A Faunal Analysis
of the Jackson Site (DiMe-17) in Southwestern Manitoba

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Abstract

The Jackson site (DiMe-17) is a Late Precontact site located in the Lauder Sandhills of southwestern Manitoba. The majority of the site consists of a Vickers Focus bison kill and associated processing/refuse areas radiocarbon dated to 290±50, 300±70, and 410±60 BP. At the southwestern corner of the site, a small amount of Blackduck pottery was recovered below the Vickers Focus occupation.

Excavations occurred at the site between 1994 and 1997 and were completed by university archaeological field school students, paid crew members, and one volunteer. The site was excavated in an attempt to better understand the Vickers Focus presence in the Lauder Sandhills and to provide archaeological field school students with an opportunity to gain first hand knowledge of field excavation techniques.

A total of 194, 198 bone specimens were analyzed from the Vickers Focus occupation at the Jackson site. Element and species distribution patterns verified proposed activity areas, while an examination of bison mandible eruption and wear patterns in conjunction with foetal bison remains corroborate that the site was occupied during the winter months. The fragmented nature of the assemblage is a result of human butchery and subsequent processing of elements for marrow and grease. Non-cultural processes such as carnivore modification, weathering, rootlet etching, and trampling left visible traces on the assemblage but did not cause density-mediated destruction.

A comparison of the subsistence strategies employed by the Jackson and Sanderson site inhabitants did not provide sufficient information to confirm proposed contact between Vickers Focus and Mortlach groups. The Sanderson site is a multiple Mortlach occupation located on the Souris River in southeastern Saskatchewan. Inhabitants of both sites were reliant on bison, and both employed a smash and strip method of bison butchery. Intensive bison utilization was evident at both sites but the Jackson site inhabitants may have been under greater nutritional stress. The greatest difference between the two groups was visible in the method of meat storage. The Mortlach inhabitants at the Sanderson site used frozen meat caches while no such evidence for this exists at the Jackson site.

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Chapter 1

Introduction

1.1 Statement of Objectives

The Jackson site (DiMe-17) is a large Late Precontact site located in the Lauder Sandhills of southwestern Manitoba. It was initially discovered in 1993 by avocational archaeologists Doug Jackson and the late Ray Bradshaw when road construction unearthed pottery, lithics, and bone. The site was brought to the attention of Drs. Bev Nicholson and Scott Hamilton who were currently working in the area.

A total of 36 excavation units were excavated between 1994 and 1997 under the supervision of Drs. Nicholson and Hamilton. The first 11 one m^2 units were excavated during the 1994 Brandon University Field School. The following field season, an additional 14 one m^2 units were excavated as part of the 1995 Brandon University Field School. Also that summer, 9 one m^2 squares and a single one and a half m^2 unit were excavated by paid crew members. In 1996, two one m^2 units were excavated by paid crew members. Paid crew members excavated two more one m^2 units in 1997 and a single one m^2 unit was excavated that year by volunteer T.J. Hall.

An analysis of the pottery assemblage indicates that the majority of the site represents a single or multiple closely-spaced Vickers Focus occupation. At the southwest corner of the site, a small amount of Blackduck pottery was recovered below the Vickers Focus pottery.

Excavation of the site fulfilled a dual purpose. The artifact assemblage was collected and analyzed in order to explore the nature of the Vickers Focus occupation in southwestern Manitoba. The excavations also provided university archaeological field school students with an opportunity to gain first hand knowledge of proper excavation, recovery and cataloguing techniques.

A large faunal assemblage was amassed during the five years of excavation. It was suggested by Dr. Nicholson that the faunal remains from units excavated during the 1995 to 1997 field seasons would provide an excellent sample for a Master of Art's thesis topic. This assemblage was analyzed by the author in fulfillment of the Master of Art's requirements in the Anthropology and Archaeology Department at the University of Saskatchewan, Saskatoon.

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A primary goal of this thesis is to accurately identify the faunal resources exploited during the Vickers Focus occupation of the Jackson site. This is necessary to enable an interpretation of the subsistence strategies undertaken by the site's inhabitants. Verifying specific activity areas through faunal element distribution analysis is another main objective. Establishing the season of site occupation is considered vital in the attempts to understand past subsistence strategies. An analysis of bison mandibular tooth wear as well as immature and foetal bison elements provides sufficient evidence of site seasonality. A detailed analysis of the taphonomic processes affecting the faunal assemblage is undertaken to determine if the observed bison element frequencies were the result of human butchery and transport, or density-mediated destruction. This was necessary in order to ascertain the importance and degree of bison procurement practiced by Vickers Focus people. A comparison of the faunal assemblage to that recovered from the Sanderson site is executed in an effort to determine what, if any, subsistence strategy similarities existed between the Mortlach occupants of the Sanderson site, and the Vickers Focus people present at the Jackson site.

1.2 Chapter Summary

Chapter One is an introduction to the Jackson site faunal assemblage, including information regarding the site's discovery and excavation. Thesis objectives and a chapter summary are also presented.

Chapter Two describes the biophysical area of the site. Descriptions of current physiography, soils, climate, hydrology, flora and fauna are presented.

Chapter Three provides a concise summary of the Vickers Focus archaeological entity. Sites located in the south-central part of the province as well as later dated sites from southwestern Manitoba are described. The disappearance of Vickers Focus pottery from the archaeological record is discussed.

Methods of excavation, cataloguing, and analysis are explained in Chapter Four. The site's natural stratigraphy is illustrated in this chapter and a brief discussion regarding the terminology used during the analysis of the assemblage is presented.

Chapter Five is a presentation of the faunal assemblage by block. For each of the nine blocks analyzed, the total number of specimens and weight of the assemblage is presented. The number and weight of identified and unidentified specimens is listed, as are all the species identified for each block. A discussion of identified elements is given for each block. The distribution of various faunal elements is discussed and specific activity areas are delineated.

Chapter Six is a presentation and analysis of the Jackson site bison population. The sex structure of the herd is determined through carpal and tarsal measurements. Eruption and wear

of the Jackson site bison mandibular teeth are compared to published wear schedules to determine the age structure of the Jackson site bison. Immature bison elements are compared to known fusion rates to infer age. Foetal element frequency and distribution is presented by block and specific developmental stages are assigned to various foetal elements. The seasonality of site occupation is deduced through an analysis of the bison mandibular dentition and of the immature and foetal bison remains. A discussion regarding winter occupation of the Northern Plains and the theory of seasonal mass migration of bison is presented.

Chapter Seven is a detailed study of the taphonomic processes affecting the Jackson site faunal assemblage. The percent completeness of the bison assemblage is discerned. Bison utility indices and bone density values are examined to determine whether the highly fragmented nature of the site is due to cultural or natural agents. Non-cultural taphonomic traces are assigned to various non-cultural agents such as carnivores, weathering, trampling and rootlet growth. Cultural processes that have modified the assemblage are manifested in cut marks, percussion marks, bone breakage, and tool use.

Chapter Eight summarizes the subsistence strategies employed by the makers of Vickers Focus pottery at the Jackson site and the makers of Mortlach pottery at the Sanderson site. The subsistence strategies, butchering procedures, and meat storage practices of each are compared in an attempt to detect similarities between the two archaeological cultures.

A summary of the results is presented in Chapter Nine. Conclusions regarding the subsistence strategies employed by the makers of Vickers Focus pottery, seasonality of site occupation, taphonomic history of the faunal assemblage, and relationship between Mortlach and Vickers Focus butchering practices are presented.

Chapter 2
Biophysical Environment

2.1 Site Location

The Jackson site is located in the Lauder Sandhills, approximately 70 km southwest of Brandon, Manitoba (Figure 2.1). Numerous sites, including the Jackson site, have been discovered along the southwestern edge of these sandhills and this area has been named *Makotchi-Ded Dontipi*, a Dakota translation of the phrase, "a place where we live" (Nicholson and Hamilton 1999:11). The majority of the Jackson site is found in a wooded area directly west of the Maple Hill municipal road, about three km north of provincial highway 345. A small portion of the southeast corner of the site is situated east of the municipal road and a small portion was destroyed during road construction. The site is positioned on the boundary between two sections, and the legal land description is the west half of Section 28 and the east half of Section 29, Township 5, Range 25, west of the prime meridian.

2.2 Physiography

The Jackson site is found in the Saskatchewan Plains physiographic region that ranges from south-central Saskatchewan to south-central Manitoba and extends northwestwards into central Saskatchewan (Corkery 1996:21). It is an area of vast gentle relief, usually due to ground moraine cover (Richards 1969:41). Manitoba is divided into four discrete physiographic regions with the Jackson site encountered in the Southwest Uplands (Figure 2.1). Upland regions such as the Porcupine Hills, Duck Mountain, Riding Mountain and Pembina Mountain, which form part of the Manitoba Escarpment, characterize the region. The uplands are interspersed with preglacial broad valleys and the entire area is underlain by Upper Cretaceous shale of the Riding Mountain Formation (Corkery 1996:21,13). The Southwest Uplands are further divided into 12 physiographic regions with the Souris Plain covering Manitoba's southwest corner (Figure 2.2). The Souris Plains consist mostly of flat to undulating relief, although dune areas tend to be rolling to hilly (Weir 1960:06).

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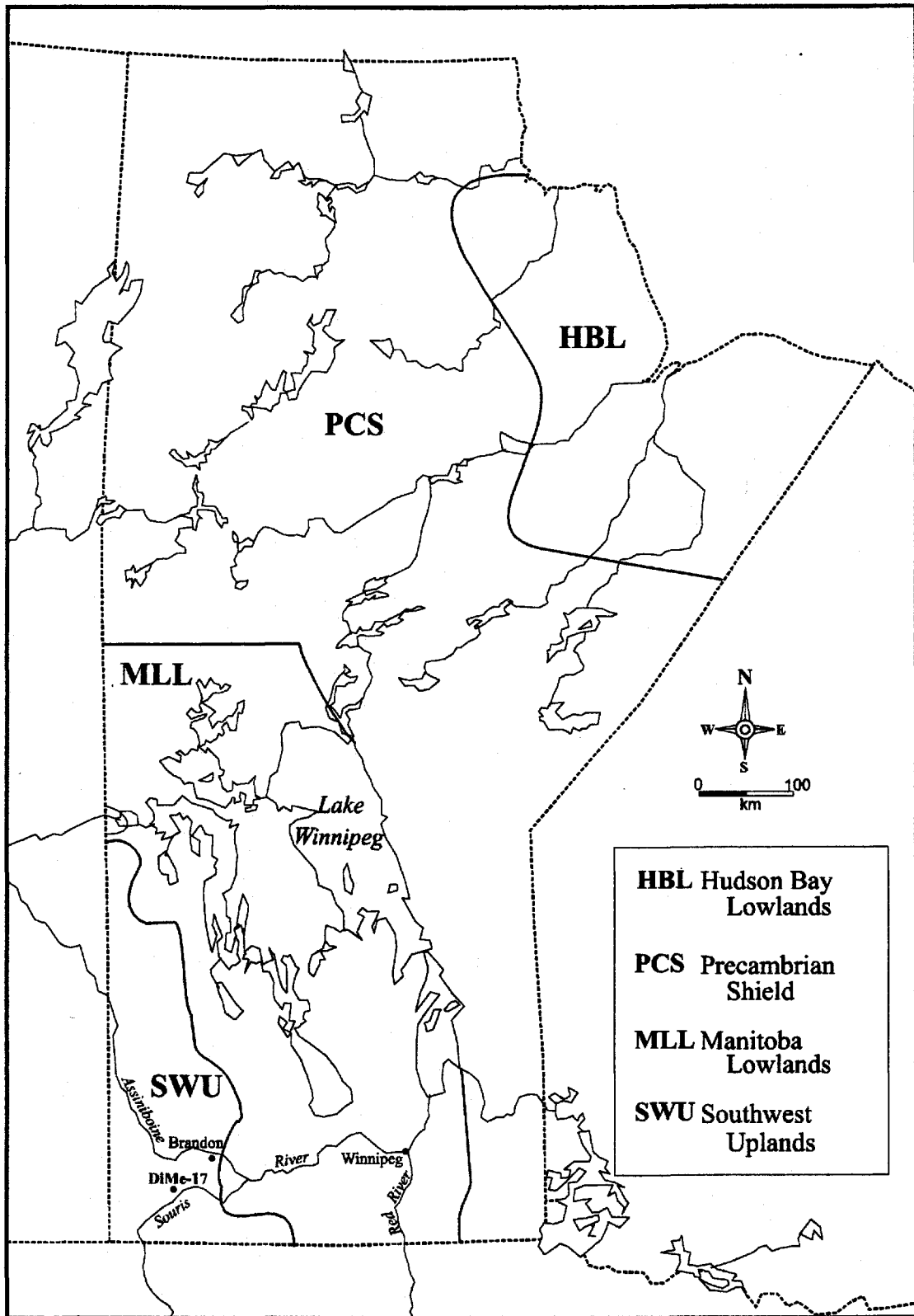
Figure 2.1 Physiographic regions of Manitoba (after Corkery 1996).

Precambrian Shield
1A Precambrian Shield

Manitoba Lowlands
2A Interlake-Westlake Plain
2B Red River Plain
2C Lower Assiniboine Delta
2D Southcast Section

────── Manitoba
Escarpment

Southwest Uplands
3A Porcupine Hills
3B Swan River Plain
3C Duck Mountain
3D Valley River Plain
3E Riding Mountain
3F Minnedosa-Reston Till Plain
3G Upper Assiniboine Delta
3H Souris Plain
3I Tiger Hills
3J Pembina Mountain
3K Boissevain Till Plain
3L Turtle Mountain

Figure 2.2 Physiographic regions of southwestern Manitoba (after Corkery 1996).

The Lauder Sandhills are part of the dunes and wetland sub-area of the Souris Plain (Ellis and Shafer 1940:14). This local area constitutes a unique landform comprised of lacustrine sand and silt deposited by Glacial Lake Hind about 12,000 years ago (Sun and Teller 1997:11). Groundwater accumulations in the underlying Oak Lake Aquifer rose and created small lakes and sloughs in low-lying regions. These lakes and sloughs then became surrounded by vegetation. Prevailing winds eroded and transported sediment until they encountered these wetlands and dropped their sediment load, forming sand dunes along the windward sides of the wetlands (Hamilton and Nicholson 1999:09). "The resultant landscape

consists of stabilized sand dunes interspersed with wetlands of various sizes." (Hamilton and Nicholson 1999:09).

Although found in the sandhills, the Jackson site is not characterized by dramatic local relief. Instead, the area is composed of gently undulating topography formed by a series of shallow hollows and localized knolls. The southern edge of the site is flanked by a winding stabilized sand dune while the northern edge is just south of relatively open prairie (Hamilton and Nicholson 1999:16-20).

2.3 Soils

The sandhills are covered with well drained Souris sand to loamy sand. Soils are coarse black chernozems and gleysolic to humic gleysols (Weir 1960:13). Nutrient and humus rich topsoils are standard because of the limited bleaching potential of the subhumid prairie climate and humification of fibrous rooting system (Scott 1996:46). Prior to agriculture, the region was well adapted to a stressful climate of droughts, fires, strong winds and herds of grazing and soil compacting plains bison. There was a rapid nutrient recycling with very little litter buildup because of the palatability of the herbaceous cover and a huge soil biota (Scott 1996:36).

2.4 Climate

Manitoba is a province with a continental climate as indicated by temperature and precipitation regimes. The warmest month is July, with a mean daily maximum temperature of 26°C in the southwestern corner of the province. Minimum temperatures for this month are about 12 to 13°C lower than the daily maximum. January is usually the coldest month with daily maximum temperatures averaging about -12°C in the south. The normal minimum temperature for this time of year ranges between -22°C and -33°C. On average, there are about 250 days per year when the maximum temperature rises above freezing in the southern part of the province, and 115 to 125 frost-free days per year (Blair 1996:34-35).

There is an extreme variation in precipitation both across the province and seasonally. The south and west part of the province receives about 600 mm of precipitation per year, with two thirds falling between May and September and snow accounting for up to 25% in the southern part of the province (Blair 1996:35, 53).

2.5 Hydrology

Currently the Souris River, located about four kilometres southeast of the Jackson site is the closest water source. Field notes written during the late nineteenth century Canadian Dominion Land Survey indicate the presence of a lake about two kilometres east of the site.

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These water sources are still quite distant from the site area and water may have been more accessible to the site's inhabitants than it is today. Hamilton and Nicholson (1999) theorize that during the Jackson site occupation, the Lauder Sandhills region was characterized by the co-occurrence of stabilized sand dunes and associated wetlands. As previously mentioned, ground water accumulation within in the Oak Lake Aquifer created small lakes and sloughs in low-lying areas. These wetlands have since disappeared due to a declining ground water level caused by the suppression of prairie fires, modern farming practices, and the development of aspen-oak forest on uncultivated land. As late as 1969, the wetlands continued to support mesic vegetation such as willow and river birch. However, the construction of a drainage canal from the Maple Lakes to the Souris River changed the local drainage patterns and lowered the ground water levels. Very quickly the aquatic vegetation died as did the riparian vegetation. "The dried potholes and surrounding willow thickets were quickly colonized by aspen and are now completely overgrown." (Hamilton and Nicholson 1999:14). By mapping local relief in conjunction with the distribution of dead willow thickets, Hamilton and Nicholson (1999) were able to estimate the distribution of former wetlands for several archaeological sites in the Lauder Sandhills.

Several such dead willow thickets found in localized hollows at the Jackson site likely indicate areas of former standing water. Hamilton and Nicholson (1999:17) created a digital elevation model for the Jackson site based on 25 cm contours and the distribution of dead willow thickets were plotted and considered to represent former wetland margins. The densest dead willow distribution formed a partial ring around a low meadow south of the site. "These dead willows were used to identify and constrain zones that might be former wetlands. All elevations below 435.75 m Above Sea Level (ASL) were treated as former wetlands, and land up to 25 cm above this level was reclassified as the aquatic vegetation fringe surrounding the wetlands. " (Hamilton and Nicholson 1999:17). The resulting landscape suggested a series of closely spaced small wetlands interspersed with woody vegetation.

2.6 Flora

Southwestern Manitoba is part of the Transitional Grassland Ecoclimatic Region (Figure 2.3). This is an area where sufficiently large moisture deficits favour herbaceous rather than woody species. Exceptions occur in areas of abundant ground water such as treed pothole/lake fringes and riverine gallery forests. The Transitional Grassland is further divided into natural vegetation zones and the Jackson site is presently found at the northern boundary of the mixed-grass prairie zone (Figure 2.4).

Map labels:

LA

HS

LS

HBs

Lake
Winnipeg

MBs

MBs

MBs

MBs

LBs

LBst

Gt

Winnipeg

Assiniboine

River

Souris

Red

N
W E
S

0   100
      km

Arctic
LA Low Arctic

Subarctic
HS High Subarctic
LS Low Subarctic

Boreal
HBs Subhumid High Boreal
MBs Subhumid Mid-Boreal
LBs Subhumid Low Boreal
LBst Subhumid Transitional
        Low Boreal

Grassland
Gt Transitional Grassland
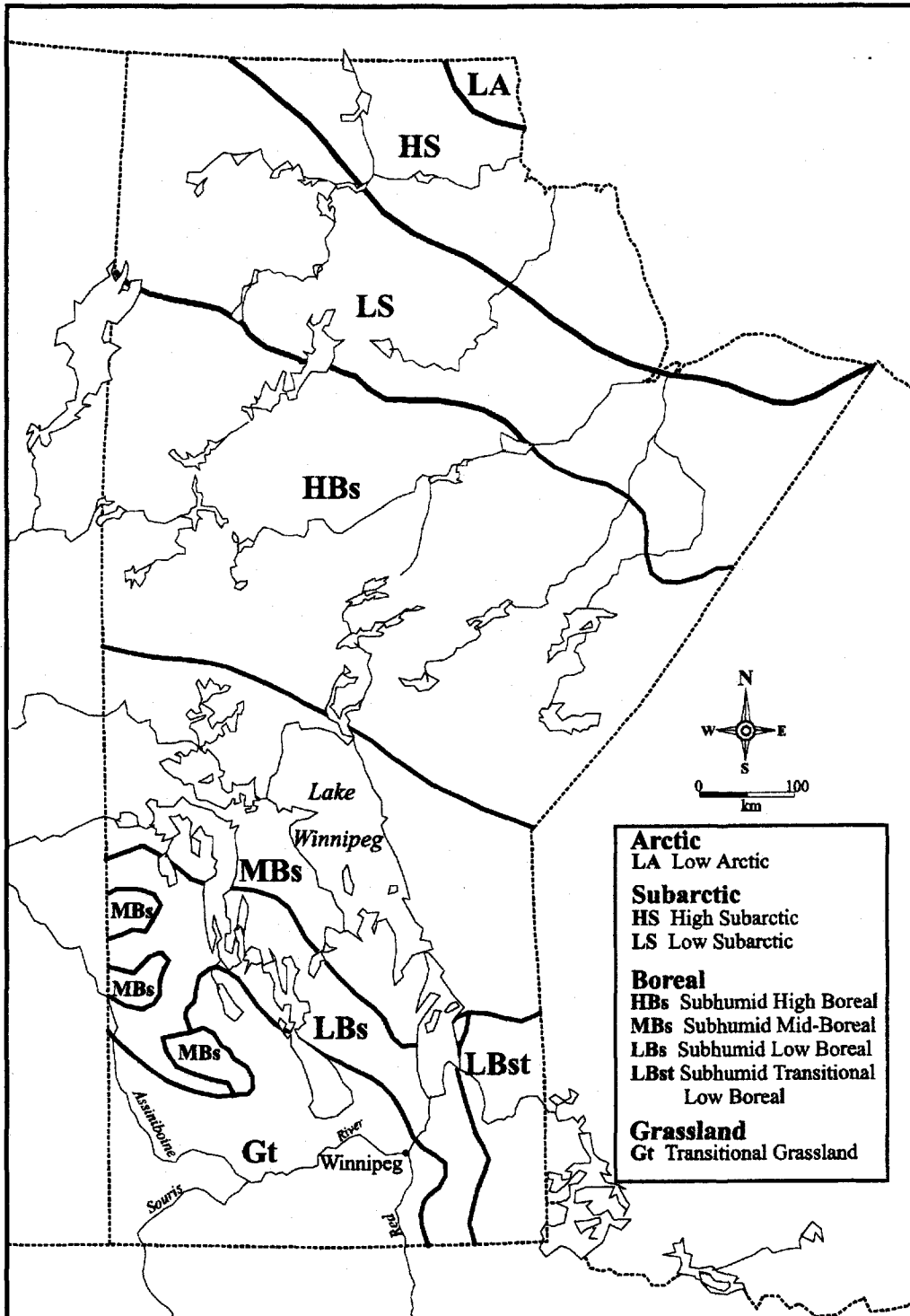
Figure 2.3 Ecoclimate regions of Manitoba (after Scott 1996).
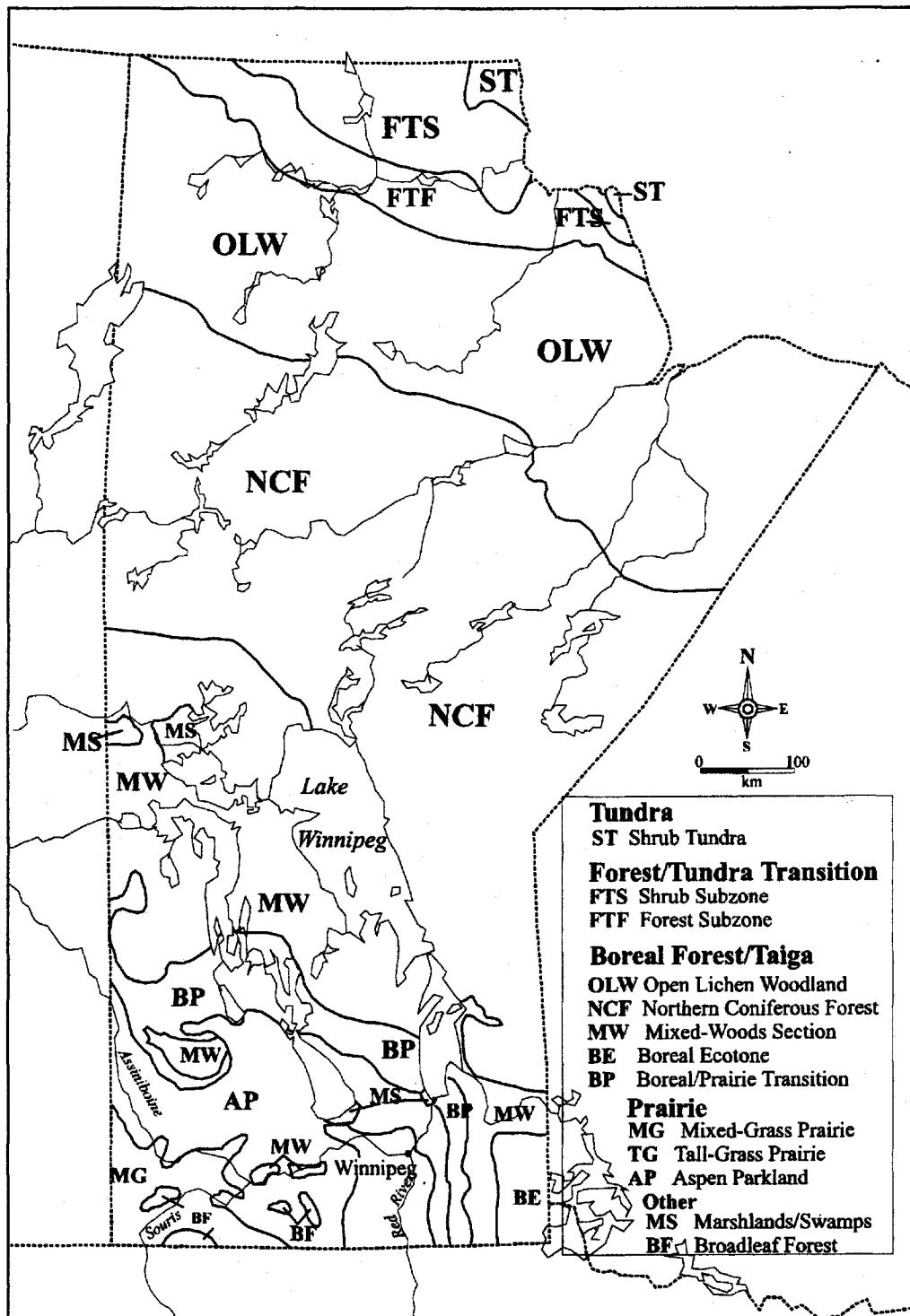
Figure 2.4 Natural vegetation zones of Manitoba (after Scott 1996).

