46	45	57	73	53	75	Male

* Estimated measurements on weathered specimens

Table A.7 Calcaneus Measurements

Catalogue Number	Side	Lc	Lt	L	Wp	Wd	Dp	Wp	Dd	Sex
200302372	R	41	33	146	35	45	39	35	60	Male
200303909	R	58	32	151*	26*	45	42*	26	61	F/Imm
200305881	L	43	33	N/A	22*	56	38*	22	66	F/Imm
200306396	R	49	30	138	38	47	44	38	53*	Male
200306436	R	37	30	126*	24	43	34	24	55	Imm.
200306397	L	N/A	32	N/A	35.5	45	42	35.5	47.5	Male
200306399	L	N/A	35	N/A	38	47.8	46.5	38	54	Male
200306398	R	N/A	36	N/A	43.5	52.5	44	43.5	52	Male

* Estimated measurements on weathered specimens

Table A.8 Fused Central and Fourth Tarsal Measurements

Catalogue Number	Side	L	W	D	Sex
200302616	L	46	70	60	F/Imm
200302656	R	45	63	61	F/Imm
200303171	L	51	68	67	Male
200303394	R	48	64	66	Male
200304046	R	49	70	65	Male
200304470	R	51	67	68	Male
200304635	R	45	53	57	F/Imm
200305880	R	N/A	64	65	?
200306356	R	44	53	54	F/Imm
200307512	R	N/A	65	58	?
200308058	R	49	69	65	Male
200308089	R	50	67	65	Male
200308484	L	51	63	61	Male
200308882	L	45	60	60	F/Imm

Table A.9 Fused Second and Third Tarsal Measurements

Catalogue Number	Side	W	D	Sex
200302292	R	24	36	Male
200302321	R	23	35	F/Imm
200302363	L	30	43	Male
200302679	R	28	42	Male
200303268	L	22	39	F/Imm
200303946	R	25	35	F/Imm
200304488	L	30	44	Male
200306440	L	31	45	Male
200307564	R	24	39	F/Imm
200307882	R	24	36	F/Imm

Table A.10 Lateral Malleolus Measurements

Catalogue Number	Side	D	L	Sex
200302700	R	35	28	F/Imm
200301879	R	39	32	F/Imm
200302533	R	37	28	F/Imm
200303650	R	39	31	F/Imm
200303995	L	36	28	F/Imm
200304296	L	38	30	F/Imm
200306257	L	39	30	F/Imm
200307099	R	33	27	F/Imm
200307290	R	45	35	Male
200307950	L	32	22*	F/Imm

* Estimated measurements on weathered specimens

Table A.11 Phalange Measurements

Catalogue Number	Side	L	GL	DH
200302954	LLRM	67	69.5	38
200302472	LMRL	66.5	68	29
200303570	LLRM	68	69.5	34.5
200309017	LMRL	64	67.8	31.5
200306146	LLRM	69.5	72.5	30.5
200304273	LMRL	64	66.5	29
200308945	LLRM	65	69	30
200306614	LLRM	65.2	70	30.1
200308523	LMRL	66.9	67*	39
200304873	LMRL	65	71	34
200302365	LLRM	65.9	70	29.2
200306891	LLRM	61	65	28.9
200306993	LLRM	62.1	60*	25
200303417	LLRM	66	N/A	26

* Estimated measurements on weathered specimens