Legend:

Tundra
ST Shrub Tundra

Forest/Tundra Transition
FTS Shrub Subzone
FTF Forest Subzone

Boreal Forest/Taiga
OLW Open Lichen Woodland
NCF Northern Coniferous Forest
MW Mixed-Woods Section
BE Boreal Ecotone
BP Boreal/Prairie Transition

Prairie
MG Mixed-Grass Prairie
TG Tall-Grass Prairie
AP Aspen Parkland

Other
MS Marshlands/Swamps
BF Broadleaf Forest

This cover type is dominated by spear grass (*Stipa comata*), northern wheat grass (*Agropyron smithii*), June grass (*Koeleria cristata*) and little bluestem (*Andropogon scoparius*). Some scholars have classified southwestern Manitoba as Aspen Parkland (i.e. Bird 1961). The parkland is a transitional zone between the northern boreal forest and the southern grassland with characteristics of each being present. Changes over the past 3,500 years enabled a slow southern expansion of the aspen parkland into the prairie and this has greatly accelerated during the last 100 years due to the demise of large-scale grassfires and the local extinction of bison. The northern boundary of the mixed-grass prairie is believed to have been significantly further north prior to European settlement (Scott 1996:44-46).

The Lauder Sandhills are an island of relatively intact natural vegetation amid cultivated grassland and encroaching aspen parkland. A complete list of all flora species currently encountered in the Lauder Sandhills is presented in Table 1, Appendix I. Ernest Thompson Seton's 1905 vegetation map shows that even 25 years after homestead settlement began, the dominate vegetation cover in southwestern Manitoba was grassland. Isolated forest habitats were recorded in several areas including lands underlain by the Oak Lake Aquifer (Hamilton and Nicholson 1999:09). Hamilton and Nicholson (1999) confirm that the topography and former hydrology of the Lauder Sandhills led to the development of stabilized mixed forest, wetland and meadow zones of vegetation or "islands" surrounded by mixed grass prairie (Hamilton and Nicholson 1999:09-10).

A flora and fauna inventory conducted in the Lauder Sandhills Wildlife Management Area during the summer of 1992 identified three main vegetation habitat types which can be extrapolated to the entire Lauder Sandhills region (Hohn and Parson 1993:03).

2.6.1 Sandhills

The sandhills consist of rolling terrain formed during the recession of glacial Lake Souris. They are sparsely wooded with small bur oaks (*Quercus macrocarpa*) in the sunny areas and stunted trembling aspen (*Populus tremuloides*) in the wetter and more shaded areas. Oaks grow on the crowns of the hills while aspens dominate the depressions and north facing slopes. Associated shrubs are primarily chokecherry (*Prunus virginiana*) with a layer of prairie rose (*Rosa arkansana*), poison-ivy (*Rhus radicans*), and creeping juniper (*Juniperus horizontalis*) near the ground. The smaller shrub species extend out from the treed areas onto the open hillsides which are sparsely covered with grasses and have recently been invaded by leafy spurge (*Euphorbia esula*) (Hohn and Parsons 1993:03-04).

2.6.2 Grasslands

The grasslands are former hay fields, pastures and croplands as indicated by non-native species such as smooth brome grass (*Bromus inermis*) and fescue (*Festuca* spp.). Plants common to disturbed areas such as many-flowered aster (*Aster ericoides*) and perennial ragweed (*Ambrosia psilostachya*) attest that these habitats have been heavily modified by human activity (Hohn and Parsons 1993:04). Species indicative of remnant prairie include: Big bluestem (*Andropogon geradii*), black eyed susan (*Rudbeckia hirta*), June grass (*Koeleria cristata*), smooth camas (*Zygadinus elegans*), mat muhly (*Muhlenburgia richardsonis*) low goldenrod (*Solidago missouriensis*), smooth aster (*Aster laevis*), western red lily (*Lilium philadelphicum*) and harebell (*Campanula rotundifolia*) (Hohn and Parsons 1993:12-14).

2.6.3 Aspen Forest

High density aspen forest located on gently rolling hills comprises the largest portion of the Lauder Sandhills Wildlife Management Area. The primary species is aspen, with scattered stands of balsam poplar (*Populus balsamifera*) and isolated oaks. The trees are generally larger than those found in the sandhill habitat. A dense shrub understory of chokecherry, snowberry (*Symphoricarpos occidentalis*), prickly rose (*Rosa acicularis*), saskatoon (*Amelanchier alnifolia*) and scattered hazel (*Corylus* spp.) is present, under which is a dense layer of poison-ivy. Willows (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), dwarf birch (*Betula glandulosa*), and river birch (*B. occidentalis*) appear in the wetter areas (Hohn and Parsons 1993:05).

The Jackson site is found in an area currently dominated by aspen parkland habitat as defined by Hohn and Parsons (1993). This corroborates the theory that the site was the locality of a former wetland environment. Air photographs from the 1940's show groves of aspen parkland developing around localized hollows with dead willows. The aspen parkland groves eventually spread to form contiguous aspen parkland forest as is found today. The wetland environment would have supported aquatic vegetation such as willows and sedges as well as arboreal vegetation.

2.7 Fauna

The Lauder Sandhills are an ecologically diverse region, and this richness is reflected in the variety of animal species present in the area. Some have been eradicated since the arrival of European settlers, while others are recent immigrants. A complete list of all vertebrate faunal species is included in Table 2, Appendix 1.

2.7.1 Mammalian Fauna

A wide variety of large mammals inhabited the Lauder Sandhills area. Undoubtedly one of the most important species, bison (*Bison bison*) has since been extirpated along with the antelope (*Antilocapra americana*). Other large herbivores such as moose (*Alces alces*) and wapiti (*Cervus elaphus*) are still present but moose sightings are relatively rare. Although both whitetail (*Odocoileus virginianus*) and mule deer (*O. hemionus*) are present, the whitetail have recently inhabited the region and tend to be more numerous (Banfield 1974).

A large number of carnivores roam the Sandhills. Still common are the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), river otter (*Lutra canadensis*), striped skunk (*Mephitis mephitis*), badger (*Taxidea taxus*) and a variety of weasels (*Mustela* sp.). Although a pair of wolves (*Canis lupus*) was sighted during the 1996 field season, this species is essentially eradicated from the region. The swift fox (*Vulpes velox*) is a species that has recently been reintroduced. Carnivores no longer in the area include the large cats (*Lynx canadensis, L. rufus* and *Felis concolor)*, as well as the grizzly and black bear (*Ursus arctos* and *U. americanus*) (Banfield 1974).

Three leporid and numerous rodent species inhabit southwestern Manitoba. These are the snowshoe hare, whitetail jackrabbit *(L. americanus* and *L. townsedii*) and the Eastern Cottontail (*Sylvilagus floridanus*). The larger rodents are the beaver (*Castor canadensis*), porcupine (*Erethizon dorsatum*), woodchuck (*Marmota monax*), and muskrat (*Ondatra zibethicus*). Small rodents encompass a variety of prairie dogs (*Cynomys*), squirrels (*Sciurus* sp.), ground squirrels (*Spermophilus* sp.), and a pocket gopher (*Thomomys talpoides*). There are several species of microrodents belonging to the family Cricetidae and four shrew species belonging to the family Soricidae. Bats (Vespertillionidae) are represented by six species (Banfield 1974).

2.7.2 Avian Fauna

Well over 200 bird species inhabit or visit the Lauder Sandhills. Migratory waterfowl and waders frequent the nearby rivers and wetlands. The area is very attractive to a variety of songbirds with almost 50 sparrow species alone being present. Birds of prey are quite common and include eagles, hawks, falcons and owls. Game birds such as the ruffed grouse (*Bonasa umbellus*), gray partridge (*Perdix perdix*), and the sharp-tailed grouse (*Tympanuchus phasianellus*) are also present (Godfrey 1966, Weidl and Young 1991).

2.7.3 Amphibians and Reptiles

Fifteen species of amphibians and reptiles can be found in southwestern Manitoba. The seven species of amphibian includes one salamander (*Ambystoma tigrinum*), one toad (*Bufo americanus*), two treefrogs (*Hyla versicolor* and *Pseudacris triseriata*) and two true frogs (*Rana pipiens* and *R. sylvatica*). Five species of garter snake (Colubridae), one snapping turtle (*Chelydra serpentina*), one box turtle (*Chrysemys picta*) and one skink (*Eumeces septentrionalis*) constitute the reptiles present (Conant 1958, Ernest *et al* 1994).

2.7.4 Fish

Numerous species of fish can be found in the streams, rivers and lakes. Over a dozen species of minnow undoubtedly provided food for other fish species. Some of the more prevalent ones include, burbot, suckers, northern pike, mooneyes, catfish, perch, walleye, and rainbow trout (Bjornson *et al* 1991, Scott and Crossman 1973).

2.8 Summary

The location of the Jackson site on the Souris Plain within the Lauder Sandhills was ideal for habitation. The sand to sandy loam sand soils of the region support sandhill, grassland and aspen forest habitats. These habitats in turn provide refuge for a wide variety of animal species including bison, cervids, carnivores, rodents, birds, amphibians, reptiles and fish. The forested areas of the region would have supplied protection from the continental climate of southern Manitoba with its extreme seasonal temperatures and precipitation. During occupation of the site, water would have been easily obtained from local pot hole water sources.

Chapter 3
The Vickers Focus

3.1 Introduction

It was a long held belief that the northern parklands of southern Manitoba were utilized only by small bands of hunting and gathering groups as part of their seasonal round subsistence strategy (Nicholson 1990:33). Research undertaken in this portion of the province, initially by Chris Vickers in the 1940's and 1950's, and recently by Drs. Nicholson and Hamilton, show that the Late Precontact culture history of southern Manitoba is considerably more complex. An intrusive group whose material culture is identified as the Vickers Focus originated in the northern United States (Nicholson and Hamilton 1997a). They entered and settled in south-central Manitoba about AD 1450 and essentially disappeared from the archaeological record about two centuries later. Vickers Focus sites are characterized by large site size, unusual site location and distinctive pottery. Circumstantial evidence of horticulture production is present in the earlier sites (known as the eastern cluster) while an increased reliance on bison procurement is hypothesized for the later sites (known as the western cluster). It is suggested that the Vickers Focus people may have evolved into or have been subsumed into the Mortlach archaeological culture (Nicholson and Hamilton 1999).

3.2 Eastern Cluster

In the late 1980's, Dr. Nicholson began work in south-central and southwestern Manitoba. He proposed that an intrusive group supplementing a hunting and gathering subsistence with horticulture was present in southern Manitoba by AD 1450 (Nicholson 1990, 1991, 1993, 1994, Nicholson and Hamilton 1997a, 1997b, 1999, Nicholson and Malainey 1991, 1995). Nicholson (1990:34-35) demonstrated that southern Manitoba's environment would have been conducive to the growth of native cultigens. Conclusive evidence of corn production has been uncovered in the province. The Lockport site (Figure 3.1) located north of Winnipeg, produced scapula hoes, bell-shaped storage pits, and macro fossils of corn (Nicholson 1990:53). Horticultural paraphernalia has been recovered from other sites in southern Manitoba. Modified bison scapula hoes, grinding stones and scapula knives were found at the Lovstrom site (Figure 3.1) while stone hoes were noted by Vickers at the Lowton
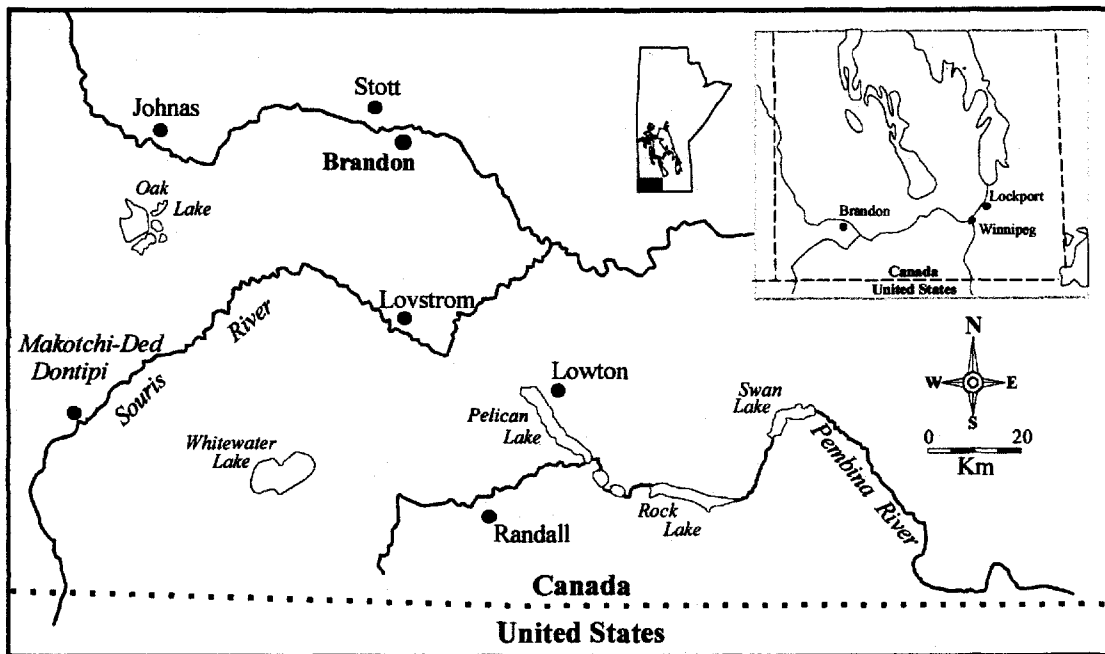
Figure 3.1 Location of archaeological sites discussed in Chapter Three.

site (Figure 3.1), and such hoes have been surface collected from the Johnas site (Figure 3.1) (Nicholson 1990:39, 1991:169). The large extent and implied extended occupations of the Lovstrom and Lowton sites without the expected large quantity of faunal remains is another indicator that horticulture may have been practiced (Nicholson 1990:36).

The recovered pottery from these sites also implies that inhabiting groups may have been involved in horticulture production. Nicholson and others (Nicholson 1990, 1991, 1993, 1994, Nicholson and Hamilton 1997a, 1999, Nicholson and Malainey 1991, 1995) defined this pottery as belonging to the Vickers Focus. Chris Vickers was an avocational archaeologist working in the Rock Lake and Pelican Lake areas of south-central Manitoba during the 1940s and 1950's. He classified two village cultures based on the presence of unique pottery. One, the Pelican Lake Focus, was defined by pottery recovered from the Lowton site. Since the term Pelican Lake has come to denote a Middle Precontact projectile point typology and phase/complex, Nicholson (1991a:167) proposed that the Pelican Lake Focus be renamed the Vickers Focus in honour of Chris Vickers.

The Lowton site (DiLv-03) is considered the type site for the Vickers Focus (Nicholson and Malainey 1995:87). It is presently located within a cultivated field, but Chris Vickers excavated small treed areas prior to cultivation. Unfortunately some of this information has since been lost (Taylor-Hollings 1999:231). The site continues to be surface collected by avocationalists, attesting to its richness. In 1992, Nicholson tested a portion of the

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site to determine if undisturbed components were present under the plough zone. The discovery of a hearth and associated artifacts verified the presence of intact cultural deposits (Nicholson and Malainey 1995:97).

The Lowton site pottery assemblage is extensive and diverse. Vessels are globular with rims ranging from straight to slightly flaring to S-rims. Surface treatment is usually obliterated fabric impressed. A great variety of decorations are present and include finger pinched nodes along the exterior lip edge, twisted cord impressions, tool impressions and incising on the lip and neck area. Punctates are present on two sherds in addition to effigy tabs. The effigy tabs indicates that quartering of the lip may have occurred on this vessel (Nicholson 1991:167).

Pottery surface collected from the Johnas site is similar to Lowton pottery. The Johnas site is located in a cultivated field along a linear sand ridge adjacent to a permanent slough. The pottery displays decorative traits such as rim tabs, trailing and finger pinched rims on smoothed exteriors (Nicholson 1990:36).

Traits similar to those seen at Lowton and Johnas are visible on vessels recovered from the Lovstrom site, a multi-occupation site situated on a till plain overlooking the Souris River valley. Incipient S-rims, incising, blade impressions on the interior and exterior of the lip, as well as finger pinched rim decorations are common (Nicholson 1990:39).

A number of Vickers Focus vessels have also been identified in the Randall collection (Hartlen 1997:63), but were not originally used in defining the Vickers Focus. The Randall assemblage is an assortment of artifacts from five sites north of the Killarney Lakes (Figure 3.1) collected by Gordon Randall between 1969 and 1979 (Hartlen 1997:45). Other pottery wares present in the Randall collection include Blackduck, Laurel, Rainy River, Sandy Lake, Mortlach, and Plains Cord Impressed (Hartlen 1997). Because the entire collection was surface collected from at least five sites and contains numerous other pottery wares, it is impossible to make definitive statements regarding the Vickers Focus occupation on the basis of this material. The recovery of vessels identical to those found at the Lowton site suggests that at least at one point in time, one or more of the Randall sites were occupied by Vickers Focus people (Hartlen 1997:64).

The first three sites share similar but diverse pottery wares. Consequently, Vickers Focus pottery is an amalgam of non-local wares that lack any major component of Woodland Blackduck or Duckbay. In addition to unique finger pinched decorations along the exterior lip, a characteristic considered diagnostic of Vickers Focus, the pottery closely resembles a variety of wares associated with groups known to have inhabited Minnesota and the Dakotas. These

groups practiced horticulture during the Late Precontact Period and their pottery wares include; Sandy Lake, Red River which is now called Northeastern Plains Village (Ahler *et al* 1991), Great Oasis, Talking Crow, Campbell Creek, Fort Yates Cord Impressed, and Scattered Village Complex (Nicholson 1991:169). The majority of the Vickers Focus pottery resembles plain wares from Northern Alabama to the Upper Mississippi regions of Illinois, Iowa and Minnesota. Oblique tool impressions on the inside and/or outside of the lip are decorative traits consistent with the Scattered Village Complex in North Dakota (Nicholson 1994:106). Many vessels also fit with the overall description of Sandy Lake. Taylor-Hollings (1999:235) identified a significant number of Sandy Lake vessels from the Lowton pottery assemblage, corroborating Nicholson's statement that the majority of Vickers Focus pottery in the Tiger Hills resembled Sandy Lake ware (Nicholson and Hamilton 1997a:29). A small number of the Lowton vessels resemble Middle Missouri wares from South Dakota. This includes at least five Knife River Fine ware vessels and vessels with effigy tabs (Nicholson 1994:106-107). Nicholson (1994:107) maintains that these vessels most likely were manufactured in Mississippian influenced villages and represent trade items.

Nicholson (1991:175) postulated that Eastern Woodland groups and Missouri Basin groups immigrated to southern Manitoba sometime around AD 1450 (Table 3.1). These people formed a series of temporary co-residences that can be identified by the presence of Vickers Focus pottery (Nicholson 1991:171).

Site	Lab Number	Uncorrected Age	Normalized Age	Reference
Lowton	S-3459	510±110	590±110	Nicholson and Malainey 1995
Lowton	TO-9215	350±80	-	Nicholson (personal communication 2001)
Lowton	TO-9216	440±80	-	Nicholson (personal communication 2001)
Lowton	TO-9217	390±50	-	Nicholson (personal communication 2001)
Lovstrom	SFU-no#	380±50	460±55	Nicholson 1986
Lovstrom	S-3032	405±110	485±110	Nicholson 1986
Lovstrom	S-3033	465±100	545±100	Nicholson 1986

Table 3.1 Radiocarbon dates of eastern Vickers Focus occupations (dates for non-Vickers Focus occupations at the Lovstrom site have not been included in this table).

Population movements in the northern states are the source for Vickers Focus in Manitoba. Hamilton and Nicholson (1999:06) clarify the terms Plains Woodland and Plains Village since they are somewhat vague. They followed Gregg (1994) who employed the terms to denote 'cultural traditions' or general adaptive strategies. The term Plains Village is associated with large villages, often fortified, that were usually sustained by foraging and horticulture. Sites are usually found in the Missouri River valley of North and South Dakota.

Plains Woodland implies a more generalized and mobile forager economy. The Woodland Tradition east of the Mississippi is evident by traits such as pottery production and burial mound construction. "We use the term Plains Woodland to reflect an ongoing process of population movement out of the Eastern Woodlands that persisted up to the post-contact era. In sum, we use the terms Plains Village and Plains Woodland to imply the end points of a continuum of economic and subsistence options. The former implies some level of commitment to horticulture and sedentary village life, while the latter suggests reliance upon intensive foraging and greater degrees of population mobility." (Hamilton and Nicholson 1999:06).

About 1,000 years ago, Woodland groups expanded into the eastern plains during the Neo-Atlantic episode; a period of warmer wetter conditions optimal for river valley horticulture. With the onset of the hotter, drier Pacific episode about AD 1250, Plains Village groups from the Central Plains moved north into the well watered Middle Missouri area. These movements initiated changes in culture and social organization found in the Initial Coalescent. Increased levels of competition and eventually warfare followed an initial period of peaceful coexistence (Nicholson and Hamilton 1997a:31). Nicholson and Hamilton (1997a:32) argue that these developments caused a 'demographic ripple' across the Northeastern Plains, with some groups moving northward along waterways such as the Red, Pembina and Souris Rivers. They further postulate that one group continued north along the Red River and inhabited the Shea and Lockport sites. Another group, the Vickers Focus people, branched off westward following the Pembina trench into the Tiger Hills (Nicholson and Hamilton 1997a:31).

Once in Manitoba, Vickers Focus people sought out site locations conducive to horticulture. In southern Manitoba, river channels and other depressions form 'cold sinks' and are susceptible to late spring and early fall frosts. Vickers Focus sites in the Tiger Hills region tend to be located on high ground with medium to light textured soil in areas where pothole water sources could have supplied water for crop irrigation (Nicholson 1993:212). These sites are located north of major waterways and are not visible from the waterways. They are very difficult to approach, especially from the south. This suggests that site location selection was influenced more by perceived socio-political variables from their homeland rather than anxieties about strangers to the north (Nicholson 1993:215).

Vickers Focus pottery assemblages are the product of a unique aggregate of people drawn from diverse origins, but who shared a similar subsistence practice and likely shared a similar social organization. The presence of Eastern Woodland and Middle Missouri wares, as well as distinctive characteristics in Vickers Focus assemblages, suggests a polyethnic

coresidence (Nicholson 1994:113). "If small, fragmented Mississippian social units were emigrating from their 'homelands" into territory which was already being exploited by other groups, some form of alliance might well emerge. Within these polyethnic groups there would be little pressure toward a unified or conforming culture during an initial *Early Alliance* configuration" (Nicholson 1994:119). A polyethnic coresidence would account for the presence of various pottery wares, and the finger pinching trait that is considered characteristic of Vickers Focus assemblages may be evidence of an emerging normative consensus (Nicholson 1994:119).

It seems that Vickers Focus people experienced initial success in the Tiger Hills region. The Lowton site is interpreted as a large central village (Nicholson and Hamilton 1997a:30) with Lovstrom and Johnas as smaller subsistence orientated satellite hamlets (Nicholson 1994:121). A dispersed population lived in these hamlets during the summer and accumulated small surpluses of bison and horticulture produce; the inhabitants may have returned to the major village (Lowton) for the winter (Nicholson and Hamilton 1997a:30). Nicholson (1993:214) maintains that bison hunting was of primary importance to the Vickers Focus subsistence strategy. Highly fragmented bison remains dominate faunal assemblages from eastern Vickers Focus sites. Independent research supports this idea. Malainey (1997:259) tested pot sherd residue samples from the Lowton site, and of the 14 samples, only one had a residue signature for plant mixed with large herbivore. The remaining residue signatures were all large herbivore. These results verify that bison was a primary food resource utilized by the Lowton site's inhabitants (Malainey 1997:200). The practice of small scale horticulture supplemented by hunting and gathering dominated by bison procurement, would have allowed Vickers Focus people to sustain themselves year round (Nicholson 1991:173, 1996a:81).

Recoveries from the Lowton, Lovstrom and Johnas sites imply that the Vickers Focus people also continued their socio-political customs. The settlement nature of the sites, a large central village and associated satellite hamlets, is consistent with those observed in the Mississippian heartland and suggests a relatively complex social organization (Nicholson 1994:121, 1993:214). The relative abundance of catlinite pipes at Lowton indicates that this site may have been an important regional centre where exchanges took place to facilitate the redistribution of wealth (Nicholson 1994:122). Another indicator of the complex socio-political organization of Vickers Focus groups is their extensive trade networks. Exotic lithic material such as Knife River Flint (KRF), Tongue River Silicified Sediment (TRSS), and catlinite is relatively abundant in Vickers Focus sites. The presence of TRSS suggest trade

networks or travel to the southeast while KRF and catlinite indicates interaction to the southwest (Nicholson 1991:171). The presence of finely made, exotic vessels also indicates trade with Mississippian influenced villages to the south (Nicholson 1994:107).

The success of the Vickers Focus people can be attributed to their settlement and subsistence strategy. Large extended occupied villages such as Lowton were headquarters for more short-term satellite or task specific activity sites such as Lovstrom (Nicholson and Hamilton 1999:15). Unlike groups previously inhabiting the region (i.e. Blackduck, Duck Bay), Vickers Focus people were able to maintain year round occupations in favorable parkland locales by intensive exploitation of the natural resources and supplementing their diet with small crop surpluses. When Blackduck groups returned from seasonal rounds in the boreal forest, prime parkland sites were already occupied by Vickers Focus people. This resulted in a general abandonment of the parkland by Blackduck people around 850 BP with a only a few sites dating slightly later. Limited interaction may have initially occurred between resident groups and emigrants. The continued presence of Blackduck at the Stott site (Figure 3.1) until 800 BP coupled with Plains Woodland vessels at that site suggests some communication transpired. This was not extensive however as Blackduck pottery is notably rare in Vickers Focus sites. The retreat of the Blackduck people into the boreal forest and out onto the plains coincides with the Vickers Focus influx and it appears that the displacement was peaceful as no evidence of village fortifications is present at any Vickers Focus sites (Nicholson 1996a:81).

Sometime between AD 1500 and 1600, the Vickers Focus people left the Tiger Hills region of southern Manitoba. Their disappearance from this area coincides with the beginning of the Neo-Boreal climatic episode, a period of cooler conditions. It would have been difficult for Vickers Focus people to maintain horticulture production during this time period (Nicholson and Hamilton 1997a:34). A cataclysmic volcanic explosion in the South Pacific between AD 1453 and 1454 resulted in a severe worldwide climatic deterioration recorded in tree rings from northern California, northern Europe and northern China. This event would have made an "already deteriorating growing season unsuitable for imported cultigens like corn." (Nicholson and Hamilton 1997a:34). Nicholson and Hamilton (1997a:34) imply that a group of the Vickers Focus people returned to North Dakota and resumed their horticulture lifestyle. The Awatixa Hidatsa arrived at the Knife River villages around this time after having lost their corn (Ahler *et al* 1991). Oral traditions of these people relate that they had, "previously lived in a land of snow and boreal forest where there were moose. These conditions are fulfilled in many of the Manitoba uplands… " (Nicholson 1996a:82).

3.3 Western Cluster

At least some Vickers Focus people remained in Manitoba, moving westward from the Tiger Hills into the *Makotchi-Ded Dontipi* locale of the Lauder Sandhills. Identified Vickers Focus sites in this area include Jackson, Bradshaw, and Vera (Figure 3.2). Calibrated C^{14} dates cluster around AD 1450 to 1650 with the calibrated intercepts falling between AD 1500 and AD 1620 (Table 3.2) (Nicholson and Hamilton 1997a:30). These sites are identified as Vickers Focus based on their large size, unusual placement, and diverse pottery assemblages (Hamilton and Nicholson 1999:05).
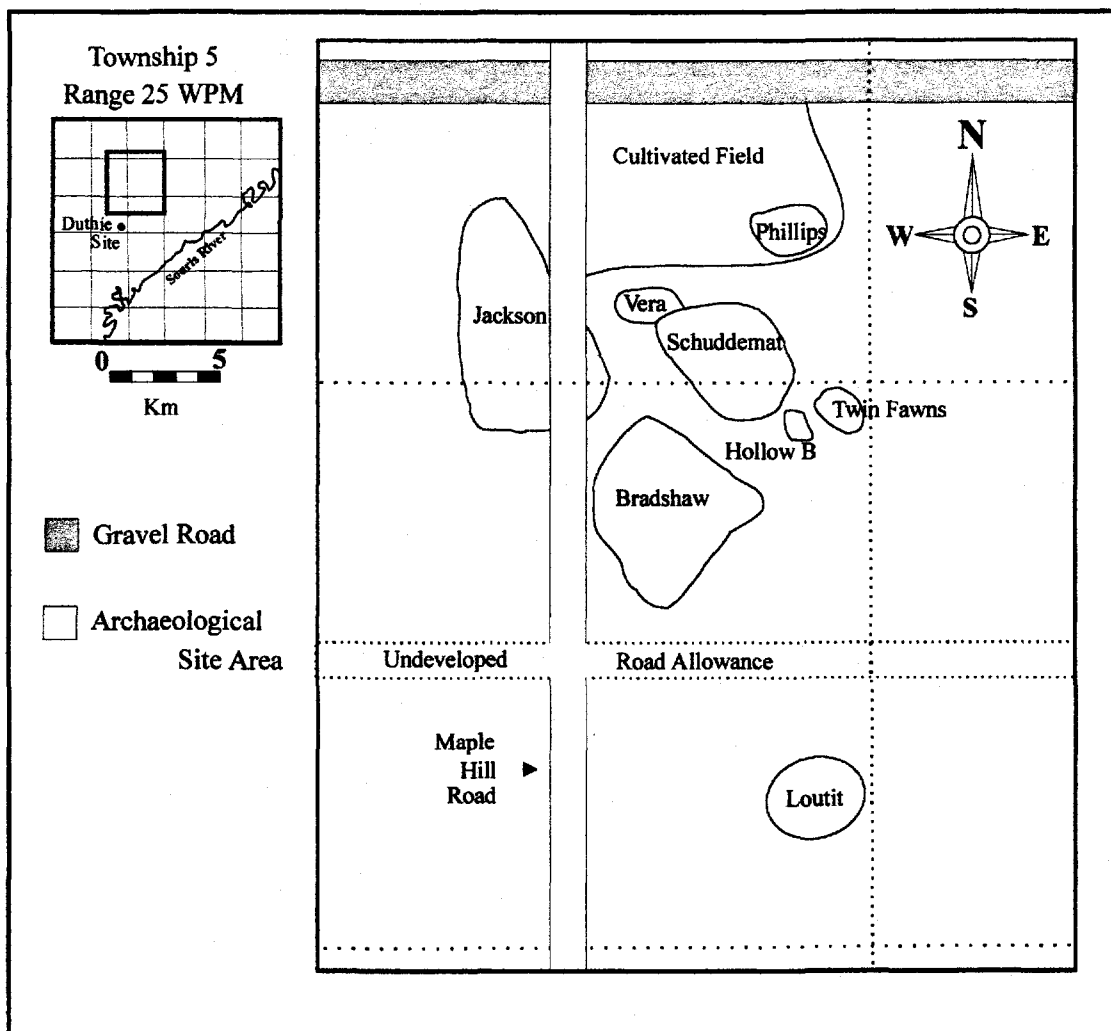
Figure 3.2 *Makotchi-Ded Dontipi* **locale and associated archaeological sites (from Nicholson and Hamilton 1996).**

Site	Lab Number	Normalized Age	Reference
Jackson	Beta 83865	290±50	Nicholson 1996a
Jackson	Beta 83864	300±70	Nicholson 1996a
Jackson	Beta 82792	410±60	Nicholson 1996a
Vera	Beta 106109	340±60	Nicholson and Hamilton 1997b

Table 3.2 Radiocarbon dates from Vickers Focus sites in the *Makotchi-Ded Dontipi* locale.

Jackson and Vera site pottery has strong affiliations with Lowton pottery. Finger pinched lip nodes on vertical fabric-impressed vessels is a diagnostic trait on these vessels present in the earlier Tiger Hills sites (Nicholson and Hamilton 1999:17). A unique decoration present at Lowton, twisted cord loop, is also seen on the Vera and Jackson vessels. Other common traits include: fabric and smoothed surface treatments, twisted cord impressions on the rim, straight to flaring and occasional incipient S-rims. Over a dozen vessels at Vera have decorative traits such as CWO, twisted cord and dentate stamping, commonly associated with Plains Woodland and Plains Village assemblages. One vessel has an unusually complex sequence of decorative elements that is similar to sherds observed at the Mandan Double-Ditch site along the Missouri River in North Dakota (Nicholson and Hamilton 1999:21). The *Makotchi-Ded Dontipi* sites show continuity from the eastern Vickers Focus sites and an increased presence of Middle Missouri related wares.

Also present in the *Makotchi-Ded Dontipi* area is an increased Mortlach presence. Mortlach pottery in Saskatchewan is dated between AD 1550 and the late 1700's (Walde 1994:105-106). Its makers appear to have followed a full fledged bison hunting economy (Malainey 1991). Several Mortlach sites have been identified in the *Makotchi-Ded Dontipi* area including Twin Fawns, Hollow B, Schuddemat, and portions of the Bradshaw site (Figure 3.2). It is almost impossible to date these sites via radiocarbon dating as the samples show multiple intercepts ranging from about 300 BP to the present. The recovery of a single brass knife from the Twin Fawns site suggests that it dates to either the late 1600's or early 1700's (Nicholson and Hamilton 1999:21). In addition to the Mortlach sites, "Reconstructed rims indicate wares which appear to be transitional between Vickers Focus and Mortlach . . . and the collection of rim sherds from these sites show a mixture of Vickers Focus and Mortlach wares." (Nicholson and Hamilton 1999:21).

The hypothesized contact between these groups is supported by the apparent subsistence strategy change the Vickers Focus underwent in the *Makotchi-Ded Dontipi* area. No horticultural paraphernalia has been recovered from Vickers Focus sites in this region, even though site selection would have been consistent with horticultural production. Sites are located on warm sandy soil adjacent to pothole water sources. Instead, given the high

biodiversity and predictability of seasonally available resources in the Lauder Sandhills, it is proposed the Vickers Focus people abandoned horticultural production. It appears they developed an intensive native resource exploitation strategy, one that continued to support their complex social structure (Nicholson and Hamilton 1999:15). An increased reliance upon bison, indicated by the small bison kill at the Jackson site supports the hypothesized subsistence strategy change, and may be indicative of direct contact between Vickers Focus groups and Plains bison hunters (i.e. Mortlach) (Nicholson and Hamilton 1999:24). The temporal and spatial closeness of Vickers Focus and Mortlach sites and dates indicate some degree of continuity (Nicholson and Hamilton 1997a:21).

3.4 Disappearance of Vickers Focus from the Archaeological Record

Currently, the relationship between Vickers Focus and Mortlach is uncertain. Nicholson and Hamilton (1999:25) proposed that the Vickers Focus people evolved into the Mortlach Complex through contact with Plains Village people. This scenario presents the 'best fit' in that it explains the disappearance of the Vickers Focus people from the archaeological record and is consistent with the Vickers Focus ongoing changing subsistence economy model. Nicholson and Hamilton (1999) did not, however, rule out alternate schemes. The Vickers Focus and Mortlach groups could have interacted in the *Makotchi-Ded Dontipi* region, sharing ideas but maintaining individual identities. This does not account for the disappearance of the Vickers Focus in the archaeological record. A third scenario sees the Vickers Focus and Mortlach people learning pottery techniques from a third, unidentified group and Vickers Focus people independently developing bison procurement skills. This once again does not explain the disappearance of Vickers Focus from the archaeological record. It is also unlikely that Vickers Focus and Mortlach would only interact with a third unidentified group and not each other. The final scenario sees both groups as part of a larger phenomenon and the differences between them are more apparent than real. "The differences which appear in the archaeological record may simply reflect different historical experiences and contacts and the exploitation of different territorial resources bases." (Nicholson and Hamilton 1999:25). In this case, the Vickers Focus and Mortlach Complex would be viewed as parallel subsets within some larger emigration phenomenon such as that which produced the Scattered Village Complex (Nicholson and Hamilton 1999:25).

After the Vickers Focus people left south-central Manitoba, this area essentially became a 'no man's land'. At contact, groups such as the Assiniboine, Cree and Ojibwa occupied the region only as part of their seasonal rounds which focused on resources of the

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boreal forest (Nicholson 1996b:72-73). Other groups such as the Sioux, Mandan and Gros Ventre occasionally entered south-central Manitoba to raid or trade.

The disappearance of the Vickers Focus in southwestern Manitoba coincides with an increased presence of Mortlach sites. This correspondence suggests that the Vickers Focus may have ultimately evolved into Mortlach although the exact nature of the relationship between Vickers Focus and Mortlach is presently unknown (Nicholson and Hamilton 1999).

3.5 Summary

Social and/or cultural change initiated by the onset of the Pacific episode, may have caused groups of northern United States inhabitants to emigrate. One group, the Vickers Focus, settled in south-central Manitoba prior to AD 1450. Vickers Focus sites can be identified by the presence of Eastern Woodland and Middle Missouri pottery wares, as well as distinctive Vickers Focus pottery attributes. In Manitoba, the Vickers Focus people maintained their complex social organization. A large central village, the Lowton site, and smaller hamlets have been identified. Bison hunting was of primary importance to the makers of Vickers Focus pottery, but it is possible that they supplemented this with incipient horticulture. Between AD 1500 and 1600, the makers of Vickers Focus pottery left south-central Manitoba and moved westward into the southwestern corner of the province. Here, an increased reliance on bison procurement seems to have replaced any horticulture produce. Pottery traits suggest an increased presence of Middle Missouri related wares. Vickers Focus pottery disappears from the archaeological record about the same time as Mortlach sites increase in southwestern Manitoba. The makers of Vickers Focus pottery may have joined with or evolved into the makers of Mortlach pottery.

Chapter 4
Methodology and Site Stratigraphy

4.1 Excavation Procedures

The Jackson site was first identified and tested in 1993 and work was undertaken during the following five field seasons. An arbitrary 500S 500W datum was established in 1994 on the 1972 Manitoba Land Survey marker delineating Sections 28 and 29 of Township 5, Range 25 West of the Prime Meridian. An overlying grid was surveyed using a 30 m tape and a theodolite. All excavation units as well as all shovel tests later than 1993 were surveyed from this datum or turning points tied into the datum.

A total of 35 one m^2 units and a single unit measuring 1x 1.5 m were excavated. Twenty-five of the one m^2 units were excavated under the auspices of the 1994 and 1995 Brandon University field schools. Remaining units were excavated by crew members between 1995 and 1997 (Figure 4.1).

This thesis addresses only the faunal remains recovered from the 1995-1997 excavation units, and discussion of the methodology will be limited to the faunal assemblage recovered from these excavation units. All units were excavated in arbitrary five cm levels and divided into quadrants to ensure reliable stratigraphic control. Matrix, except for collected soil samples, was passed through a 0.3175 cm mesh screen. Three point provenience was taken on all diagnostic artifacts as well as identifiable bone found *in situ*. Artifacts and ecofacts not recovered *in situ* were bagged and catalogued according to quadrant and level. The first six to ten levels were excavated using hand tools such as trowels, dental picks and brushes, and when a drastic decrease in artifacts was encountered, the remaining one or two levels were shovel shaved by quadrant. To ensure an exhaustive recovery of artifacts, a small trench was excavated along whichever wall was to be profiled.

Upon the completion of each level, a black and white photograph was taken of the plan view and a colour slide or photograph was taken when deemed appropriate. Level summary forms were completed, listing the artifacts, ecofacts and features, as well as soil type and

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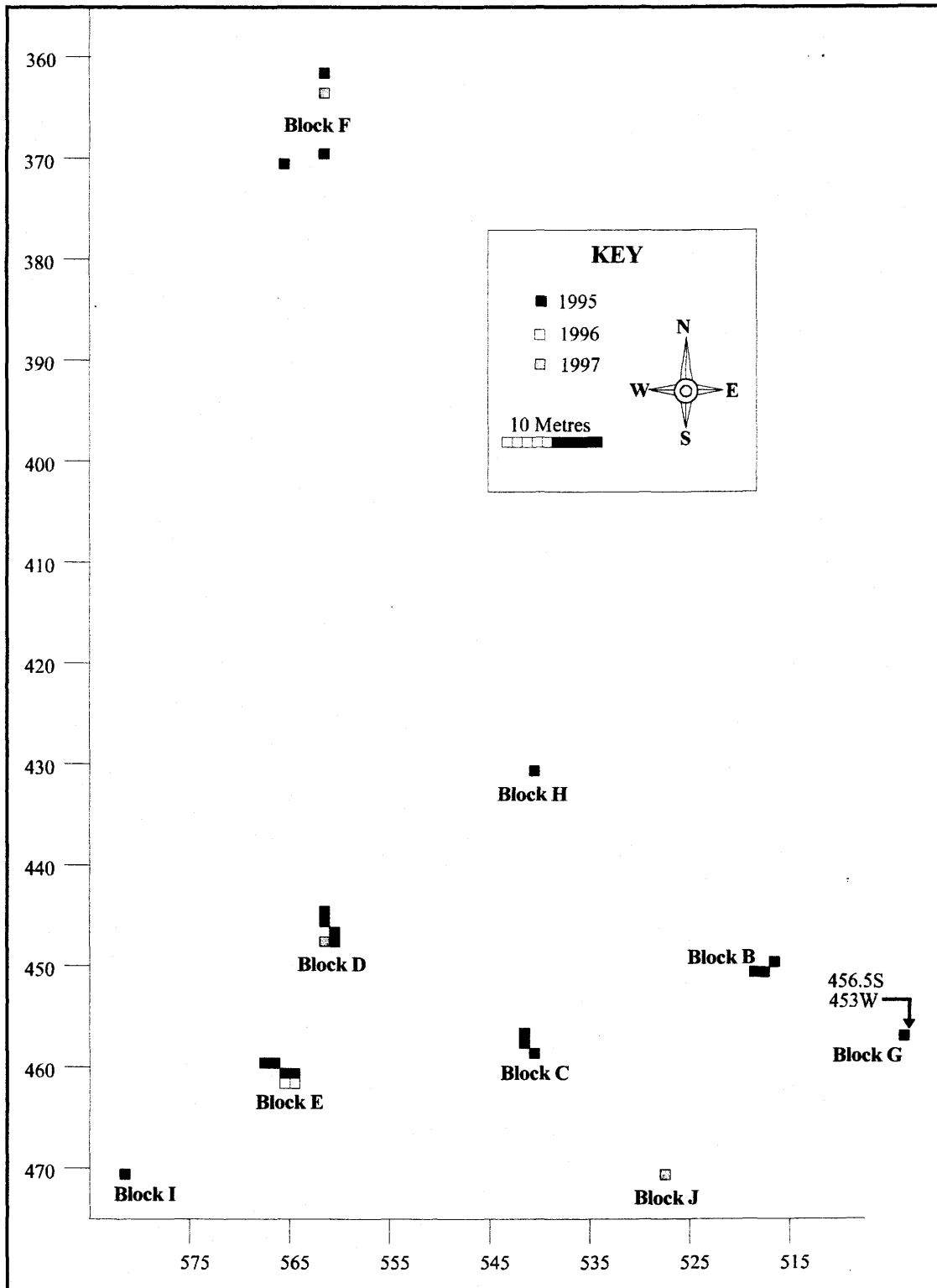
Figure 4.1 Map of 1995-1997 excavation units at DiMe-17.

colour in addition to any visible disturbance. A floor plan of recoveries, disturbance, and soil changes was drawn prior to excavating the next level.

Features were well documented. Each was recorded on the level summary, unit summary, and feature forms. They were photographed, drawn, and then cross-sectioned. Half of the feature was excavated and the matrix passed through the 0.3175 cm mesh. Recoveries were identified and catalogued. The remaining half of a feature was left unexcavated. It was photographed and drawn, then collected and catalogued as a soil sample for potential further analysis.

When a unit was completed, at least one wall was profiled. A small trench usually about 20-30 cm wide by 10-20 cm deep was excavated along the wall to be profiled to ensure no other artifacts were present. The profile was photographed using black and white and colour film and then drawn using a 1:10 scale.

4.2 Site Stratigraphy

The general soil stratigraphy at the Jackson site is relatively simple (Figure 4.2). A thin leaf litter consisting of fresh and decomposing organic material was removed to reveal a dark grey (Munsell 10YR 4/1) sandy loam A horizon at about five to 10 cm depth below surface (dbs). The extent of this horizon varied across the site, but was usually between 10 and 15 cm thick. Almost all artifacts were recovered from the A horizon (see feature in Figure 4.2). The grayish brown (Munsell 10YR 5/2) B horizon is comprised of a sand, with iron oxide staining visible as shallow as 50 cm dbs. The B horizon was usually encountered below the A horizon. Individual unit stratigraphy was locally slightly more complex. In Figure 4.2 a small thin organic horizon was located between the leaf litter and the A horizon. In several cases, as in excavation unit 35, a B2 horizon was encountered. Artifacts were almost never recovered outside of the A horizon unless it was from a disturbed patch of sediment.

4.3 Cataloguing Procedures

All artifacts and ecofacts were identified in the field, and given an artifact number comprising of the unit number, level it was recovered and individual identification number. In partial fulfillment of their field school grade, students were required to clean and identify the materials recovered from one excavation unit.

Recoveries from the remaining units were cleaned and identified either by the author or a Brandon University archaeology laboratory employee. All micro-vertebrate and many of the small mammal specimens were identified by Mr. Sean Webster, a Ph.D. candidate at the University of Saskatchewan. All identifications except those done by Mr. Webster were
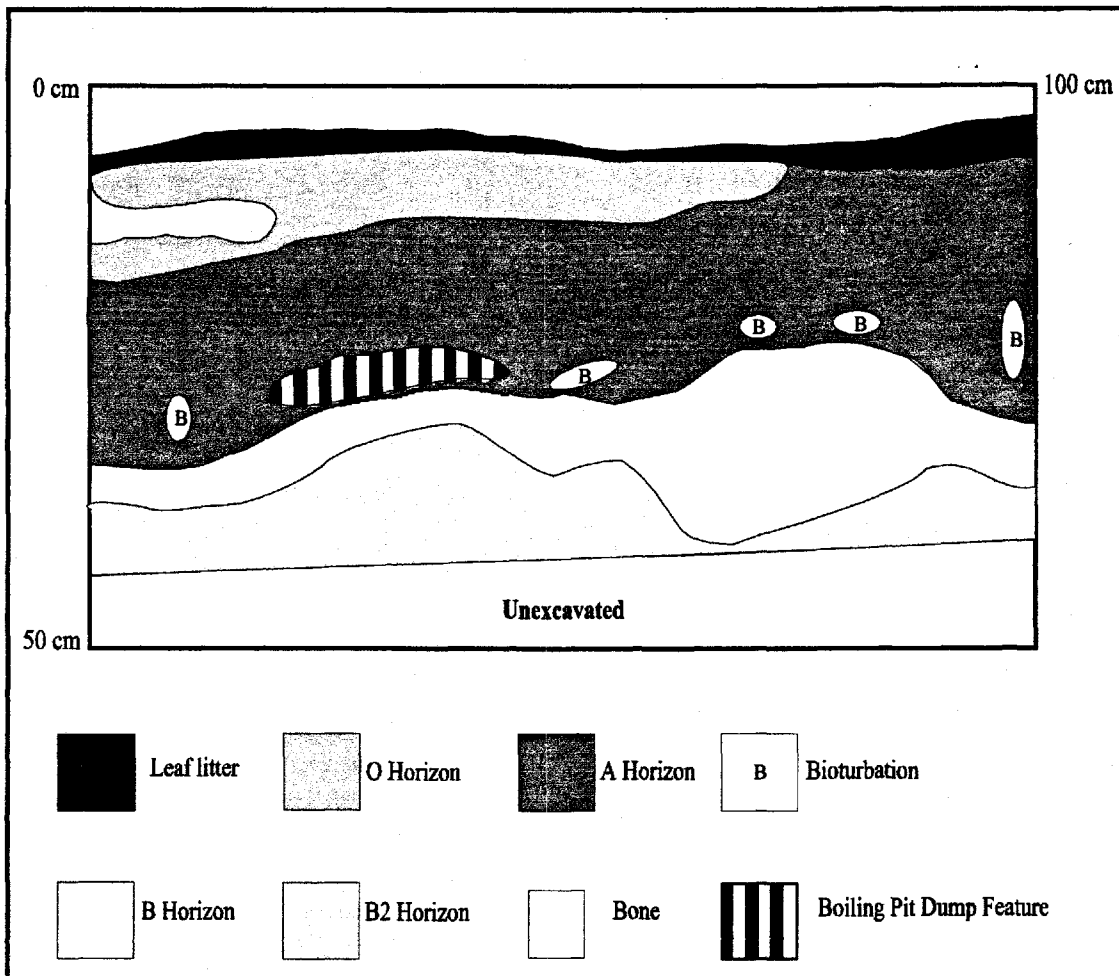
Figure 4.2 East wall profile of excavation unit 35 (447S/560W) from block D.

confirmed by the author using several manuals as well as the University of Saskatchewan Department of Anthropology and Archaeology zooarchaeological comparative collection.

Cleaning consisted of washing the remains in water and removing adhering matrix with a toothbrush. Materials were left to air dry. Once completely dry, faunal remains were sorted into identifiable and unidentifiable categories.

The term 'identified' requires clarification. 'Identified' usually means identified to taxon, but it also implies identified to skeletal element (Lyman 1994a:100). An element is a single complete bone or tooth from the skeleton of an animal. A specimen is a bone or tooth, or a fragment of such from an archaeological site (Grayson 1984:16). The majority of the identifiable faunal remains from the Jackson site consist of skeletal fragments, not whole skeletal elements. As such, they are termed skeletal specimens but where whole bones and

teeth are present, the term skeletal element is used. Bone that cannot be identified to element or to a broad specimen category (i.e. tooth enamel, skull fragment) is considered to be unidentifiable.

Faunal recoveries were identified and described as extensively as possible. Elements and specimens were identified and sided where possible, and element portion (i.e. proximal versus distal) was noted for specimens. Elements and specimens were identified to the lowest taxon possible. Most elements and some specimens could be classified at the species level; many however could only be identified to the genus, class, or size class level.

All faunal recoveries were examined for evidence of taphonomic forces affecting the assemblage. Natural forces encompass weathering, root etching, trampling and abrasion, as well as carnivore or rodent gnawing. Cultural forces include: cutmarks, polishing, and incising (Lyman 1994a). Macroscopic evidence of these forces was noted for each artifact. Bone exhibiting visual evidence of excessive heat such as a scorched, blackened or calcined appearance was classified as thermal.

Upon completion of identification, all material was catalouged using the MacADEM computer software program developed by Terry Gibson. Each identified artifact was given a catalogue number. Data associated with this number included; unit provenience, level, artifact provenience (either three point or quadrant provenience), count, weight, taxon, element, side, modification, age group and comments. Artifacts were bagged with the appropriate catalogue card printed with the catalogue number and associated information.

Individual MacADEM databases were created for each season, and two were created for the 1995 field season (one for the field school units and one for the paid crew units). Although the multiple databases meant that several catalogue numbers were repeated up to four times, the collection was not re-catalogued as a single MacADEM database. Such a task would have required an immense amount of time. Instead, each catalogue number is used in conjunction with the artifact number to provide a unique identification number.

The author evaluated the entire faunal collection, and some major as well as many minor changes were made. The lack of complete elements necessitated the use of landmarks to determine a minimum number of elements (MNE). Element landmarks were identified and recorded for each possible specimen. Changes to the classification of animal classes required reorganization of the original database. MacADEM's program classifies animals into the following categories: ungulate, medium mammal, small mammal, aves, reptile, fish, amphibian, mollusc, insect, unknown class and indeterminate mammal, with each category

further divided into subclasses or species. This is adequate when elements can be speciated. Given the fragmentary nature of the Jackson assemblage, speciation was often difficult and broader categories adopted. The MacADEM program does not specify which ungulates belong to the large or medium categories, as well, the medium mammal category encompassed animals ranging from 170 kg (*Ursus*) down to 2.0 kg (*Vulpes*). A revised animal classification scheme was followed (Table 4.1).

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

Table 4.1 Description of size classes used in this thesis (After Webster 1999:40).

Reprogramming of the MacADEM catalogue program was not undertaken, instead changes to the animal class categories were written into the comments. Corrections were noted and changes were made to the existing catalogue number and when re-identification necessitated a new catalogue number (i.e. an identifiable specimen in an unidentifiable bone bag) the new catalogue number was entered at the end of the MacADEM database with the artifact number was written as the unit number, level and the original identification number with a letter (i.e. 16-3-2a came from 16-3-2).

4.4 Analysis Procedures

4.4.1 Qualitative Analysis

Some of the qualitative descriptions were recorded in conjunction with the initial identification of the faunal assemblage. The entire assemblage was evaluated for all taphonomic processes affecting the site. Changes made to the catalogue were entered into the existing MacADEM database and when a category did not exist in the MacADEM database, observations were recorded in the comment section.

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4.4.2 Quantitative Analysis

After the faunal assemblage was catalogued, all MacADEM databases were exported into various Microsoft Excel© spreadsheets for data manipulation. When additional information was noted for specific specimens, changes or corrections were made to the Microsoft Excel© spreadsheet database.

Several methods of quantification have become standard practice for faunal analysis. The most common two are the number of identified specimens (NISP) and MNI. NISP is the number of identified specimens per taxon, where a taxon is a specified taxonomic category such as a subspecies, species, genus, family, etc. The MNI is the minimum number of individual animals necessary to account for all identified specimens (Lyman 1994b:43). Since White (1953:397) first introduced MNI's to archaeology by using the most abundant sided element, archaeologists have varied this technique by taking additional factors such as age, sex and size of the elements into consideration (Lyman 1994a:100).

While MNI and NISP measure taxa abundance, they do not account for taphonomic processes. Minimum number of elements (MNE) and minimum number of animal units (MAU) measure factors such as fragmentation and differential preservation. MNE values were calculated by recording pertinent landmarks present on specimens, and the landmark with the highest count becomes the count for the element (Webster 1999:39). Because MNE values are calculated using complete elements as well as element portions, resulting MNI values can be established for a fragmented assemblage (Ringrose 1993:130). The MNI values for the Jackson assemblage were calculated using the most numerous sided MNE.

The MAU measures how humans affect an assemblage with their butchering practices and the survivorship of skeletal parts (Binford 1978, Binford and Bertram 1977). It is calculated by dividing the observed bone count for each anatomical unit by the number of times that anatomical unit occurs in one complete skeleton (Binford 1978:70). By multiplying the MAU by 100% and dividing that by the maximum MAU observed in the assemblage, the %MAU is calculated (Binford 1978:72).

4.5 Summary

The Jackson site was excavated between the years of 1994 and 1997 using standard academic excavation techniques. The natural soil stratigraphy of the site is relatively simple although slight variations across the site do exist. Faunal specimens recovered from unit excavated during the 1995 to the 1997 field seasons were cleaned, identified, catalogued, and analyzed as part of the author's Master of Art's thesis research.

Chapter 5

The Jackson Site Faunal Assemblage

5.1 Introduction

A total of 193,548 faunal specimens weighing 64.80 kg (not including foetal or immature remains) were recovered from 25 excavation units dug during the 1995, 1996, and 1997 field seasons at the Jackson site. These 25 units were not a continuous excavation block but instead a series of small block excavations and single excavation units. Only four blocks contain contiguous units, the largest of which is comprised of six one-m^2 units. This method was rational at the time of excavation; units were located in areas of rich artifact concentration as indicated by shovel test results. The unit locations however generate several problems when attempting to analyze the faunal assemblage.

The main concern with the widely distributed excavation blocks is association. Because some units are over 100 m apart, it can only be assumed that all are related to the same occupation. Without stratigraphic continuity, however, it is impossible to decisively state that all recoveries belong to a single occupation. Radiocarbon dating and material culture evidence suggests that the majority of the Jackson site was produced by a single occupational event, or by multiple, closely spaced events, and that all the blocks excavated during the 1995, 1996 and 1997 field seasons belong to this occupation.

To address these concerns, the faunal assemblage from the Jackson site is initially presented by block. This is done so recoveries and potential patterns in the smaller blocks are not obliterated by the larger excavation block samples. The assemblage is also analyzed in its entirety for site wide patterns of species and element distribution.

5.2 Block B Faunal Assemblage

A total of 13,905 specimens weighing 3,529 g were identified in the Block B assemblage (Table 5.1). The vast majority of these (98.3%) are unidentifiable. Twenty-five percent of the identified specimens and 76% of the unidentified specimen exhibit evidence of heat alteration.

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	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	g
Unburned	180	5.1	933.6	59.0	3329	94.9	648.9	41.0	3509	1582.5
Burned	61	0.6	328.2	29.9	10335	99.4	1618.3	83.1	10396	1946.5
Total	241	1.7	1261.8	42.4	13664	98.3	2267.2	64.2	13905	3529.0

Table 5.1 Block B faunal assemblage separated by burning.

Bison and an unidentified leporid are the only genera identified in the block B faunal assemblage (Table 5.2). The remaining specimens are assigned by size and class categories. Some rib and vertebral elements are classified as bison, based on size.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	153	2
Hares	*Lepus sp.*	1	1
Miscellaneous			
Very Large Mammal (SC6)		36	-
Small-Medium Mammal (SC3)		1	-
Indeterminate Mammal		50	-
Total		241	3

Table 5.2 Summary of block B faunal remains by taxa.

5.2.1 Order Artiodactyla

Bison bison

Specimens identified: Table 5.3 summarizes the 153 identified bison specimens. Landmarks were used to calculate MNE and the MAU values and a complete list can be found in Table 1, Appendix II.

Distribution and habitat: The bison is North America's largest living terrestrial mammal. An average adult bull weighs 570 kg while the average female weighs 420 kg. Bison are a very gregarious animal and travel in cohesive family groups numbering between four and 20 individuals. These groups often congregate into larger herds numbering into the thousands. Bison are primarily grazing animals, subsisting on grasses, forbs and sedges. Because of their diet, bison can be found in a wide range of habitats from arid plains to aspen parklands, meadows, river valleys and even coniferous forests. The rutting season occurs from early July to late September and peaks in mid-August although out of season mating has been observed. The 270 to 300 day gestation period establishes parturition between mid-April and June with a peak in early May (Banfield 1974:405-407).

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				..
Mandible	32	1	1	0.5
Rib	9	1	1	0.04
Axis	9	1	1	0.5
Cervical Vertebrae	2	1	1	0.14
Thoracic Vertebrae	9	1	0	0
Forelimb				
Scapula	24	1	1	0.5
Humerus	7	1	1	0.5
Ulna	1	1	1	0.5
Internal Carpal	1	1	1	0.5
Accessory Carpal	1	1	1	0.5
Ulnar Carpal	2	2	2	1
Unciform Carpal	1	1	1	0.5
Metacarpal	1	1	1	0.5
Hindlimb				
Innominate	2	1	1	0.5
Femur	1	1	0	0
Calcaneus	3	2	2	1
Astragalus	1	1	1	0.5
Fused C/4 Tarsal	3	1	1	0.5
Fused 2/3 Tarsal	1	1	1	0.5
1st Tarsal	1	1	1	0.5
Metatarsal	2	1	1	0.5
Other Elements				
1st Phalanx	4	1	1	0.13
3rd Phalanx	3	1	1	0.13
Miscellaneous				
Vertebrae Indeterminate	9	-	-	-
Molar/Premolar Indeterminate	24	-	-	-
Total	153			

Table 5.3 Summary of *Bison bison* elements from block B.

Discussion: At least two bison are represented in block B as indicated by two left ulnar carpals and two relatively complete left calcanei. Only 20% of the sample exhibits evidence of thermal alteration.

5.2.2 Order Lagomorpha

Lepus sp.

Specimens identified: NISP=1; right astragalus (181/13-2-69).

Discussion: This incomplete specimen represents one individual whose species could not be determined. Evidence of cultural modification is not present on the specimen but the colour is consistent with the rest of the assemblage indicating that it is part of the archaeological assemblage.

5.2.3 Miscellaneous Specimens

Specimens identified: NISP=87; see Table 5.4.

Discussion: Eighty-seven specimens could not be assigned to taxon. Specimens identified to the SC6 category consisted of tooth enamel and longbone shaft fragments that most likely represent fragmented bison elements. The SC3 specimen is a very small longbone shaft fragment with no identifiable characteristics. The 50 pieces of tooth enamel could not be assigned to a specific size class as it could potentially belong to several size classes although most probably they came from a bison.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	36	Tooth enamel and longbone shafts
3 – Small/Medium Mammal	1	Longbone shaft
Indeterminate Mammal	50	Tooth enamel
Total	**87**	

Table 5.4 Summary of block B miscellaneous specimens by size and class categories.

5.3 Block C Faunal Assemblage

Of the 7,341 specimens found in block C, a small percent (5.8) were identified at least to the size or class category (Table 5.5). The identifiable portion weighs 56.3% of the total 4,126.7 g assemblage. Less than 30% of the entire assemblage exhibited evidence of heat alteration and only six percent of the identified specimens are burned.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	g
Unburned	398	7.5	2253.2	62.3	4903	92.5	1350.2	37.7	5301	3583.4
Burned	25	1.2	92.5	17.0	2015	98.8	450.8	83.0	2040	543.3
Total	423	5.8	2355.7	56.3	6918	94.2	1801.0	43.3	7341	4126.7

Table 5.5 Block C faunal assemblage separated by burning.

Of the 423 identified specimens, 246 could be identified only to size or class category (Table 5.6). The remaining specimens represent the two taxa identified, bison and large canid.

5.3.1 Order Artiodactyl

Bison bison

Specimens identified: Table 5.7 Summarizes the 166 identified bison specimens. Landmarks were used to calculate MNE and the MAU values and a complete list can be found in Table 1, Appendix II.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	166	3
Medium-Large Canid (SC5)	*Canis* sp.	11	2
Miscellaneous			
Very Large Mammal (SC6)		218	-
Large Mammal (SC5)		1	-
Small-Medium Mammal (SC3)		1	-
Micro-Mammal (SC1)		2	-
Small Vertebrate (SC2)		3	-
Indeterminate Mammal		21	-
Total		423	5

Table 5.6 Summary of block C faunal remains by taxa.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	1	1	1	0.5
Mandible	18	2	2	1.0
Hyoid	4	1	1	0.5
Rib	28	1	1	0.04
Lumbar Vertebrae	1	1	0	0
Forelimb				
Scapula	1	1	0	0
Humerus	6	2	2	1.0
Radius	26	2	2	1.0
Ulna	12	3	3	1.5
Hindlimb				
Innominate	1	1	1	0.5
Tibia	24	2	2	1.0
Calcaneus	3	1	1	0.5
Astragalus	2	2	2	1.0
Fused C/4 Tarsal	1	1	1	0.5
Fused 2/3 Tarsal	1	1	1	0.5
1st Tarsal	1	1	1	0.5
Metatarsal	8	1	1	0.5
Other Elements				
1st Phalanx	4	1	2	0.25
2nd Phalanx	5	1	5	0.63
3rd Phalanx	14	1	4	0.50
Distal Inferior Sesamoid	2	1	2	0.25
Miscellaneous				
Molar/Premolar Indeterminate	2	-	-	-
Sesamoid Indeterminate	1	-	-	-
Total	166			

Table 5.7 Summary of *Bison bison* elements from block C.

Distribution and habitat: See page 34.

Discussion: At least three individual bison were present in block C by three right proximal ulnae. Tarsals, phalanges and sesamoids were the only complete bison elements recovered from this block.

5.3.2 Order Carnivora

Canis sp. (SC5)

Specimens identified: NISP=11; right proximal scapula (636/15-3-52), left proximal radius (603/15-3-17), left distal radius (563/15-2-82), left ulna midshaft (568/15-2-90, 648/15-3-64, 951/17-2-09), three sternal elements (659/3-15-75), right rib head (561/15-2-78), femur midshaft (719/16-2-31).

Discussion: Based on the presence of mature elements and a single immature element it is hypothesized that at least two large canids are present in this block. The left distal radius has an unfused epiphysis which is not present. Although immature, this element is comparable in size to the fused *Canis lupus* radius in the University of Saskatchewan comparative collection, indicating it came from a wolf or large domestic dog rather than a coyote or fox. The remaining elements are mature and also similar in size to the *Canis lupus* in the University of Saskatchewan comparative collection suggesting that they too are most likely wolf or large domestic dog. Distinguishing between wolf, domestic dog and coyote archaeological specimens is virtually impossible unless relatively complete cranial elements are recovered (Lawrence 1967, Morey 1986, Morey and Wiant 1992) . The ulna midshaft was reconstructed from three specimens.

5.3.3 Miscellaneous Specimens

Specimens identified: NISP=246; see Table 5.8.

Discussion: Two hundred and forty-six specimens could only be assigned to size class. Size class six specimens and the 21 indeterminate tooth enamel fragments likely represent severely fragmented bison remains. A large mammal rib head fragment possibly represents a medium sized ungulate, but other species could not be ruled out. A small piece of longbone shaft fragment represents size class three while two fragments of skull indicate at least one micro-mammal is present in the assemblage. The three 2nd phalanges could not be identified to class as they could be either from a small bird or a small mammal.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	218	Tooth enamel, skull fragments and longbone shaft fragments
5 – Large Mammal	1	Rib head fragment
3 – Small/Medium Mammal	1	Longbone shaft fragment
1 – Micro Mammal	2	Skull fragments
2 – Small Vertebrate	3	2nd Phalanges
Indeterminate Mammal	21	Tooth enamel
Total	**246**	

Table 5.8 Summary of block C miscellaneous specimens by size and class categories.

5.4 Block D Faunal Assemblage

Three percent of the 41,675 specimens recovered in block D is identified (Table 5.9). The entire assemblage weighs 13,455.6 g, and the majority (58.2%) of the entire assemblage is unburned while only 18% of the identified remains are burned.

	Identified				Unidentified				Total	
	N	%N	G	%g	N	%N	G	%g	N	G
Unburned	1051	4.3	6370.9	63.1	23211	95.7	3718.6	36.9	24262	10089.5
Burned	223	1.2	595.7	17.7	17190	98.8	2770.5	82.3	17413	3366.2
Total	1274	3.0	6966.6	51.8	40401	97.0	6489.1	48.2	41675	13455.7

Table 5.9 Block D faunal assemblage separated by burning.

Of the 1,274 specimens recovered from block D, 641 were identified at least to the family level (Table 5.10). Eleven individuals represent eight separate species. The remaining specimens could only be assigned to a size and/or class category.

5.4.1 Order Artiodactyla

Bison bison

Specimens Identified: NISP=584; see Table 5.11for a summary. Landmarks were used to calculate MNE and MAU values and a complete list of all landmark values are found in Table 1, Appendix II.

Distribution and habitat: See page 34.

Discussion: Several elements indicate that at least two animals are represented in the block D assemblage. Two left ulnae, two right internal carpals, two right radial carpals and two right proximal metacarpals provide an MNI of two. A very small percent of the bison remains are burned (6.0%). Besides one complete metatarsal, the only whole bison elements recovered consisted of carpals, tarsals, sesamoids and phalanges.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	585	2
Medium-Large Canid (SC5)	*Canis sp.*	27	1
Snowshoe Hare	*Lepus americanus*	1	1
Rabbit family	Leporidae	8	-
Ground squirrel	*Spermophilus sp.*	1	-
Northern pocket gopher	*Thomomys talpoides*	1	1
Meadow Vole	*Microtus pennsylvanicus*	3	2
Voles	*Microtus sp.*	2	-
Gapper's red-backed vole	*Clethrionomys* cf. *gapperi*	3	2
Mice and Voles	Cricetidae	3	-
Shrews	*Sorex sp.*	1	-
Birds			
Small bird	Avian SC2	1	-
Medium bird	Avian SC4	1	-
Amphibians			
Tiger salamander	*Ambystoma tigrinum*	2	1
Toad	*Bufo sp.*	1	-
Reptiles			
Garter snakes	*Thamnophis sp.*	3	1
Miscellaneous			
Very Large Mammal (SC6)		512	-
Large Mammal (SC5)		4	-
Medium Mammal (SC4)		2	-
Small-Medium Mammal (SC3)		10	-
Micro-Mammal (SC1)		2	-
Small Vertebrate (SC2)		2	-
Indeterminate Mammal		98	-
Total		1274	11

Table 5.10 Summary of block D faunal remains by taxa.

5.4.2 Order Carnivora

Canis sp. (SC5)

Specimens identified: NISP=27; two thoracic vertebrae (1850/20-4-16), (1851/20-20), thoracic centrum (3475/20-4-15b), thoracic cranial and accessory articulation (1852/20-4-21), five lumbar vertebrae (1817/20-3-34), (1818/20-3-35), (1819/20-3-36), (1820/20-3-37), (1821/21-3-38), lumbar centrum (374/20-4-15a), lumbar caudal articular process (1848/20-4-14), caudal vertebrae (1824/20-3-42), two 2nd phalanges (1125/18-2-65).

Discussion: The canid vertebrae recovered in block D was semi-articulated. No elements were recovered complete and most are somewhat fragmented although one lumbar vertebrae (1821/21-3-38) is only missing the left transverse process and a small portion of the centrum. The remaining vertebrae are in varying stages of completeness. Only two vertebral centra (3474/20-4-15a and 3475/20-4-15b) are burned. Neither are completely burned;

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	8	1	1	0.5
Mandible	20	1	1	0.5
Hyoid	3	1	1	0.5
Rib	346	1	17	0.57
Atlas	1	1	1	1.0
Cervical Vertebrae	2	1	2	0.29
Thoracic Vertebrae	37	1	10	0.71
Lumbar Vertebrae	8	1	2	0.33
Sacrum	1	1	1	1
Forelimb				
Scapula	14	1	1	0.5
Humerus	8	1	1	0.5
Radius	10	1	2	1.0
Ulna	7	2	3	1.5
Internal Carpal	2	2	2	1.0
Radial Carpal	3	2	3	1.5
Ulnar Carpal	1	1	1	0.5
Metacarpal	4	2	2	1.0
5th Metacarpal	1	1	1	0.5
Hindlimb				
Innominate	8	1	0	0
Femur	5	1	1	1.0
Tibia	16	1	2	1.0
Astragalus	1	1	1	0.5
Fused C/4 Tarsal	5	1	2	1.0
5th Metatarsal	1	1	1	0.5
Metatarsal	15	1	2	1.0
Other Elements				
1st Phalanx	8	1	4	0.5
2nd Phalanx	6	1	5	0.63
3rd Phalanx	8	1	4	0.5
Proximal Lateral Sesamoid	3	1	3	0.38
Proximal Medial Sesamoid	6	1	6	0.75
Distal Inferior Sesamoid	10	1	5	0.63
Miscellaneous				
Molar/Premolar Indeterminate	8	-	-	-
Vertebrae Indeterminate	4	-	-	-
Metapodial Indeterminate	3	-	-	-
Phalanx Indeterminate	1	-	-	-
Sesamoid Indeterminate	1	-	-	-
Total	585			

Table 5.11 Summary of *Bison bison* elements from block D.

3474/20-4-15a is slightly darker in colour on the right side, while 3475/20-4-15b is almost

black on the right side due to heat alteration. All specimens recovered from block D are

consistent in size with the *Canis lupus* in the University of Saskatchewan collection indicating that the archaeological specimens are probably from a wolf or a large domestic dog.

5.4.3 Order Lagomorpha

Lepus americanus

Specimens identified: NISP=1; right proximal scapula (1832/20-3-50).

Distribution and habitat: The snowshoe hare is common throughout Canada. The species typically inhabits forests, swamps and riverside thickets. When on the prairies, it can be found in aspen groves (Banfield 1974:80-83).

Discussion: This single recovery does not display any evidence of cultural modification. The colour of the bone is consistent with the rest of the assemblage, suggesting that it is part of the archaeological assemblage.

Leporidae Indeterminate

Specimens identified: NISP=8; right proximal humerus (3487/20-4-48f), right proximal 2nd and 3rd metatarsal (1197/18-3-78), left tarsal (1129/18-2-69).

Discussion: These specimens could not be identified to genus as they are similar in size to both *Lepus* and *Sylvilagus*. None exhibit evidence of cultural modification and, as with the *Lepus americanus* specimen, are the same colour as the rest of the faunal assemblage indicating that they are not intrusive.

5.4.4 Order Rodentia

Spermophilus sp.

Specimens identified: NISP=1; left distal humerus (3448/19-4-119c).

Discussion: This element is similar in size to both *S. richardsoni* and *S. tridecemlineatus*. It was recovered in level four and is the same colour as the archaeological assemblage.

Thomomys talpoides

Specimens identified: NISP=1; left mandible (318/35-4-5).

Distribution and habitat: Northern pocket gophers are found in a variety of habitats from natural grasslands and riversides to cultivated fields and roadsides. When the preferred deep, heavy moist soils dry out during the summer, fresh mounds can be found on the edges of sloughs, poplar bluffs, and river banks. They are primarily subterranean, and their tunnels extend to a depth of two metres (Banfield 1974:148-149).

Discussion: This single mandible is incomplete with only the midsection present. The presence of M$_2$ and M$_3$ enabled species identification. The specimen has been subjected to

temperatures extreme enough to leave a blackened appearance. No other cultural modifications are present.

Microtus pennsylvanicus

Specimens identified: NISP=4; two left mandibles (1557/19-4-29) (3714/20-4-23), two right mandible (1330/18-5-38, 356/35-4-45).

Distribution and habitat: This species is found across Canada except for Vancouver and the Queen Charlotte islands. Meadow voles prefer wet meadows but will live in grassland habitats such as salt marshes, abandoned fields, prairies, and vacant lots. They prefer deep forests although they can be found around the edges of woods. They do not like high dry grassland. These animals do not hibernate or burrow (Banfield 1974:209-211).

Discussion: At least two animals are present in block D. No specimen is complete although all contain the entire tooth row. Three are broken directly behind the last molar while the fourth specimen includes a small portion of the ascending ramus. Three mandibles were excavated from level four (15-20 cm dbs), and one was found in level five. Two (1330/18-5-38, 356/35-4-45) are completely blackened due to burning, while another (1557/19-4-29) is darker than the unburned faunal assemblage. It is difficult to determine whether the colour on this specimen is due to thermal alteration or some other unknown process. The fourth mandible does not exhibit any cultural modification.

Microtus sp.

Specimens identified: NISP=2; one maxilla (1429/19-2-49), one right mandible (215/35-2-18).

Discussion: Neither specimen holds adequate teeth for species identification. The fragmented mandible is burned while the maxilla is not. No other form of modification is present on either specimen.

Clethrionomys cf. *gapperi*

Specimens identified: NISP=3; two right mandibles (1521/19-3-96, 1631/19-4-117), one left mandible (1430/19-2-50).

Distribution and habitat: The Gapper's Red-Backed Vole is common throughout Canada. This species favours coniferous forests but hardwood forests are inhabited. When found on the prairies they are usually living in aspen bluffs and shrubby vegetation in coulees. Of utmost importance is the availability of water and they are seldom far from some water source. These animals do not construct tunnels of their own, but will utilize others - especially during the winter given that they remain active year round (Banfield 1974:180-181).

Discussion: The two right mandibles indicate two animals. Once again, none are complete. Specimen 1631/194-4117 is represented by only the midsection while the other right mandible is almost complete, missing only the mandibular condyle. The left mandible has only a portion of the mandible with the incisor and M_1. One of the specimens is a darker colour than the others, but it is difficult to determine if this is due to heat alteration or soil staining.

Cricetidae Indeterminate

Specimens identified: NISP=3; one maxilla (273/35-3-55), one right proximal mandible (1431/19-2-51), one right distal mandible 504/35-6-8).

Discussion: These specimens could not be identified to species because no teeth are present. They probably represent one of the species already discussed, but could potentially be from any mouse or vole species. None are culturally modified.

Sorex sp.

Specimens identified: NISP=1; one left mandible (1395/19-2-8).

Discussion: At least one shrew is present in the block D faunal assemblage although species could not be determined. This specimen exhibits no cultural modification, however it is slightly weathered.

5.4.5 Miscellaneous Avians

Aves Indeterminate (SC4)

Specimens identified: NISP=1; longbone shaft fragment (325/35-4-12).

Discussion: This single fragmented longbone shaft could only be identified as belonging to a medium-sized bird. The specimen displays no cultural modification although the beginning of rootlet etching is visible.

Aves Indeterminate (SC2)

Specimens identified: NISP=1; sternum fragment (1692/19-5-28).

Discussion: This specimen is comparable in size to a sparrow. A species could not be determined because it is size correlated with several different species. There are no cultural modifications on this specimen. Its colour is consistent with the archaeological assemblage, and it was recovered in level 5 (20-25 cm dbs) suggesting that it is not intrusive.

5.4.6 Order Caudata

Ambystoma tigrinum

Specimens identified: NISP=2; two vertebrae (294/35-5-78, 295/35-3-79).

Distribution and habitat: The tiger salamander can be found east of the Rockies to Ontario and south to the Mexican plateau. These animals are active from early spring to early fall, hibernating during the winter months. They can tolerate dry conditions but are most often found near small lakes, ponds or dugouts (Russell and Bauer 2000:55-56).

Discussion: These two vertebrae were found in the same unit, same level, and same quadrant, strongly suggesting they are from the same animal. Neither specimen exhibits evidence of cultural or natural modification.

5.4.7 Order Anura

Bufo sp.

Specimens identified: NISP=1; last lumbar vertebrae (1017/35-4-11a).

Discussion: This specimen may represent *Bufo americanus*, the only toad currently found in the region. Given that it could also be from a species no longer present in the area, it is only identified to genus level. This unmodified specimen is complete.

5.4.8 Order Squamata

Thamnophis sp.

Specimens identified: NISP=3; three vertebrae (3128/18-5-36, 392/35-4-82, 421/35-4-112).

Discussion: It is uncertain which species these three vertebrae came from. The *Thamnophis radix* (plains garter snake) and *Thamnophis sirtalis* (red-sided garter snake) are presently found in southwestern Manitoba. The plains garter snake is widely distributed throughout the Prairie provinces into the great plains and the upper midwestern United States. It is found in a variety of habitats including ponds, lakes, streams, marshes and dugouts. The red-sided garter snake inhabits all of southern Canada and the northern United States. Although it prefers aspen parkland and boreal forest, it may occur in all habitats (Russell and Bauer 2000:107-113). All three archaeological specimens were found between 20 and 30 cm dbs and only one is burned.

5.4.9 Miscellaneous Specimens

Specimens identified: NISP=630; see Table 5.12.

Discussion: The majority of the 630 specimens are represented by skull, longbone shaft and tooth enamel fragments of very large mammals (SC6). These specimens as well as the indeterminate mammal tooth enamel are most likely bison. Two distal sesamoids, an occipital condyle fragment and a rib shaft fragment could be from any SC5 animal. Skull,

Size Class	NISP	Elements Represented
6 – Very Large Mammal	512	Tooth enamel, skull fragments and longbone shaft fragments
5 – Large Mammal	4	Skull and rib shaft fragment, sesamoids
4 – Medium Mammal	2	Rib shaft fragment, vertebrae zygopophysis
3 – Small/Medium Mammal	10	Longbone shaft fragments, skull fragments
1 – Micro Mammal	2	Skull fragments
2 – Small Vertebrate	2	Proximal phalanx fragment, rib fragment
Indeterminate Mammal	98	Tooth enamel
Total	**630**	

Table 5.12 Summary of block D miscellaneous specimens by size or class categories.

vertebrae, rib and longbone shaft fragments represent SC4, SC3, and SC1 animals. A proximal phalanx and a rib fragment could not be identified to class and are listed as small vertebrate.

5.5 Block E Faunal Assemblage

A total of 45,676 specimens weighing 13,344.3 g was recovered from block E (Table 5.13). Less than half (46.8%) exhibit evidence of heat treatment and over 90% of the assemblage is unidentifiable.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	g
Unburned	2021	8.3	5799.2	64.8	22309	91.8	3151.4	35.7	24330	8950.6
Burned	1774	8.3	1356.9	30.9	19573	91.7	3036.8	69.1	21347	4393.7
Total	3795	8.3	7156.1	53.6	41882	91.7	6188.2	46.8	45677	13344.3

Table 5.13 Block E faunal assemblage separated by burning.

Eight species are represented by 16 individuals (Table 5.14). The majority of the identified remains (85%) could only be classified by size or class category.

5.5.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=509; see Table 5.15 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 2, Appendix II.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	509	4
Deer	*Odocoileus* sp.	2	1
Medium-Large Canid (SC5)	*Canis sp.*	15	1
Beaver	*Castor canadensis*	1	1
Thirteen-Lined ground squirrel	*Spermophilus tridecemlineatus*	1	1
Ground squirrel	*Spermophilus sp.*	2	-
Northern pocket gopher	*Thomomys talpoides*	2	1
Meadow Vole	*Microtus pennsylvanicus*	14	5
Gapper's red-backed vole	*Clethrionomys* cf. *gapperi*	3	1
Birds			
Small-Medium bird	Avian SC3	3	-
Small bird	Avian SC2	1	-
Amphibians			
Frogs and Toads	Anura	1	-
Reptiles			
Garter snakes	*Thamnophis* sp.	6	1
Miscellaneous			
Very Large Mammal (SC6)		2311	-
Medium Mammal (SC4)		12	-
Small-Medium Mammal (SC3)		8	-
Small Mammal (SC2)		6	-
Small Vertebrate (SC2)		2	-
Indeterminate Mammal		895	-
Total		3792	16

Table 5.14 Summary of block E faunal remains by taxa.

Distribution and habitat: See page 34.

Discussion: Four left mandibular second molars indicate the presence of four bison in block E. A small percent (12.4) of the bison assemblage is burned. Whole elements from block E include the usual carpals, tarsals, sesamoids and phalanges as well as four vertebrae.

Odocoileus sp.

Specimens identified: NISP=2; right proximal radius (3175/25-2-19), radius midshaft fragment (775/32/4/38a).

Discussion: Although these specimens could not be conjoined, they are likely from the same element of one animal. Both mule deer (*Odocoileus hemionus*) and white-tail deer (*Odocoileus virginianus*) presently inhabit the area. The main osteological difference between the two species is size with the mule deer being larger and more robust (Banfield 1974:388). Unfortunately the archaeological specimens did not match in size with either species present in

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	198	1	2	1.0
Mandible	37	4	4	2.0
Rib	22	1	2	0.07
Cervical Vertebrae	19	1	4	0.57
Thoracic Vertebrae	10	1	4	0.3
Lumbar Vertebrae	1	1	1	0.17
Caudal vertebrae	3	1	2	0.1
Forelimb				
Scapula	2	1	1	0.5
Humerus	10	2	2	1.0
Radius	4	2	3	1.5
Ulna	5	1	1	0.5
Internal Carpal	5	1	2	1.0
Radial Carpal	1	1	1	0.5
Accessory Carpal	2	2	2	1.0
Ulnar Carpal	1	1	1	0.5
Unciform Carpal	9	2	4	2.0
Fused 2/3 Carpal	3	1	2	1.0
Metacarpal	20	2	4	2.0
5th Metacarpal	1	1	1	0.5
Hindlimb				
Innominate	6	1	1	0.5
Femur	1	1	1	0.5
Patella	1	1	1	0.5
Tibia	11	1	1	0.5
Lateral Malleolus	2	2	2	1.0
Calcaneus	13	2	3	1.5.
Astragalus	8	2	3	1.5
Fused C/4 Tarsal	1	1	0	0
Fused 2/3 Tarsal	2	2	2	1.0
1st Tarsal	3	2	3	1.5
Metatarsal	7	1	1	0.5
Other Elements				
1st Phalanx	12	1	7	0.88
2nd Phalanx	9	1	3	0.38
3rd Phalanx	17	1	2	0.25
Proximal Lateral Sesamoid	7	1	7	0.88
Proximal Medial Sesamoid	8	1	7	0.88
Distal Inferior Sesamoid	3	1	2	0.25
Miscellaneous				
Molar/Premolar Indeterminate	31	-	-	-
Vertebrae Indeterminate	6	-	-	-
Metapodial Indeterminate	1	-	-	-
Phalanx Indeterminate	5	-	-	-
Sesamoid Indeterminate	3	-	-	-
Total	506			

Table 5.15 Summary of *Bison bison* elements from block E.

the University of Saskatchewan comparative collection, instead they were in between the mule deer and white-tail deer radii size.

5.5.2 Order Carnivora

Canis sp. (SC5)

Specimens identified: NISP=15; right proximal femur (520/33-3-22), right femur midshaft (516/33-3-18), right distal femur (514/33-3-16), right patella (515/33-3-17), right proximal tibia midshaft (284/32-4-23),), right distal fibula (484/33-2-42), hindlimb sesamoid (634/33-4-59), proximal second phalanx (3703/25-3-72a).

Discussion: All the canid remains recovered in block E fall between the size of the *Canis lupus* and the *Canis latrans* specimens in the University of Saskatchewan comparative collection. The elements are closer in size to the *Canis lupus* comparative sample, although not quite as large. They are identified here as canid SC5 because all were larger than the *Canis latrans* specimens. The size suggests that the archaeological specimens may be from a domestic dog, but relying solely on a single criteria, especially element size to distinguish between wild and domestic canids is flawed (Morey 1986:122). The remains most likely represent a single animal. All are from the hindlimb, with the exception of the phalanx that could also be from the forelimb. Only two specimens are burned, the patella and the sesamoid. These are also the only two elements recovered complete.

5.5.3 Order Rodentia

Castor canadensis

Specimens identified: NISP=1; right 3rd metatarsal (158/32-3-42).

Distribution and habitat: The American beaver is found throughout most of Canada and the United States. This aquatic rodent lives in slow-flowing streams, lakes, rivers, and marshes. They are most often found in forested regions, but will inhabit prairie streams, muskegs and tundra or alpine meadows. Beavers remain active year round, spending winters beneath the ice and in their lodges (Banfield 1974:158-160).

Discussion: This element is the only beaver specimen identified at the site. Its recovery from level three (10-15 cm dbs) seems to preclude it as being intrusive. No cultural modifications are easily apparent although two small marks may be obliterated incisions.

Spermophilus tridecemlineatus

Specimens identified: NISP=1; left mandible (10/32-1-10).

Distribution and habitat: The thirteen-lined ground squirrel can be found across southern and central Manitoba and Saskatchewan and also inhabits a small area of east central Alberta. Simple burrows in overgrown fields, shrubby areas and poplar bluffs, usually encountered in aspen parkland are where these animals can be found. They do not live in open grassland as do other ground squirrels. They do hibernate in the winter but experience natural arousal periods at least every twelve days (Banfield 1974:122-123).

Discussion: This complete mandible is obviously intrusive. It was recovered very close to the surface (five cm dbs) and it is a different and lighter colour than the archaeological assemblage. There is no indication that natural or cultural taphonomic processes affected this specimen.

Spermophilus sp.

Specimens identified: NISP=2; two lumbar vertebrae (462/33-2-19, 600/33-4-21).

Discussion: A separate individual than 10/32-1-10 appears to be represented by these two vertebrae. Not only were they found in levels two and four, but they are the same colour as the rest of the faunal assemblage. Specimen 600/33-4-21 shows evidence of heating. No other modifications are present on either specimen.

Thomomys talpoides

Specimens identified: NISP=2; right and left maxilla (2079/22-3-6), right innominate (547/33-3-50).

Distribution and habitat:

Discussion: Only one northern pocket gopher is represented by these remains. Their colour indicates that they are part of the archaeological faunal assemblage, but the completeness of the innominate is relatively unusual. There are no cultural modifications on either specimen.

Microtus pennsylvanicus

Specimens identified: NISP=14; two left and two right maxillaries (3241/25-3-16, 685/33-5-37), five right mandibles (2659/23-3-109, 3714/25-3-16a, 3715/25-3-60a, 3716/25-4-38a, 739/33-T-15), three left mandibles (3626/25-3-59a, 3285/25-3-60, 3336/25-4-38).

Distribution and habitat:

Discussion: At least five meadow voles are part of block E's faunal assemblage. None of the recoveries appear to be intrusive as staining on all is consistent with the rest of the assemblage. Neither set of maxillaries nor any of the mandibles are culturally modified.

<u>Specimens identified</u>: NISP=3; right maxilla (3300/25-3-75), left mandible (3191/25-2-36), right mandible (3284/25-3-59).

<u>Distribution and habitat</u>: See page 43.

<u>Discussion</u>: These specimens may belong to a single animal as they were excavated from the same level of the same unit. None are modified and all are similar in colour to the other archaeological remains.

5.5.4 Miscellaneous Avians

Aves indeterminate (SC 3)

<u>Specimens identified</u>: NISP=3; distal right radius (49/32-2-27), longbone shaft fragments (27/32-2-5).

<u>Discussion</u>: These specimens could not be speciated although the radius may be from an Anatinae but the lack of defining characteristics necessitated a more general identification. The longbone shaft fragments (N=2) are quite fragmented and all specimens are burned. No other modifications are present. These specimens may be related as they were recovered from the same level of the same unit.

Aves indeterminate (SC2)

<u>Specimens identified</u>: NISP=1; longbone shaft fragment (3650/24-4-30b).

<u>Discussion</u>: This single small longbone shaft fragment cannot be identified beyond size class. No modifications are visible although the specimen appears to be part of the archaeological assemblage.

5.5.5 Order Anura

Anura indeterminate

<u>Specimens identified</u>: NISP=1; hindlimb element (3279/25-3-54).

<u>Discussion</u>: This element cannot be identified beyond Order because the epiphyses are not present. Although there are no modifications visible, the specimen does not appear to be intrusive.

5.5.6 Order Squamata

Thamnophis sp.

<u>Specimens identified</u>: NISP=6; six vertebrae (3592/23-3-2b,3593/23-3-2c, 3594/23-3-2d, 2935/24-3-45, 2967/24-3-79, 3712/25-6-2a).

<u>Discussion</u>: One specimen is charred, and the rest do not exhibit any cultural modifications. It seems that these are not intrusive as their colour is consistent with the faunal recoveries. All except the burned specimen, which was found in level six, were excavated from level three (10-15 cm dbs).

5.5.6 Miscellaneous Specimens

Specimens identified: NISP=3234; see Table 5.16.

Discussion: The vast majority (85.4%) of block E identified faunal remains could only be catalogued to size or class categories. Most of the very large mammal (SC6) and the indeterminate mammal recoveries are likely highly fragmented bison remains. A cervical vertebrae spinous process can only be identified as SC4. The mammal SC2 and SC3 categories include a variety of element fragments.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	2311	Tooth enamel, skull and longbone shaft fragments
4 – Medium Mammal	12	Skull fragments, vertebrae fragment
3 – Small/Medium Mammal	8	Caudal vertebrae, 2nd phalanx,
2 – Small Mammal	6	Incisor, mandible, calcaneous, indeterminate element
2 – Small Vertebrate	2	Longbone shaft fragment, indeterminate element
Indeterminate Mammal	895	Tooth enamel, skull fragments
Total	3234	

Table 5.16 Summary of block E miscellaneous specimens by size or class categories.

5.6 Block F Faunal Assemblage

In block F, 57,107 faunal remains weighing 21,001.6 g were catalogued (Table 5.17). Most of the assemblage is unidentified, and slightly less than half is burned while only 11% of the identified specimens are burned.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	G
Unburned	3955	13.1	10971.1	73.2	26051	86..9	4010.7	26.8	30006	14981.8
Burned	518	1.9	973.4	16.2	26583	98.1	5046.4	83.8	27101	6019.8
Total	4473	7.8	11944.5	56.9	52634	92.2	9057.1	43.1	57107	21001.6

Table 5.17 Block F faunal assemblage separated by burning.

Five bison represent over half of the identified specimens (Table 5.18). Two deer elements and a small-medium sized bird element fragment are the only other specimens identified beyond size or class category.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	2496	5
Deer	*Odocoileus* sp.	2	1
Birds			
Small-Medium bird	Avian SC3	1	-
Miscellaneous			
Very Large Mammal (SC6)		1667	-
Large Mammal (SC5)		4	-
Small-Medium Mammal (SC3)		2	-
Indeterminate Mammal		301	-
Total		4473	6

Table 5.18 Summary of block F faunal remains by taxa.

5.6.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=2,495; see Table 5.19 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 2, Appendix II.

Distribution and habitat: See page 34.

Discussion: Five individuals are indicated by the presence of five right proximal mandibles. A very small amount (3.4%) of the bison assemblage from block F are identified as having been heat altered. Elements recovered in their entirety included carpals, tarsals, sesamoids, phalanges, two cervical and one thoracic vertebrae, and one right metatarsal.

Odocoileus sp.

Specimens identified: NISP=2; right 1st incisor (705/36-6-19), thoracic spine (19/26-3-8).

Discussion: Both specimens are consistent in size with mule deer although species identification is tenuous. Neither specimen is culturally modified but the incisor has fragmented since excavation.

5.6.2 Miscellaneous Avians

Aves indeterminate (SC3)

Specimens identified: NISP=1; rib shaft fragment (559/36-3-10).

Discussion: This small rib shaft fragment could not be identified beyond size category. No cultural modifications are present on the bone.

5.6.3 Miscellaneous Specimens

Specimens identified: NISP=1,974; see Table 5.20.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	206	3	5	2.5
Mandible	174	4	5	2.5
Hyoid	8	2	3	1.5
Rib	498	1	9	0.35
Atlas	244	2	2	2.0
Axis	103	2	2	2.0
Cervical Vertebrae	11	1	5	0.71
Thoracic Vertebrae	291	1	11	0.85
Lumbar Vertebrae	43	1	1	0.17
Forelimb				
Scapula	45	2	3	1.5
Humerus	61	2	2	1.0
Radius	6	2	2	1.0
Ulna	26	1	1	0.5
Internal Carpal	4	3	4	2.0
Radial Carpal	2	1	2	1.0
Ulnar Carpal	4	3	4	2.0
Unciform Carpal	1	1	1	0.5
Fused 2/3 Carpal	1	1	1	0.5
Hindlimb				
Innominate	108	1	2	1.0
Femur	3	1	2	1.0
Tibia	9	1	1	0.5
Lateral Malleolus	3	2	3	1.5
Calcaneus	1	1	1	0.5
Astragalus	3	2	3	1.5
Fused C/4 Tarsal	9	3	5	2.5
Fused 2/3 Tarsal	4	2	3	1.5
1st Tarsal	2	2	2	1.0
Metatarsal	137	4	5	2.5
Other Elements				
1st Phalanx	55	2	9	1.13
2nd Phalanx	3	1	3	0.38
3rd Phalanx	13	2	9	1.1
Proximal Lateral Sesamoid	4	1	4	0.5
Proximal Medial Sesamoid	7	1	7	0.88
Distal Inferior Sesamoid	4	1	3	0.38
Miscellaneous				
Molar/Premolar Indeterminate	16	-	-	-
Vertebrae Indeterminate	382	-	-	-
Metapodial Indeterminate	4	-	-	-
Sesamoid Indeterminate	1	-	-	-
Total	2495			

Table 5.19 Summary of *Bison bison* elements from block F.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	1667	Longbone shaft fragments, skull fragments, tooth enamel, indeterminate elements
5 – Large Mammal	4	Skull fragments, indeterminate phalanx
3 – Small/Medium Mammal	2	Skull fragments
Indeterminate Mammal	301	Tooth enamel, skull fragments
Total	1974	

Table 5.20 Summary of block F miscellaneous specimens by size and class categories.

Discussion: Most of the specimens identified to size class (99.8%) belong to either the very large mammal (SC6) or the indeterminate mammal category. These likely represent severely fragmented bison elements. The large mammal (SC5) and the small-medium mammal (SC4) skull fragments were quite small with no distinguishing characteristics.

5.7 Block G Faunal Assemblage

Of the 4,611 specimens weighing 4 584.8 g excavated from block G, 1,119 were identified beyond size or class category (Table 5.21). Only 23% of the identified remains are burned but when the entire assemblage is considered, this rises to 67%.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	g
Unburned	857	57.9	2691.9	90.9	625	42.1	269.6	9.1	1482	2961.5
Burned	262	8.4	386.3	23.8	2867	91.6	1237.0	76.2	3129	1623.3
Total	1119	24.2	3078.2	67.1	3492	75.8	1506.6	32.9	4611	4584.8

Table 5.21 Block G faunal assemblage separated by burning.

Only two taxa and two size classes are identified in the block G assemblage (Table 5.22).

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	153	2
Hares	*Lepus sp.*	7	1
Miscellaneous			
Very Large Mammal (SC6)		952	-
Indeterminate Mammal		7	-
Total		1119	3

Table 5.22 Summary of block G faunal remains by taxa.

5.7.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=153 see Table 5.23 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 2, Appendix II.

Distribution and habitat: See page 34.

Discussion: One-hundred and fifty-three specimens identified as *Bison bison* represent two animals. Two left metatarsals attest to at least two individuals. Twenty-five specimens or 16.3% of the assemblage is burned. A relatively large number of elements were recovered whole from block G. Most of these are sesamoids, tarsals and phalanges, but a single complete patella, and a single complete left metatarsal were also catalogued.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	27	1	2	1.0
Mandible	49	1	1	0.5
Rib	40	1	0	0
Forelimb				
Radius	2	1	0	0
Internal Carpal	1	1	1	0.5
Hindlimb				
Femur	1	1	1	0.5
Patella	1	1	1	0.5
Tibia	14	1	1	0.5
Lateral Malleolus	1	1	1	0.5
Calcaneus	1	1	1	0.5
Astragalus	1	1	1	0.5
Fused 2/3 Tarsal	1	1	1	0.5
Metatarsal	2	2	2	1.0
Other Elements				
1st Phalanx	1	1	1	0.13
2nd Phalanx	3	1	3	0.38
3rd Phalanx	1	1	1	0.13
Proximal Medial Sesamoid	1	1	1	0.13
Distal Inferior Sesamoid	2	1	2	0.25
Miscellaneous				
Vertebrae Indeterminate	4	-	-	-
Total	153			

Table 5.23 Summary of *Bison bison* elements from block G.

5.7.2 Lagomorpha

Lepus sp.

Specimens identified: NISP=7; two lumbar vertebra (703/29-1-11, 704/29-1-12), right distal humerus (699/29-1-01), right innominate (702/29-1-10), left femur (701/29-1-09), left proximal tibia (700/29-1-08).

Discussion: These elements are undoubtedly intrusive. They were recovered directly below the leaf litter, most elements are complete, and all exhibit a lighter colour than the rest of the archaeological assemblage.

5.7.3 Miscellaneous Specimens

Specimens identified: NISP=959; see Table 5.24.

Discussion: Only two miscellaneous categories are identified in block G. Both may represent fragmented bison remains.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	952	Longbone shaft fragments, tooth enamel, indeterminate elements
Indeterminate Mammal	7	Tooth enamel
Total	959	

Table 5.24 Summary of block G miscellaneous specimens by size and class categories.

5.8 Block H Faunal Assemblage

Only two percent of the 2,537 specimens catalogued from block H are identified beyond size or class (Table 5.25). Slightly over half the assemblage is burned and its total weight is 709.0 g.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	g	%g	N	g
Unburned	40	30.4	164.1	38.6	1143	96.7	261.4	61.4	1183	425.5
Burned	10	0.8	29.4	10.3	1344	99.2	254.1	89.7	1354	283.5
Total	50	2.0	193.5	27.2	2487	98.0	515.5	72.8	2537	709.0

Table 5.25 Block H faunal assemblage separated by burning.

Only a single bison, represented by 13 specimens, is identified (Table 5.26). The remaining identifiable specimens are grouped according to size and class categories.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	13	1
Miscellaneous			
Very Large Mammal (SC6)		26	-
Medium Mammal (SC4)		2	-
Small Vertebrate (SC2)		1	-
Indeterminate Mammal		8	-
Total		50	1

Table 5.26 Summary of block H faunal remains by taxa.

5.8.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=13; see Table 5.27 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 3, Appendix II.

Distribution and habitat: See page 34.

Discussion: The identified bison remains in block H indicate only one animal. Three specimens belonging to a single element are burned. The only complete bison elements from this block are two sesamoids and a carpal.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Mandible	3	1	1	0.5
Rib	3	1	1	0.04
Forelimb				
Fused 2/3 Carpal	3	1	1	0.5
Hindlimb				
Femur	1	1	0	0
Other Elements				
Proximal Lateral Sesamoid	2	1	2	0.25
Miscellaneous				
Molar/Premolar Indeterminate	1	-	-	-
Total	13			

Table 5.27 Summary of *Bison bison* elements from block H.

5.8.2 Miscellaneous Specimens

Specimens identified: NISP=37; see Table 5.28.

Discussion: The indeterminate mammal tooth enamel and the very large mammal (SC6) recoveries most likely represent unidentifiable bison elements. A small fragment of rib

shaft was not complete enough to be assigned beyond medium mammal (SC4) and a small faunal fragment could not be identified beyond small vertebrate (SC2).

Size Class	NISP	Elements Represented
6 – Very Large Mammal	26	Longbone shaft fragments, tooth enamel, indeterminate elements
4 – Medium Mammal	2	Rib body fragment
2– Small Vertebrate	1	Indeterminate element
Indeterminate Mammal	8	Tooth enamel
Total	37	

Table 5.28 Summary of block H miscellaneous specimens by size and class categories.

5.9 Block I Faunal Assemblage

In total, 17,020 specimens weighing 3,074.5 g were recovered from block I (Table 5.29). Twenty-seven percent of the identified remains and 44% of the unidentified remains are burned.

	Identified				Unidentified				Total	
	N	%N	g	%g	N	%N	G	%g	N	G
Unburned	161	1.7	273.0	18.5	9490	98.3	1249.1	81.6	9652	1522.1
Burned	61	0.9	157.2	10.1	7308	99.1	1395.2	89.9	7369	1552.4
Total	222	1.3	430.2	14.2	16798	98.7	2644.3	85.8	17020	3074.5

Table 5.29 Block I faunal assemblage separated by burning.

Thirty-nine of the 223 identified remains, represent four animals of four taxa (Table 5.30). The remaining 184 specimens are identified only to size or class category.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	26	1
Medium-Large Canid (SC5)	*Canis* sp.	3	1
Northern pocket gopher	*Thomomys talpoides*	1	1
Reptiles			
Garter snakes	*Thamnophis* sp.	9	1
Miscellaneous			
Very Large Mammal (SC6)		125	-
Medium Mammal (SC4)		3	-
Small-Medium Mammal (SC3)		1	-
Indeterminate Mammal		55	-
Total		223	4

Table 5.30 Summary of block I faunal remains by taxa.

5.9.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=26; see Table 5.31 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 3, Appendix II.

Distribution and habitat: See page 34.

Discussion: The 26 bison remains recovered from block I indicate only one animal. Nine specimens are burned. Various sesamoids, a tarsal and a phalanx were the only elements recovered whole.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Mandible	6	1	1	0.5
Rib	9	1	1	0.04
Hindlimb				
Tibia	1	1	1	0.5
Fused C/4 Tarsal	2	1	1	0.5
Other Elements				
1st Phalanx	1	1	0	0
3rd Phalanx	1	1	1	0.13
Proximal Lateral Sesamoid	1	1	1	0.13
Proximal Medial Sesamoid	1	1	1	0.13
Distal Inferior Sesamoid	2	1	1	0.13
Miscellaneous				
Sesamoid Indeterminate	2	-	-	-
Total	26			

Table 5.31 Summary of *Bison bison* elements from block I.

5.9.2 Order Carnivora

Canis sp. (SC5)

Specimens identified: NISP=3; two canine teeth fragments (1071/31-2-23, 1283/31-3-42a), third phalanx (1110/31-3-36).

Discussion: The teeth fragments are identified as canid based on size and morphology. It is possible that both fragments are from the same tooth as both are burned. The third phalanx displays no cultural modification but is very slightly weathered with small weathering cracks beginning to form.

5.9.3 Order Rodentia

Thomomys talpoides

Specimens identified: NISP=1; right mandible (1136/31-4-12).

Distribution and habitat: See page 42.

Discussion: This single specimen represents one animal. There are no signs of cultural modification. It does not appear to be intrusive as it was recovered at a depth of 20 cm dbs and the colour is consistent with the rest of the assemblage.

5.9.4 Order Squamata

Thamnophis sp.

Specimens identified: NISP=9; nine vertebrae (1057/31-2-9, 1099/31-3-25, 1120/3).

Discussion: All except one vertebra were found in level three (10 to 15 cm dbs). Only one specimen is blackened, indicating that it had been heated. The rest of the remains also seem to part of the archaeological assemblage.

It has been shown that small animals such as rodents, amphibians and reptiles can inadvertently become incorporated into the archaeological record. This commonly happens when a site's inhabitants utilize features such as pits and hearths. Small animals can become trapped in such features after site abandonment or even while the site is still inhabited. These remains can and have erroneously been considered part of the archaeological assemblage (Whyte 1991).

It does not appear that this is the scenario at the Jackson site as no pit features were excavated in any of the units. It is also possible that these small animals were attracted to the refuse littering the area, died of natural causes and became incorporated into the archaeological record. This, however, does not account for the grouping of elements throughout the block. It is most likely that the small animal remains are the visible trace of a cultural activity centred on processing of animals for food.

5.9.5 Miscellaneous Specimens

Specimens Identified: NISP=184; see Table 5.32.

Discussion: One hundred and eighty-four specimens could be identified only to size or class. The very large mammal category (SC6) and the indeterminate mammal category undoubtedly contain fragmented bison specimens. Two rib shaft fragments are beaver size and therefore are catalogued as medium mammal (SC4). A small piece of bone could only be identified as a small-medium mammal.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	125	Longbone shaft fragment, skull fragment, indeterminate element
4 – Medium Mammal	3	Rib shaft fragments
3 – Small/Medium Mammal	1	Indeterminate element
Indeterminate Mammal	55	Tooth enamel
Total	184	

Table 5.32 Summary of block I miscellaneous specimens by size and class categories.

5.10 Block J Faunal Assemblage

Sixteen percent of the 3,640 specimens found in block J are identified (Table 5.33). Just under half of the assemblage is burned but 76% of the identified remains show evidence of heat treatment.

Three individuals are represented by three separate species (Table 5.34). The remaining 524 specimens are classified to size or class categories.

	Identified				Unidentified				Total	
	N	%N	G	%g	N	%N	g	%g	N	G
Unburned	174	9.3	478.6	65.0	1696	90.7	257.3	35.0	1870	735.9
Burned	452	25.0	98.9	42.4	1355	75.0	134.3	57.6	1807	233.2
Total	626	17.0	577.5	59.6	3051	83.0	391.6	40.4	3677	969.1

Table 5.33 Block J faunal assemblage separated by burning.

Common Name	Taxon	NISP	MNI
Mammals			
Bison	*Bison bison*	49	1
Medium-Large Canid (SC5)	*Canis* sp.	51	1
Reptiles			
Garter snakes	*Thamnophis* sp.	2	1
Miscellaneous			
Very Large Mammal (SC6)		469	-
Indeterminate Mammal		55	-
Total		626	3

Table 5.34 Summary of block J faunal remains by taxa.

5.10.1 Order Artiodactyla

Bison bison

Specimens identified: NISP=49; see Table 5.35 for a summary. Landmarks were used to calculate MNE and MAU vales and a complete list of all landmark values can be found in Table 3, Appendix II.

Distribution and habitat: See page 34.

	NISP	MNI	Total MNE	Total MAU
Axial Skeleton				
Cranium	3	1	0	0
Rib	12	1	1	0.04
Cervical Vertebrae	2	1	0	0
Thoracic Vertebrae	2	1	0	0
Forelimb				
Radius	1	1	1	0.5
Ulna	21	1	0	0
Metacarpal	1	1	1	0.5
Hindlimb				
Femur	1	1	1	0.5
Patella	1	1	1	0.5
Tibia	1	1	0	0
Other Elements				
2nd Phalanx	1	1	1	0.13
3rd Phalanx	1	1	1	0.13
Miscellaneous				
Sesamoid Indeterminate	2	-	-	-
Total	49			

Table 5.35 Summary of *Bison bison* elements from block J.

Discussion: The 49 specimens from block J represent one individual. Ten percent of the assemblage is burned. Two phalanges and a single patella were the only whole elements recovered in this block.

5.10.2 Order Carnivora

Canis sp. (SC5)

Specimens identified: NISP=51; indeterminate deciduous incisor (60/34-3-53), left 1st incisor (53/34-3-44), right 1st incisor (103/34-3-107), left 2nd incisor (104/34-3-108), right 2nd incisor (102/34-3-106), left 3rd incisor (153/34-5-19), right 3rd incisor (59/34-3-52), deciduous canine (58/34-3-51), right canine (180/34-7-2), right 2nd premolar (99/34-3-103), left deciduous 2rd premolar and left 3rd premolar (54/34-3-45), right 3rd premolar, 4th premolar, 1st molar, 2nd molar (60/34-3-54), left 4th premolar, 1st molar, 2nd molar, deciduous 3rd premolar, deciduous 4th premolar (62/34-3-55), right deciduous 4th premolar (55/34-3-46), left 3rd molar (101/34-3-15) indeterminate tooth enamel (148/34-5-19).

Discussion: The recovery of deciduous and unerrupted permanent teeth in the identical stages of development from left and right mandibles attests to a single individual in block J. Specimens were compared to various *Canis* species, including an immature wolf cub housed in the University of Saskatchewan comparative collection. The Jackson site elements

are much larger than the comparative wolf cub and more closely correlate in size to a fully mature *Canis latrans*. Given the immature nature of the archaeological specimen, this indicates that it is from a wolf or large domestic dog. Measurement ratios of canid mandibles have been used to speciate animals (Walker 1995:66). Unfortunately these measurements are only valid for adult specimens and a species designation for the Jackson site mandible cannot be achieved.

None of the permanent teeth have yet erupted, and most of the deciduous teeth are still present although they were not uncovered intact in the mandibles (Figure 5.1). The eruption sequence of the archaeological specimen was compared to that presented by Sisson and Grossman (1975:1543) who note that deciduous teeth erupt between three and five weeks of age. Permanent teeth begin to erupt in about the third month, with the first molar and the first premolar emerging.   The second molar and remaining premolars erupt between five and six months while the third molar and permanent canines appear in the sixth or seventh month (Hillson 1986:217). Based on this schedule, the archaeological specimen is at least five weeks old but younger than six months. A single permanent canine was blackened by heat alteration.
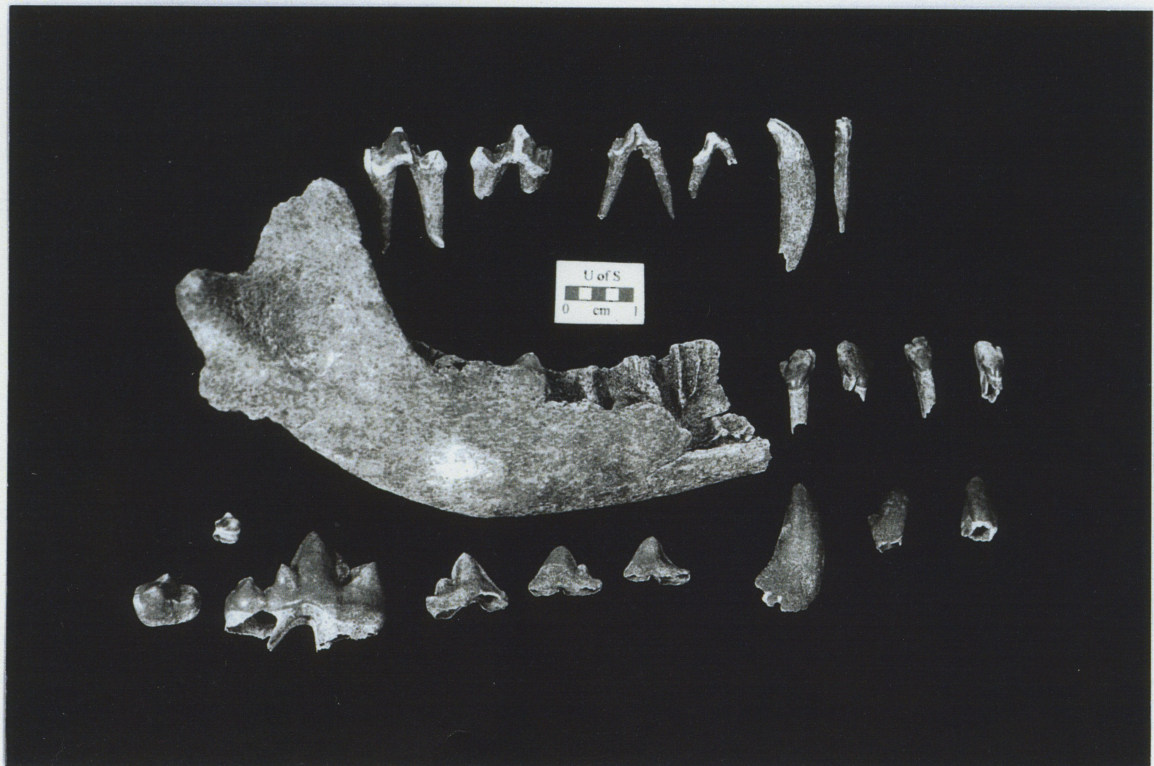
Figure 5.1 Immature canid mandible from block J. Deciduous teeth are top row.

5.10.3 Order Squamata

Thamnophis sp.

Specimens identified: NISP=2; two vertebrae (174/34-6-15, 175/34-6-16).

Discussion: These two vertebrae were recovered in the same quadrant of the same level. One is blackened suggesting that it has been burned.

5.10.4 Miscellaneous Specimens

Specimens identified: NISP=524; see Table 5.36.

Discussion: The miscellaneous specimens in block J represent only one size class and one class category. The very large mammal category is inflated by the recovery of a single indeterminate tooth that fragmented into 405 pieces. This is probably bison but given the fragmentary nature, it could not be positively identified. The remaining specimens too are most likely bison.

Size Class	NISP	Elements Represented
6 – Very Large Mammal	469	Longbone shaft fragment, skull fragment, indeterminate element
Indeterminate Mammal	55	Tooth enamel
Total	524	

Table 5.36 Summary of block J miscellaneous specimens by size and class categories.

5.11 Distribution of Faunal Remains

By examining the distribution of remains across a site, archaeologists are able to make inferences about activities undertaken by the site's inhabitants. Certain artifact and faunal element distribution patterns have come to represent specific activities such as primary kills and butchering, secondary butchering, processing, waste disposal and habitation. Ideally, the faunal element distribution within a site can be evaluated to determine if concentrations of specific elements or element groups exist. Often such faunal element concentrations are associated with a variety of features that further help explain past activities. Distribution maps for all excavation levels were created for bison, canid, rodent, as well as amphibian and reptile elements represented by landmark (Appendix III). Maps were also created for burned and unburned unidentified bone (Appendix III). Bison element distribution maps were created for the cranium, vertebrae, forelimb, hindlimb as well as phalanges and sesamoids (Appendix III). Given the high fragmentation of the remains, the landmark with the highest frequency for each element was mapped. Although this may result in some element fragments not being mapped,

it was deemed the most reasonable method to ensure that high fragmentation did not obscure distribution patterns.

5.11.1 Bison cranial distribution

No complete crania or mandibles were recovered at the Jackson site. The highest landmark count for the cranium (petrous) and the mandible (M_2) were mapped (Figure 1, Appendix III). Blocks B, C, D, E and G all contain scattered cranial elements, while the majority were recovered from block F where light concentrations were present in units 27 and 36.

5.11.2 Bison vertebrae distribution

The vertebral elements were mapped much in the same manner as the cranial elements. Only specimens relating to the highest landmark count for each element were mapped (Figure 2, Appendix III). Clusters are present in blocks D, E and F while scattered individual specimens were recovered in block B. A concentration of thoracic spines in block D is directly related to a boiling pit feature. Recoveries from block E are light clusters. Block F vertebral elements are concentrated in unit 26 although vertebral elements were recovered from all units in block F.

5.11.3 Bison forelimb distribution

Forelimb elements are found in all blocks except block I (Figure 3, Appendix III). Scattered elements were identified in blocks B, C, G, H, and J. A medium cluster is associated with the boiling pit feature in block D while a heavy concentration is present in block E. Light concentrations are present in units from block F.

5.11.4 Bison hindlimb distribution

Hindlimb element distribution differs slightly from the forelimb distribution (Figure 4, Appendix III). Blocks G and I contained no hindlimb elements while a few were scattered in block D. Block B has three light clusters while block E has several light clusters. Concentrations in block F are mostly light except for a single medium cluster at the north end of unit 27. Block C has a single heavy concentration centered in unit 16.

5.11.5 Bison phalanges and sesamoid distribution

Phalanges and sesamoids are scattered throughout the entire site (Figure 5, Appendix III). Scattered elements are identified in blocks B, H, and J. Blocks D and E both contain several light clusters each while blocks G and I have two and one light clusters respectively. Medium concentrations are present in blocks C and F. Once again, the medium concentration

in block C is found in unit 16 while the medium concentrations in block F is found in units 26 and 36.

5.11.6 Cervid element distribution

Only three cervid elements were identified. No concentrations were present as one element was recovered from block E and the other two were from separate units in block F.

5.11.7 Canid element distribution

Canid remains were recovered from five blocks (Figure 6, Appendix III). Blocks C and E each have a few scattered elements as well as localized medium concentrations. Block I has a single light concentration while block J also has a single light concentration of an immature canid mandible. A heavy concentration of canid elements consisting mostly of vertebral elements is present in block D, about one metre north of the boiling pit feature.

5.11.8 Leporid element distribution

A total of 11 leporid elements were found at the Jackson site. Over half of these are intrusive remains recovered from block G. A single element was recovered in block B and a light concentration was recovered in block D adjacent to the boiling pit feature.

5.11.9 Rodent element distribution

Rodent remains were recovered from only three blocks (Figure 7, Appendix III). A single element was found in the northwest quadrant of unit 31. Blocks D and E contained the remaining rodent specimens. Several scattered elements, two light clusters and a medium concentration is found in block D. Block E has two single elements in addition to a medium concentration in unit 33 and a heavy cluster in the northern quadrants of unit 25.

5.11.10 Avian element distribution

Five elements are identified to the avian category. A single element was recovered in block F. Blocks D and E contain two scattered elements each.

5.11.11 Amphibian and Reptile element distribution

The amphibian and reptile distribution pattern closely resembles that for the rodents (Figure 8, Appendix III). Remains were excavated from blocks D, E, I and J. A single light cluster is present in block J. The recovery of several snake vertebrae in the northeast quadrant of block I creates a medium concentration and a single element is also present in this unit's southeast quadrant. Block D has three light clusters adjacent to the boiling pit feature while block E has two light clusters.

5.12 Discussion

Only a few features were instantly recognizable at the Jackson site. A greasy organic stain was encountered in units 13 and 14 of block B. This feature was identified by a dark 'sticky' soil with several charcoal fragments. No distinguishable morphology was present, neither was ash or heat oxidized sediment beneath the feature which would have indicated excessive temperatures. Faunal remains and an abundance of surrounding fire broken rock (FBR) identified the remnants of a boiling pit in block D. A lithic reduction station was located in block E. A large quantity of small reduction flakes was excavated from units 22, 23, 32 and 33, with the highest concentration occurring in unit 22. No other definitive features are identified from blocks B through J. It is possible that small isolated features such as post molds were simply not recognized as the mottled nature of the sediment may have masked such features, Hearths, however, can easily be identified in the sandy matrix of the Lauder Sandhills (Playford 2000). The lack of identified hearths at the Jackson site is most likely due to sampling bias.

The majority of the faunal remains in block B are unidentifiable burned bone fragments recovered from unit 13. Of the identified remains, all except a single hare element were bison. The only bison bone to occur in significant concentrations were hindlimb and forelimb elements consisting mostly of carpals and tarsals. These are generally found about 20 cm southeast of the organic stain. There is also a high frequency of burned, unidentified fragmented bone around the organic stain (Figure 9, Appendix III). The remains suggest that block B is centred on a small waste disposal area concentrated in the north and western quadrants of unit 13. The concentration of tarsals and carpals in addition to the burned unidentified bone fragments is considered to represent waste disposal following grease extraction.

A concentration of fragmented bison forelimb longbone elements and tarsals, as well as phalanges and sesamoids is present in unit 16 of block C. Two canid elements are found east of, and a small cluster of canid forelimb elements is located southeast of, the bison bone concentration. An immature element within the canid cluster shows that at least two different individuals were present in this part of the site. The recovery of bison forelimb longbone fragments suggests that marrow extraction may have been taking place in or adjacent to block C although this issue is further addressed in Chapter Seven. Unidentified bone fragments are fairly equally represented throughout the block although a slightly higher frequency of unburned bone fragments occur in the western quadrants of unit 16 (Figures 9 and 10,

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Appendix III). No features were excavated, suggesting that the processing activity took place elsewhere. Instead, it appears that block C is adjacent to a processing area such as a boiling or grease-rendering pit. The recovery of disarticulated canid forelimb elements from at least two individuals southeast of the bison bone concentration indicates that this might have been an area where canids were systematically being butchered for processing and ultimately consumed.

The most definitive feature at the Jackson site was excavated in block D. A semi-circular construction of FBR is associated with a concentration of bison bone. These bones consisted mostly of rib bodies, thoracic spines as well as longbone shafts. All bone in the feature was fragmented; many of the longbone shaft portions did not contain landmarks but could be identified to element. Surrounding the bison bone concentration were longbone articular ends of the forelimb elements except the humerus. Several carpals as well as a few tarsals were recovered adjacent to the bison bone concentration. A higher percent of the bulk bone in block D was unburned. Very few burned bone fragments were excavated adjacent to the bison bone concentration. No visible pit was unearthed during excavation, and the soil beneath the bone concentration did not exhibit signs of oxidization. It appears that the bison bone concentration is the remnants of a meat-boiling pit. The pit may have been adjacent to the excavated units, or the site's inhabitants used an apparatus such as a bison stomach supported on sticks as a container. Peter Fidler relates observing such an event during the winter. "The Indians made to me a new fashioned kettle, of the paunch of the cow; by making a hole in the ground of about two feet diameter and one foot deep to support the bag and four corners were propped up with sticks set in the ground in six or eight places keeping the mouth extended about two feet wide. They broke the bones of the buffalo made marrow fat – boiled meat – made broth all in this uncommon apparatus by immersing hot stone frequently into it . . . " (MacGregor 1966:37).

The high species diversity of the block D faunal assemblage suggests that bison was not the only animal being butchered and processed. A semi-articulated canid vertebral column located approximately one metre north of the bison bone concentration is interpreted as a butchering unit. A leporid proximal scapula and humerus head were excavated adjacent to the canid elements. A small cluster of burned rodent elements is directly associated with the boiling pit contents. Larger clusters are found east and north of the bison bone concentration. These rodent elements cannot be dismissed as intrusive. The cluster associated with the boiling pit contents contain fragmented Meadow and Gapper's red-backed vole elements.

Neither species burrow or hibernate. Once again, Meadow and Gapper's red-backed vole elements were recovered from the larger clusters, as were ground squirrel, Northern pocket gopher and shrew elements. Other species excavated adjacent to the boiling pit contents include salamander, snake, toad and bird.

Like block D, the species diversity of block E is quite high with bison elements being the most numerous. Besides a partial bison skull, few cranial elements are present in this block. Concentrations of vertebral elements are found northeast of the bison skull. A heavy concentration of bison forelimb elements is clustered in the eastern quadrants of unit 32. The concentration consists mostly of longbone articular ends as well as carpals. A concentration of fragmented forelimb longbone shafts is present in unit 24 although the majority of these specimens lack landmarks. Hindlimb elements are not very numerous and are widely scattered throughout the block. Phalanges and sesamoids are also widely scattered throughout the block although one heavy concentration is present in unit 24 and two medium concentrations are in unit 33. Disarticulated canid hindlimb elements are clustered along the southern edge of unit 33, directly north of the partial bison skull. Two deer specimens that characterize a single element were recovered from units 32 and 25. Bird bone was identified in units 32 and 24. Two heavy concentrations of rodent remains are visible in block E. One is slightly north of the canid remains while the heaviest concentration is in the northern part of unit 25. A single beaver element was excavated from unit 32. Amphibian and reptile remains are also present in block D, but are found straddled between units 24 and 25 as well as in the southeastern quadrant of unit 23.

The faunal distribution pattern in block E does not reveal any specific activity. The bison bones save for the forelimb elements are fairly scattered throughout the entire block. The concentration of forelimb elements in unit 32 most likely represents disposal after marrow extraction occurred either in or adjacent to unit 25. The concentrations of canid, rodent and amphibian/reptile elements may correspond with butchering and/or processing of these animals or perhaps subsequent disposal of the remains. No detectable pattern of unburned or burned unidentifiable bone exists with both equally represented in this block. The high species diversity, the scattered nature of the faunal elements and the lack of patterned unidentified bone deposition coupled with a dearth of features and the excavation of a lithic reduction station demonstrate that block E is plausibly a refuse area. Limited activities such as marrow extraction and processing of small animals may have taken place either in or adjacent to block E.

A small bison kill occurred in block F. Subsequent activities including butchering and initial processing of the bison carcasses were also carried out. As expected in a kill area, bison dominate the faunal assemblage although two deer elements and a single small to medium bird element were recovered. Unlike a kill site, very few of the elements were recovered whole. Cranial and vertebral elements are relatively numerous compared to the rest of the site, but many are fragmented and lack landmarks. Cranial elements tend to be concentrated in units 37 and 36 while vertebral elements clustered in unit 26. A high frequency of hyoid fragments is noted in unit 27. Rib bones are also quite numerous in block F, but once again these elements are quite fragmented. Forelimb elements are somewhat scattered throughout the block but clear patterns are present. Carpals are concentrated in the northern portion of unit 27 while the southern part of the unit and unit 36 contain fragmented longbone shafts and articular ends. Another small concentration of carpals is present in unit 26. Hindlimb elements exhibit a similar distribution pattern. Tarsals are numerous in the northern portion of unit 27 although fragmented longbones are also present. Recoveries from unit 36 comprise a few tarsals as well as fragmented longbones and pelvic fragments. A cluster of tarsal and pelvic fragments were also found in unit 26 while a single tarsal was recovered in unit 28. Distribution patterns of burned and unburned unidentified bone fragments are almost identical although burned bone fragments are more numerous. High concentrations of both are present in the northeast quadrant of unit 27 and all of unit 36. This appears to be the core area of the bison kill as indicated by the high number of cranial elements. Primary butchering immediately took place and the clusters of disarticulated carpals and tarsals likely represent discard piles of low utility elements. The recovery of such high numbers of smashed bone in these units suggests that initial intensive processing was occurring adjacent to the kill/butchering area. It is most likely that marrow extraction was a primary activity given the high percentage of longbone shaft fragments and longbone articular ends.

It is difficult to infer activities that may have occurred in blocks G through J. This is a factor of block size as all are single excavation unit blocks rather than the nature of the excavated faunal assemblage. It is readily apparent that the majority of recovered faunal remains are concentrated in the northeast quadrant of unit 29. Bison is predominately represented by hindlimb elements and phalanges with sesamoids. The cranial NISP is relatively high although the MNE is quite low. A single carpal makes up the forelimb elements while hindlimb elements in addition to the phalanges and sesamoids are concentrated in two discrete clusters. The cluster in the northeast quadrant consists of a complete

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metatarsal, patella, fused second and third tarsal, sesamoids and phalanges. An additional proximal metatarsal is also present. The second cluster in the southwest quadrant is comprised of a fragmented femur midshaft, an astragalus, a calcaneous, a lateral malleolus and a couple of phalanges. It is interesting to note that all elements are lefts although this may be related to small sample size rather than cultural patterning. Unidentifiable bone recovery is most prominent in the northeastern quadrant and burned bulk bone is slightly more numerous than unburned. The remains of a hare are considered to be intrusive and not part of the archaeological record. The unit is likely along the edge of a refuse area where secondary processing was taking place. The recovery of several tarsals and a single carpal implies that hindlimb butchering units were being processed adjacent to unit 29.

Very few faunal remains were recovered from block H. Bison was the only identified species with 13 specimens, and unidentified bone was relatively scarce. The lack of remains suggests that block H is situated in an area of the site where little or no food preparation was occurring. The block is either located within the habitation area, which would explain the lack of artifacts or is simply on the outskirts of activity areas.

Identified bison elements are also relatively scarce in block I. Elements with identifiable landmarks consisted mostly of phalanges and sesamoids as well as a single tarsal. Ribs and tibia fragments did not exhibit landmarks that were mapped. For the block size, the species diversity is rather high. A canid femur, 3rd phalanx and tooth fragment were recovered from the eastern part of the unit. A single Northern pocket gopher element was excavated from the northwest quadrant while snake vertebrae were found in the western quadrants. The unidentified bone recovery in block I is rather high and is also centred in the northeastern quadrant. Unburned bulk bone is slightly more numerous than burned bulk bone. No evidence of cultural activities such as butchering or processing is present in this block. The pattern of faunal distribution instead indicates that block I is situated on a refuse pile that may be the southwestern boundary of the refuse pile associated with block E.

Recoveries from block J are similar to those in block H. Overall, few bison elements were recovered and species diversity is low. An immature canid mandible was excavated from the northwest quadrant and a few snake vertebrae were recovered from the southwest quadrant. The canid mandible is associated with the few bison phalanges recovered from this unit. Like block H, this unit is situated in an area of the site where little cultural activity was taking place and the remains probably denote a scattering of refuse either in the habitation locale or on the outskirts of main activity areas.

5.13 Summary

A large faunal assemblage was amassed during the 1995, 1996 and 1997 excavations at the Jackson site. A total of 193,548 specimens were identified and catalogued, the vast majority of which are unidentifiable bone fragments, either burned or unburned. The identified faunal assemblage consisted primarily of bison bone although a variety of other animal species are present.

The distribution of the faunal assemblage across the site provides insight into the cultural activities occurring at the site. A small bison kill with subsequent butchering and processing of the bison carcasses transpired at the north of the site where block F is situated. Intensive processing of bison bone was taking place adjacent to blocks B and C where remnants of such activities are present. An area of small animal processing is associated with a boiling pit dump in block D. The faunal remains in block E indicate that this area is on the edge of a main refuse pile and processing activities like marrow and grease extraction occurred adjacent to block E. Block I may be on the southwestern edge of this main refuse pile. A small localized refuse dump is located in the northeastern quadrant of unit 29 while blocks H and J are either located outside of camp activity areas or possibly within the habitation zones.

Chapter 6
Bison Population Dynamics and Site Seasonality

6.1 Introduction

Faunal evidence is one of the most useful indicators of site seasonality on the northern plains. At the Jackson site, bison remains offer the best information regarding season of site occupation. The recovery of foetal and immature bison elements provides information about the bison population age structure. Dentition studies undertaken on the mandibular teeth enable tentative statements about the bison age structure to be put forth. Analysis of bison carpal and tarsal bones allow for the bison population sex structure to be determined. Dentition studies in conjunction with the foetal remains can be used to determine the season of site occupation.

6.2 Bison Population Age Structure

Establishing the age structure of an archaeological bison population can be accomplished by analyzing the faunal remains. Dentition studies in addition to the analysis of immature and especially foetal elements provide a general age structure for the Jackson site faunal assemblage. The dentition studies and analysis of the foetal remains are based on the premise that bison have restricted schedules of conception and birth.

Modern studies indicate that the bison rut and birthing schedules are restricted events while ethnohistoric evidence suggests that these events can occur anytime during the year. Banfield (1974:406) states that the rut takes place from early July to late September and peaks in mid-August. Parturition follows a 270 to 300 day gestation period and occurs between mid-April and June with a peak in early May. Historical accounts concur that the rut usually began sometime in July but disagree about the length of the rutting period. These periods have been said to last two, three, three and a half as well as four months by various observers. It is noted that the rut tends to begin earlier in the south and later in the north. During Catlin's travels through South Dakota, he reported that the breeding season was in August and September. Modern herd rutting seasons in Utah begin in late July while those in Oklahoma start at the beginning of June (Arthur 1975:48-49). McHugh (1972:192) states that the rutting

season on the southern and central Plains usually began in July, but peaked around mid-August in the northern Canadian Plains. Although there is disagreement regarding the onset and length of the rut, it does appear to begin anywhere from early June to August and last until September, with it beginning slightly later on the northern Plains.

Given a fairly restricted rutting season and known gestation period, it is assumed that parturition will also be a restricted event as suggested by Banfield (1974). Roe (1972:96) contends that although the birthing season generally extends from mid-April to the end of June, historical accounts attest that births have been recorded as early as January and as late as August. Arthur (1975:52) reports that historic evidence implies a calving season of about four months; from the beginning of March to the end of June. Arthur (1975:49) also states that newborn calves have been recorded in every month of the year, suggesting that calving is not as seasonally restricted as originally believed.

Studies of modern herd populations demonstrate that while these out of season births do occur, they are relatively rare events. In a 12 year study of a Wichita herd, the first calves were born between March 10 and April 7 (Halloran 1968 cited in Arthur 1975:52). Ninety-seven percent of calves in a Montana herd were born within a six week period between April 20th and June 1st. Furthermore, eighty percent of the animals were born within a three week period between April 20th and mid May (Rutberg 1984:418-420). Even the historical accounts of calves born outside the main calving season, although a recurrent occurrence, are repeatedly considered unusual (Arthur 1975:52).

Both the rut and the calving season have been shown to be seasonally restricted events although the onset and length of each can be variable. Latitude is a one factor that consistently affects the rutting and birthing schedules.

6.2.1 Bison Dentition Analysis

Dentition studies are now widely used by archaeologists to determine the age structure of a herd. Pioneering work was done by Frison and Reher (1970) on the bison assemblage from the Glenrock Buffalo Jump in Wyoming. By assuming a peak calving period between the end of April and beginning of May, archaeological specimens can be aged when compared to mandibles of known age (Frison and Reher 1970:46). Animals from the Glenrock Buffalo Jump clustered in age groups x.5 using this method. Work continued to be done on bison mandibles with eruption and wear schedules developed for a variety of ages from a number of sites. These include: x.1 - x.2 from the Scottsbluff site (Todd *et al* 1990:817), x.4 from the Wardell site (Reher 1973:91), x.2 - x.5 from the Lipscomb site (Todd et al 1990:817-819), x.6 from the Casper and Horner sites (Reher 1974:114-115, Todd and

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Hoffman 1987:509), x.7 from the Hawkens site (Frison *et al* 1976), and x.6 - x.9 from the Agate Basin site (Frison 1982a:244-250). Although schedules have been developed for maxillary teeth (Wilson 1974, 1980; Frison *et al* 1978), mandibular teeth are usually more numerous in the archaeological record and as such, more eruption and wear schedules have been devised for them.

Bison eruption and wear schedules are most accurate for animals under the age of 4.6 when all permanent teeth have erupted (Reher 1974). Tooth wear, can be affected by diet, nutritional deficiencies and the amount of grit or sand ingested by the animal (Haynes 1984:490). Measurements of enamel height on individuals older than 4.6 years will result in multimodal trends believed to represent successive age groups (Frison and Reher 1970:51). Measurements are most often taken on the M_1 metaconid as it is normally the first exposed. Measurements of the M_2 and M_3 metaconids can provide additional information (Reher and Frison 1980:68).

The Jackson site faunal assemblage is highly fragmented and no complete mandibles were recovered. Only three partial mandibles with teeth are present and an additional 24 unsocketed teeth were analyzed. Five teeth are from animals younger than 4.6 years. The Jackson site assemblage was compared to the above published eruption and wear schedules as well as those presented in Magee (1997), McKeand (1995) and Corbeil (1995). Terminology follows Frison *et al* (1978). Metaconid heights were measured on all molars with a pair of digital sliding calipers. Twenty metaconid heights were taken and are presented in Figure 6.1.
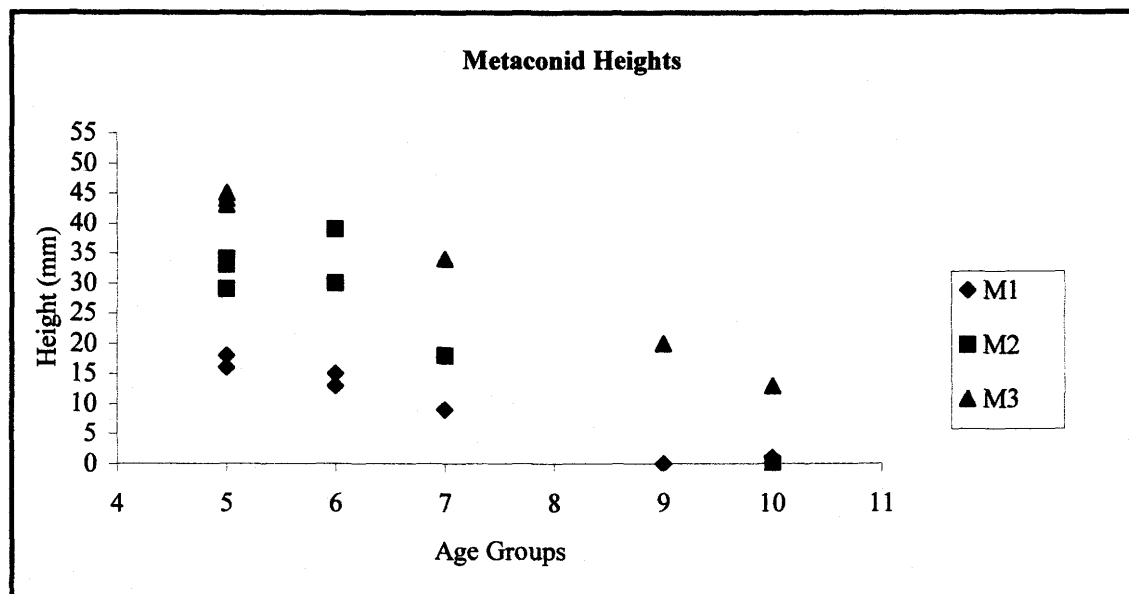
Figure 6.1 Metaconid heights of M_1, M_2 and M_3 from the Jackson site (DiMe-17).

Based on metaconid height measurements, at least five separate age groups are present in the Jackson site bison assemblage. Teeth whose metaconid heights could not be measured represent an additional two age classes. The Jackson site age increments were established by comparing the archaeological specimens to the published wear schedules. It was not always possible to assign a specific age increment to a group because identical characteristics are sometimes used to define successive age increments in the published literature. Nonetheless, the younger Jackson site age groups are comparable to the x.6 age increment while more mature specimens could only be identified as x.6 – x.9 years.

6.2.1.1 Group descriptions

Group 2 (1.6)
72/12-3-38 = RM_1, RM_2
291/32-4-32 = LM_2
592/28-6-3 = LM_2

This sample consists of four unsocketed teeth. The M_1 is in full wear. Cusps I and II of M_2 exhibit wear on specimens 72/12-3-38 and 291/32-4-32. Specimen 592/28-6-3 displays only slight wear on cusp I.

Group 4 (3.6 years)
228/13-3-39 = LM3

A single third molar represents group three. Facets I-VI are worn and slight wear is beginning to show on facet VII but facet VIII is unworn.

Group 5 (4.6 years)
773/16-2-93 = LPM_2, PM_3, PM_4, M_1, M_2
851/16-3-79 = LM_3
721/36-6-35 = RM_2, RM_3
872/36-7-26 = LPM_4, M_1, M_2, M_3

This age set is fairly well represented. All facets on the first molar are in wear. The exostylid has erupted and joins the rest of the tooth in a continuous loop. All M_2 facets are worn as is the exostylid although it has not connected to the rest of the tooth. All facets of the third molar are also in wear. The hypoconulid has barely connected to the rest of the tooth. The exostylid has either just erupted or exhibits slight wear. It is encircled in enamel and is not connected to the rest of the tooth.

Group 6 (5.6 years – 5.9 years)
41/26-4-11 = RM_1, RM_2
616/33-4-37 = L mandible midsection with M_1, M_2, M_3

Both M_1 and M_2 are worn. The exostylid of the first molar has joined the tooth while on the second molar it is still separated by a thin ring of enamel. The third molar of 616/33-4-37 has erupted and is in full wear although the third cusp is not quite level to cusps I and II. The hypoconulid is joined to the rest of the tooth. The exostylid on this specimen has yet to erupt.

Group 7 (6.6 years – 6.9 years)
2 893/24-2-39 = L midsection with PM$_2$, PM$_3$, PM$_4$, M$_1$, M$_2$
742/29-4-6 = RM$_3$

The prefossette of M1 is almost gone while the postfossette is very weak. The exostylid has almost disappeared. All facets of M2 are heavily worn. The exostylid has joined the rest of the tooth in a loop. All cusps on the third molar are worn. The hypoconulid is joined to the rest of the tooth. The exostylid is erupted and in wear but is still separated by a circle of enamel.

Group 9 (8.6 – 8.9 years)
212/32-3-96 = LM$_1$, LM$_2$, LM$_3$
589/28-5-11 = LM$_2$

Almost all enamel is gone from M1. Both fossettes of M2 have almost disappeared. The exostylid joins the rest of the tooth in a continuous loop of enamel. The exostylid of the third molar is worn but has not yet joined the rest of the tooth.

Group 10 (9.6+ years)
88/26-5-6 = R midsection with PM$_2$, PM$_3$, PM$_4$, M$_1$, M$_2$, M$_3$

It is difficult to determine the age of this specimen. All teeth are in wear. Fossettes on M_1 and M_2 are complete worn away, while M_3 is not as extensively worn (Figure 6.2). This wear pattern, however, may not be age related, as there is a root abscess on M_3 (Figure 6.3). This abscess likely expedited wear on the other molars while wear on M_3 discontinued. However, the exostylid of M_3 is worn and is joined to the main tooth body suggesting that the animal is at least 9.6 years of age.

6.2.1.2 Discussion

Comparing the Jackson mandibular teeth with published bison dentition wear schedules provide an age increment of x.6 – x.9 for the Jackson site material. Animals range in age from 1.6 to 9.6+ years. Age groups one, three and eight are not represented in the Jackson site assemblage. This is not surprising as only a small portion of the site has been excavated and this may simply reflect sample bias. It is also possible that animals from these age groups are not part of the archaeological assemblage.

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Figure 6.2 Right bison mandibular midsection 88/26-5-6 with extensive wear on all teeth except M3.

Figure 6.3 Abscess on M3 of 88/26-5-6.

6.2.2 Immature Recoveries

Five hundred and forty-five immature specimens weighing 2,433.4 g were identified in the Jackson site faunal assemblage (Table 6.1). Immature specimens were recognized by a billowy appearance, the presence of unfused epiphyses or the absence of epiphyseal caps. Most of the immature elements or element fragments could be tentatively identified as bison whereas the highly fragmented material could not.

	B	C	D	E	F	G	H	I	J	Total
Axial										
Cervical Vertebrae	1	0	11	1	42	0	0	0	0	55
Thoracic Vertebrae	1	0	0	0	113	0	0	0	0	114
Lumbar Vertebrae	0	0	0	0	5	0	0	0	0	5
Caudal Vertebrae	0	2	0	0	0	0	0	0	0	2
Rib	1	0	0	0	5	0	0	0	0	6
Forelimb										
Humerus	0	0	0	1	0	0	0	0	0	1
Unciform Carpal	0	0	0	2	0	0	0	0	0	2
Metacarpal	6	0	0	2	0	0	0	0	0	8
Hindlimb										
Femur	0	0	13	0	0	0	0	0	0	13
Tibia	0	0	0	9	0	0	0	0	0	9
Calcaneous	0	0	0	0	2	0	0	0	0	2
Metatarsal	1	0	0	0	0	0	0	0	0	1
Other										
1st Phalanx	0	0	1	0	1	0	0	2	0	4
2nd Phalanx	0	0	1	0	1	0	0	4	0	6
3rd Phalanx	0	0	0	0	0	0	0	1	0	1
Miscellaneous										
Vertebrae Indeterminate	5	4	2	0	79	2	0	0	0	92
Metapodial Indeterminate	0	0	0	2	0	0	0	0	0	2
Element Indeterminate	65	6	27	12	103	1	1	5	2	222
TOTAL	**80**	**12**	**55**	**29**	**351**	**3**	**1**	**12**	**2**	**545**

Table 6.1 NISP of immature bison/SC6 elements presented by block.

These specimens are catalogued as SC6 and for convenience sake are presented in Table 6.1 with the bison remains. Over half of the specimens (58%) could not be identified to a specific element. The remaining 316 specimens represent 40 bison elements (Table 6.2).

Analysis of immature elements can determine the age of the animal if the epiphyseal fusion rates for that species have been developed. Epiphyseal fusion rates of European bison have been well studied (Koch 1935), and the epiphyseal fusion rates for North American bison (*Bison bison*) are based on those derived from European bison (Duffield 1973:132). This is considered valid because European and North American bison are sub-specific. Epiphyseal fusion rates were created for North American bison (Duffield 1973:133) and

	B	C	D	E	F	G	H	I	J	TOTAL
Rib	1				2					3
Cervical	1		1	1	4					7
Thoracic					9					9
Lumbar					2					2
Caudal		2								2
Humerus				1						1
Unciform Carpal				1						1
P Metacarpal				1						1
D Metacarpal	1			1						2
Femur			1							1
Tibia				1						1
Calcaneous					1					1
D Metatarsal	1									1
1st Phalanx			1		1			1		3
2nd Phalanx			1		1			2		4
3rd Phalanx								1		1
Total	4	2	4	6	20	0	0	4	0	40

Table 6.2 Immature bison/SC6 elements presented by block.

immature elements from the Jackson site were compared to this fusion schedule in order to establish age estimates of the immature bison specimens.

Epiphyseal fusion rates are known for several of the immature bison elements that were excavated at the Jackson site. When elements have unfused epiphyses, only general statements regarding the age of the animal can be made. For example, the recovery of immature 2nd phalanges suggest that at least one animal is younger than three years as the proximal end fuses to the body during the second to third year. Other elements recovered from the Jackson site can only be from animals younger than five years. The proximal humerus fuses in the fourth year of life, while the proximal end of the first phalanx fuses during the middle of the fourth year. The recovery of an unfused distal tibia also suggests an animal whose age is younger than four and a half years. The distal metacarpals fuse at the end of the fourth year, as does the calcaneous epiphysis. A proximal femur fragment is immature and the epiphysis is absent. This usually fuses during the middle of the fifth year. The recovery of immature vertebrae, most from the kill area suggest that these animals are younger than eight years. Many of the vertebrae only lacked the cranial and/or caudal epiphyseal cap, suggesting the individual was about seven years in age because this is when the vertebrae fuse, proceeding from anterior to posterior. On some, the cranial epiphyseal cap

had fused while the caudal cap had not. The recovery of unfused rib heads can only come from an animal that is younger than eight years old.

At least one element provides a more accurate estimate of age. A distal metatarsal (259/3-13-74) had only recently fused to the epiphysis. This event occurs near the end of the fourth year, suggesting that this individual was almost five years old.

Although numerous immature specimens were recovered from the Jackson site, only 40 bison elements could be identified. Most of these elements provide only general age estimates. The recovery of a recently fused distal metatarsal indicates that at least one individual is about five years of age, while vertebrae in various stages of fusion suggest that another immature animal, about seven years of age, was present in the kill area.

6.2.3 Foetal Recoveries

Ninety-five foetal elements or element fragments weighing 73.3 g were excavated from blocks B, C, D, E, and I. Foetal specimens were easily identified by their small size and distinctive porous nature. Most are considered to be bison, but some are so small and fragmented that a species classification is not possible.

The University of Saskatchewan's zooarchaeological comparative collection lacks foetal bison specimens but four foetal *Bos* representing three gestational periods are present. Two of the specimens are two month fetuses, one is a four and half month fetus and the fourth is an eight month fetus. The Jackson site foetal remains were compared to these individuals in order to identify the elements and to establish general developmental stages for the Jackson site specimens. Statements regarding the exact age of the foetal assemblage could not be made based upon comparisons to fetal *Bos* specimens because it is presently unknown if fetal bone development in the two species is analogous. A review of the published literature was undertaken to determine if the Jackson site assemblage could be more accurately aged.

6.2.3.1 Previous Research

Published data regarding archaeological foetal remains is relatively scarce (Wilson 1974, Frison *et al* 1978, McKee 1985, Landals 1994, Clarke 1995) The first major work to address foetal bison remains in an archaeological site was undertaken by Wilson (1974) in his examination of the faunal assemblage from the Casper site, a Hell Gap bison trap in Wyoming. Remains of three bison fetuses were present in the site's bone bed. Comparisons to modern samples indicated that two were near term while the third was considerably smaller, approximating a seven month individual (Wilson 1974:146).

Wilson (1974) undertook a preliminary study of the periosteal layering in foetal elements. Periosteal layers were counted in seven archaeological and one modern humeri. The archaeological specimens included a seven month old fetus, five near term individuals and a newborn, while the modern specimen was a three-day-old individual. "Counts of the periosteal layers revealed a fairly consistent trend for older individuals to show more strata. However, the complicating factors of internal osteoclast action and occasional periosteal stratum bifurcation could not be assessed adequately in such a small sample." (Wilson 1974:147). Other bones exhibiting periosteal layers included portions of the femora, tibiae, metapodials, radii, nasals, frontals, mandible, and the ilium.

Wilson (1974:149-151) also presents measurements taken of several archaeological foetal elements. Measurements were recorded for the scapula, radius, femur and tibia of near full term fetuses, while measurements were only taken on the scapula and femur of a seven month fetal specimen.

The Big Goose Creek site, a Late Precontact kill and campsite in Wyoming yielded foetal remains from 13 individuals representing a wide variety of developmental stages. Twelve individuals were smaller than a modern seven month fetus and a comparison of humeri diaphyseal measurements indicate that these fetuses ranged between three and six months. A single near full term individual was also present in the assemblage (Frison *et al* 1978:43). Measurements of the Big Goose Creek site foetal humeri are presented, as are the measurements taken on a modern seven-month fetus and a three day old neonate (Frison *et al* 1978:44).

The Miniota site is an Avonlea campsite where foetal bison remains constituted almost half of the recovered bison assemblage. This site is located about 100 km north of the Jackson site and is situated in the Assiniboine River valley of southwestern Manitoba. The Miniota foetal sample was compared to two modern bison fetuses, one killed on March 2 and one killed on May 3 (Landals 1994:189). Landals (1994) followed Wilson (1974) and Frison *et al* (1978) and grouped the humeri into a series of developmental stages based on size. Five developmental stages were devised by comparing the archaeological specimens to the two modern individuals and to published samples. Stage one animals would have been obtained in December, stage two in January, stage three in February, stage four in March and April and stage five animals would have been slaughtered in late April or early May prior to calving. A brief descriptive summary of each developmental stage and photographs of the range of

variation for the humeri, tibia and metapodials are presented (Landals 1994:193-196). All five developmental stages are represented by at least 21 individuals. Developmental stage four was well represented with 10 individuals while two or three individuals each represented the other stages (Landals 1994:196).

McKee (1985) undertook a study of foetal elements in an attempt to establish the seasonality of a Proto-historic site in Wyoming, the River Bend Site. Metric measurements of scapulae and longbones were taken of the archaeological sample and on 18 comparative animals ranging in age from seven months prenatal to an eight to twelve week old individual (McKee 1985:32). Results of the metric measurements suggest that although general statements regarding ages of the archaeological sample could be made, size alone is too simplistic to establish age estimates (McKee 1985:33-34). Numerous factors besides age can affect the size of foetal elements. The age and physical condition of the cow, environmental factors such as the temperature and availability to food and water, the genetic make-up of each herd, and sexual dimorphism can potentially influence the size of foetal elements.

Counting periosteal layers in foetal elements was a second approach carried out by McKee (1985:34) to establish the ages of foetal elements present in the site. Periosteal layers in the distal femora were counted (McKee 1985:34). This method proves more reliable, with the archaeological sample and the comparative sample generally separating into discrete age groups based on periosteal counts. There were however, some discrepancies between the archaeological and comparative collection. Periosteal counts from the largest archaeological femora were identical to the comparative eight-month fetus. Metric measurements and visual inspection indicate that the comparative femora were significantly larger than the archaeological specimen. Potential causes for this include the inability of strata counts to age material precisely because of small sample size or the reflection of modern management and feeding programs which produce larger commercial bison fetuses (McKee 1985:36). Ultimately, the specimen is aged by applying known fusion rates of metapodial elements (McKee 1985:36). McKee (1985:36) suggests that a larger sample of comparative collections and a better knowledge of foetal bone development is needed in order to increase the utility of periosteal layering counts.

6.2.3.2 Jackson Site Foetal Developmental Stages

It was initially hoped that published data on foetal bison remains from other archaeological sites would provide information to determine specific ages of the Jackson foetal remains. The humerus is the only element for which an adequate sample of measurements is presented (Frison *et al* 1978, Wilson 1974), and unfortunately this element was not recovered

at the Jackson site. Periosteal layering in foetal elements is a promising technique to determine ages of foetal individuals; however, it could not be applied to the Jackson site foetal assemblage. A relatively large sample of similar elements is needed in order to establish a sequence of periosteal counts (McKee 1985, Wilson 1974). Specific element samples from the Jackson site are not large enough to create distinct age groups based on periosteal layer counts. Instead, the development stages for the Jackson site foetal remains were devised by comparing the archaeological specimens to modern *Bos* fetuses, to published photographs of elements of known age (Landals 1994) and to known ossification schedules (Lindsay 1969, Wilson and Davis 1978).

Four developmental stages were identified in the Jackson site foetal assemblage. Stage four elements (Figure 6.4) are comparable in size to the eight month *Bos* specimen and the stage four specimens from the Miniota site which are considered to be between seven and eight months old (Landals 1994:195-196). It appears then that the stage four Jackson site elements are most likely also between seven and eight months old.

Stage three elements (Figure 6.4) from the site are similar in size to the four and a half month *Bos*, with some elements slightly larger and some slightly smaller. One stage three metatarsal from the Jackson site assemblage is fused whereas the *Bos* specimen is not. Wilson and Davis (1978:324) state that the metapodials begin to fuse in the last two months of gestation. This suggests that stage three elements are at least seven months old; however, two unfused metatarsal fragments are almost identical in size to the fused element. Evidently, fusion of the metapodials is a fairly recent event in stage three specimens, with some being fused and some not. All the stage three elements are smaller than those of stage four and an age between six and seven months is hypothesized for stage three specimens.

The stage two elements (Figure 6.4) at the site are smaller than the four and a half month *Bos* skeleton but significantly larger than the two month fetus. The size of these specimens is similar to stage two elements recovered from the Miniota site, and based on this comparison, these individuals are suggested to be about five months old.

A single stage one element (Figure 6.4) was identified at the Jackson site. A very small unfused proximal metacarpal was recovered. This element is smaller than stage two elements from the site. It is comparable to stage one specimens from the Miniota site and is considered to be between three and four months old.
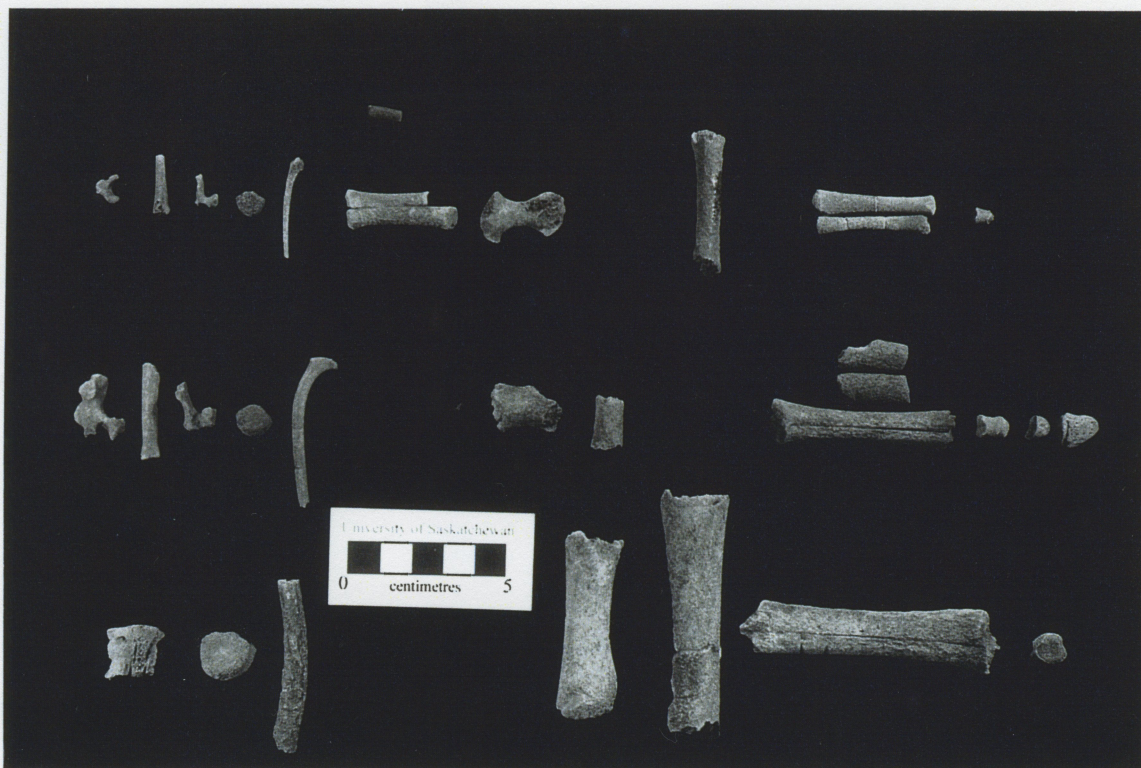
Figure 6.4 Foetal bison elements recovered from the Jackson site. Top row, developmental stage one; second row, developmental stage two; third row, developmental stage three; bottom row, developmental stage four.

6.2.3.3 Block B Foetal Assemblage

Two indeterminate foetal specimens both from unit 13 were identified in the block B faunal assemblage (124/13-2-1 and 184/13-2-72). These are small fragments of a longbone midshaft and may represent a single element. One specimen is burned while the other is not. Species identification cannot be conclusive, but it is suggested that they are bison. No development stage can be inferred given the fragmentary nature of the specimens and lack of conclusive species identification.

6.2.3.4 Block C Foetal Assemblage

Three foetal bones were recovered from block C, two from unit 16 and one from unit 15. These include a developmental stage three lumbar vertebrae (652/15-3-68) and a stage four basioshpenoid (3405/16-5-8a). The last foetal specimen was also from unit 16 but could not be identified to species or element. None exhibit cultural modification.

6.2.3.5 Block D Foetal Assemblage

The majority (86%) of the foetal remains were recovered in block D. These remains exhibit a distinctive distribution pattern (Figure 11 Appendix III) showing that most were

excavated from units 18, 19 and 35. Table 6.3 summarizes the recoveries and it is most likely that all indeterminate elements are also bison. The presence of elements from four different development stages confirms that at least four individuals are present in the block D foetal assemblage. Twenty-five elements are blackened, most likely due to thermal alteration although soil staining as a possible cause cannot be ruled out.

Element	Developmental Stage					TOTAL
	Ind.	1	2	3	4	
Cervical vertebrae			1	4		5
Thoracic spine			1	1		2
Lumbar vertebrae			5	4		9
Sacral vertebrae			1			1
Vertebrae centrum			5	5		10
Vertebrae epiphysis	3					3
Rib body	7			6	3	16
Rib complete			1	1		2
Scapula				1		1
Metacarpal		1	2			3
Ischium			2	1		3
Femur				1		1
Tibia			1		1	2
Metatarsal			3	4	1	8
1st phalanx			1	1		2
2nd phalanx				1	1	2
3rd phalanx				1		1
Metapodial	1					1
Indeterminate	10					10
TOTAL	21	1	23	31	6	82

Table 6.3 Summary of bison foetal elements from block D.

6.2.3.6 Block E Foetal Assemblage

Four foetal specimens were identified in the block E faunal assemblage. The only burned element is a metapodial midshaft fragment (2959/24-3-71). The remaining three elements were excavated from unit 32. Two are unidentified specimens (771/32-3-68a and778/32-5-25a) while the third is a stage four vertebral centrum (175/32-3-59).

6.2.3.7 Block I Foetal Assemblage

Four foetal elements were recovered from block I. A metapodial fragment (1217/31-W-17), a thoracic spine fragment (1109/31-3-35), and a vertebrae centrum (1066/31-2-18) are all burned. The metapodial midshaft is similar in size to developmental stage two while the other three elements correspond to developmental stage three.

6.2.3.8 Foetal Element Distribution

The distribution map of foetal elements at the Jackson site (Figure 11, Appendix III) shows that the vast majority of the remains were recovered in block D. These show distinct concentrations in units 18, 19 and 35 while foetal elements are rather scattered throughout unit 20. Both appendicular and axial elements were recovered from each unit. There does not appear to be any stylized pattern of element distribution throughout the block although there is a relatively high percentage of axial elements in unit 18 and a tendency for appendicular elements to be deposited in small clusters.

All four developmental stages are represented in the block D assemblage. A concentration of stage three elements occurs in unit 35 while unit 20 has a relatively high number of stage four specimens. It is suggested that the variation in developmental stages at the site is a factor of successive pregnant bison acquisition rather than a single kill situation. A look at the vertical distribution of the different developmental stages would ideally show stage one animals lower than stage two individuals etc. No such pattern exists; for example, the single stage one specimen was recovered at a depth of 20 cm dbs and four of the stage four individuals were recovered in level five (20-25 cm dbs). All foetal elements are concentrated in levels three, four and five. It is possible that given the small nature of the foetal elements, they were highly susceptible to downward migration in the sandy matrix. As well, the nature of excavation may also have obliterated any microstratigraphic configuration. All units were excavated in arbitrary five cm levels originating on the ground surface.

No consistent pattern of element distribution or developmental stage distribution is readily apparent in block D. It is impossible to evaluate any pattern of foetal element distribution in the remaining blocks given the small number of elements recovered from these blocks.

Foetal elements are relatively abundant in the Jackson site faunal assemblage. Eighty-two identified bison elements represent four different developmental stages. Developmental stage one correlates to a three to four month old fetus and is represented by a single element. Developmental stages two elements are thought to represent a five-month-old fetus and developmental stage three signifies a six to sevens month fetus. The fourth developmental stage is from a fetus that is between seven and eight months old.

6.3 Bison Population Sex Structure

It is possible to determine the sexual composition of a bison assemblage recovered from an archaeological site. Bison are sexually dimorphic animals with males weighing on average 570 kg while females weigh about 420 kg (Banfield 1974:405). This dissimilar size

and weight is reflected in bone dimensions which can be measured (Chaplin 1971:100). Such measurements have been derived for numerous bison elements including the cranium (Skinner and Kaisen 1947), horn cores (Fuller 1959), vertebrae (von den Driesch 1976), the mandible (Reher 1970), various long bones (Todd and Hofman 1987, Walde 1985, Speth 1983), metacarpals and metatarsals (Bedord 1974, 1978), carpal and tarsal bones (Morlan 1991) as well as phalanges (Duffield 1973, Roberts 1982).

6.3.1 Carpals and Tarsals

The only elements recovered from the Jackson site in sufficient numbers for analysis were carpals and tarsals. A relatively large number of bison phalanges were excavated, but the method outlined by Roberts (1982) employs the first phalanx of the front limb while the method outline by Duffield (1974) employs the second phalanx of the front limb. It was considered too time consuming to separate front from rear limb phalanges when an analysis of carpals and tarsals could be made. Morlan (1991) undertook a variety of bivariate measurements on bison carpal and tarsal bones and found that all except the accessory carpal, unciform carpal and first tarsal exhibit bimodal distribution. The two modes are thought to represent a combined group of adult cows with calves and a group of substantially larger adult bulls (Morlan 1991:215).

Measurements as outlined in Morlan (1991) were taken on the internal and ulnar carpals, as well as the astraglei and calcanei recovered from the Jackson site. Fragmented, highly weathered or severely abraded elements were not measured. A clear bimodal distribution is evident when medial length was plotted against distal width for the astraglei (Figure 6.5). Width plotted against depth of the C+4 tarsal (Figure 6.6) and anterior length against depth of the ulnar carpals (Figure 6.7) also show bimodal distribution. The only element not displaying discrete modes is a plot of the width versus the depth of the internal carpal (Figure 6.8). When the block E right internal carpal is not considered, the plot becomes bimodal. This carpal (418/32-N-2) is extremely small when compared to the other internal carpals. It is possible that this element is from a very young individual or an extremely small animal and should be considered as part of the cow/juvenile group.
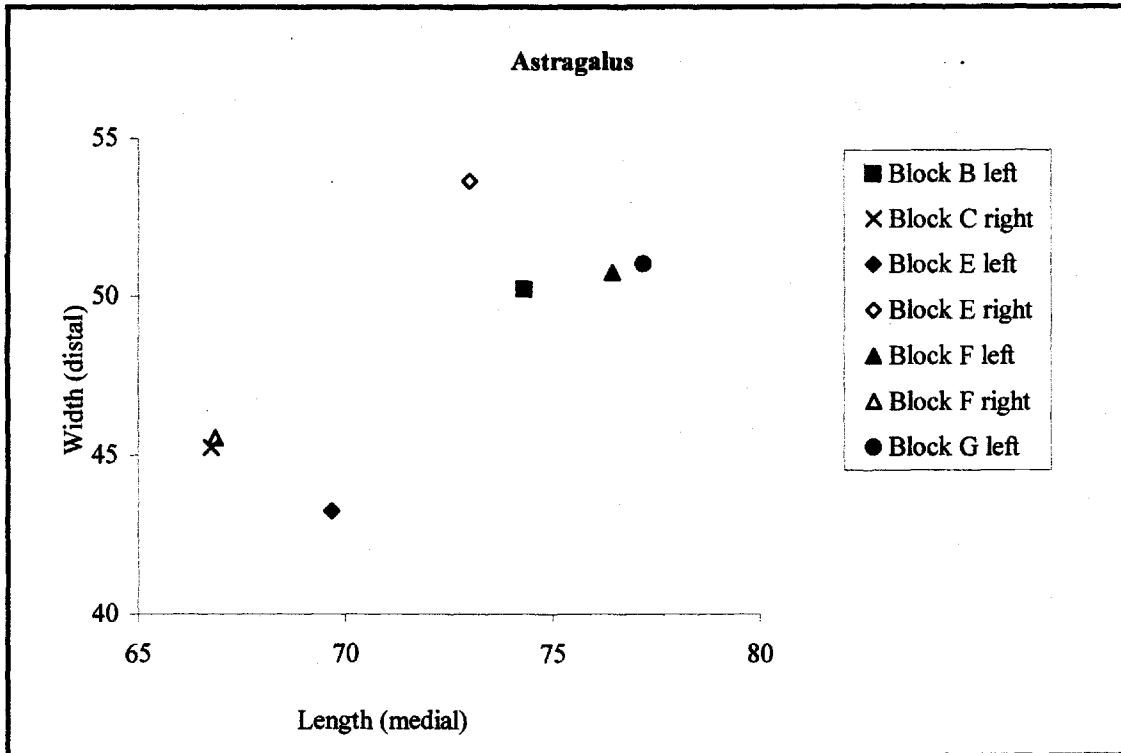
Astragalus

Figure 6.5 Bivariate plot of astraglei measurements.

Central and Fourth Tarsals
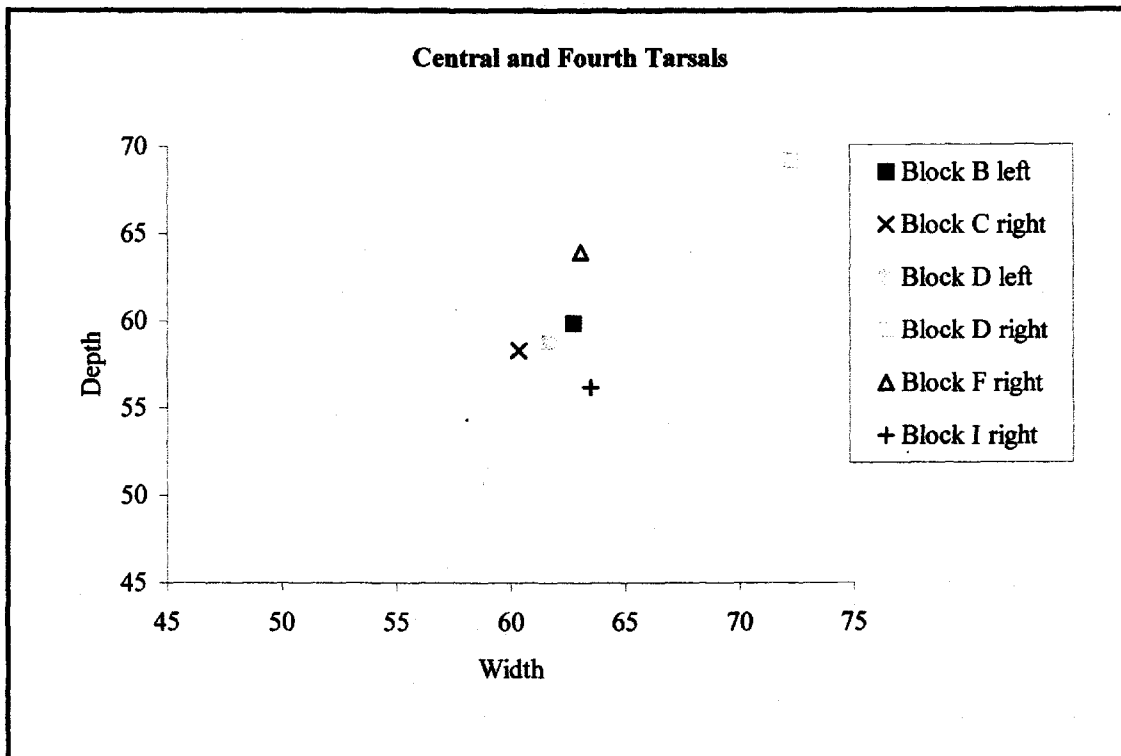
Figure 6.6 Bivariate plot of C+4 measurements.
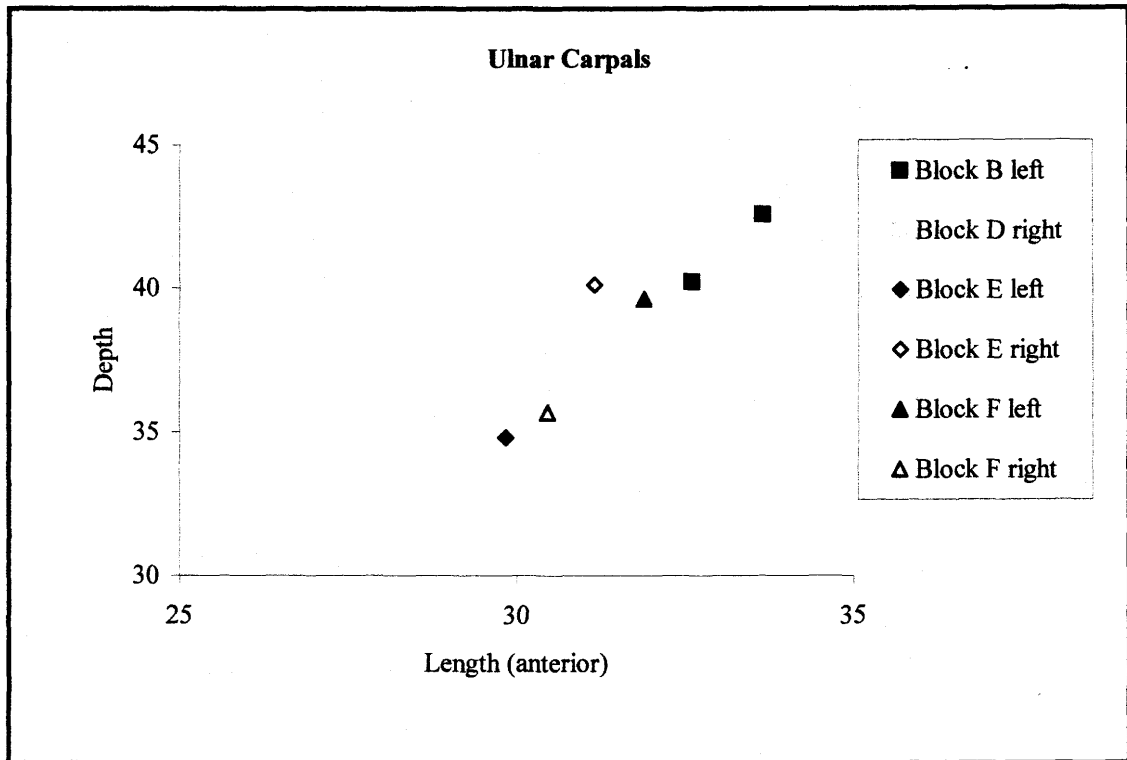
Figure 6.7 Bivariate plot of ulnar carpal measurements.
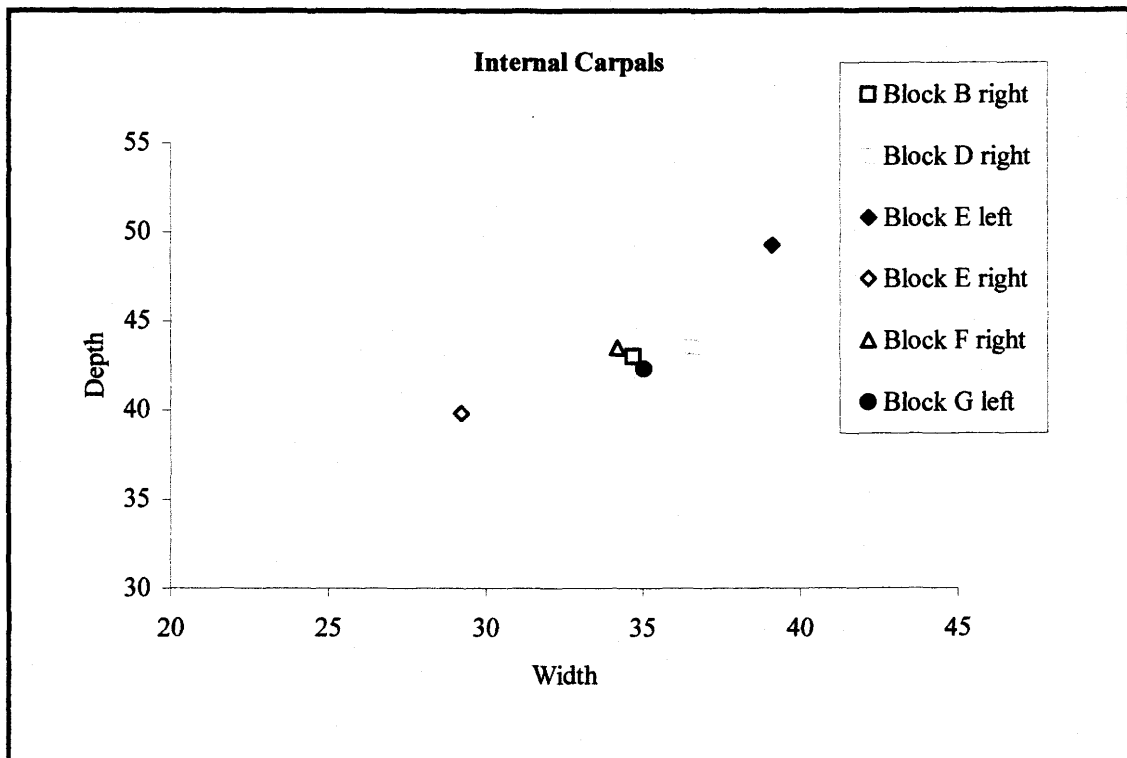
Figure 6.8 Bivariate plot of internal carpal measurement.

The carpal and tarsal measurements indicate that both male and female/juvenile bison are present in the assemblage. Furthermore, both groups are fairly equally represented in the different excavation blocks. Blocks D, E, F, and G all contain elements from at least one male and one female animal. Blocks C and I both have female elements, while block B has elements from at least two separate males and one female. Actual numbers of male and female/juvenile bison cannot be determined at this time as the interdependence of the carpals and tarsals is unknown. Also, both right and left elements were measured in order to provide a larger sample. As such, the sample size is still quite small and general statements regarding herd composition are provisional.

6.4 Site Seasonality

Determining the season in which an archaeological site was inhabited is of prime importance to archaeologists. Seasonality refers to the time of year at, or during which a particular event is most likely to occur. "Time of year" has two different meanings. It could mean an absolute calendrical date or a sequential date (estimations of spring, summer, fall, or winter). Sequential dates are general and ambiguous because seasons vary from place to place, and at a single place a season varies from year to year. Establishing absolute dates is superior; however, they may be impossible to determine based upon the data recovered (Monks 1981:178). The faunal remains recovered at the site cannot provide an absolute date, but do suggest the season of occupation.

The presence of seasonally restricted resources in an archaeological site is one of the oldest and simplest methods of determining seasonality. Both the dentition studies and the presence foetal bison remains indicate that the site was occupied during the winter months. The bison teeth could only be aged to a broad x.6 – x.9 increment. Assuming a restricted birthing season with a peak calving date of May 1st (Rutberg 198:420), these animals could have been killed anytime between the beginning of November until March. This is a fairly broad time period but the foetal remains provide a more precise estimate of seasonality.

The excavation of foetal elements representing at least four separate development stages suggests that the Jackson site was continually occupied over a series of winter months. The presence of a stage one individual suggests that the site was inhabited by December and continued to be occupied until at least late April or early May. Given the relatively small number of foetal individuals excavated (N=4) it is possible that one or more are the result of an out of season birth and such a scenario would affect the hypothesized month(s) of occupation. However it is doubtful that all are the product of out of season parturition.

The sex structure of the bison herd does not corroborate a winter occupation of the site. It is generally believed that after the autumn rut, bison separate into bull herds, and nursery herds (McHugh 1958:14, Hanson 1984:102). Nursery herds are comprised of females and immature males younger than four years old (McHugh 1958:37). The recovery of male elements and female/juvenile elements imply a mixed herd composition, a situation usually seen only during the rutting season of late summer to early fall. Given the recovery of foetal elements, and the dentition analysis a late summer/early fall occupation does not seem feasible for this site. Another explanation for the mixed herd assemblage is an attritional hunting strategy. If individual or small groups of animals were being hunted, as indicated by the small kill at the north end of the site, both males and females could be represented. This correlates with the foetal remains which suggest a continued occupation of the site during the winter months. The recovery of foetal elements of various developmental stages further indicates that bison were being procured over a period of time, rather than at a single large kill.

The presence of seasonally restricted resources is a popular method of inferring site seasonality, but it can be sensitive to small sample size (Monks 1981:180-183). Monks (1981:183) contends that the presence of several different indicators of a given season is required before any conclusions regarding site seasonality are advanced. The seasonality indicators from the Jackson site unfortunately are not numerous. Foetal bison elements were the only seasonally restricted remains. The bison dentition studies however support the suggestion that the site was inhabited continuously throughout the winter months. In addition to these two indicators of seasonality, the total absence of warm season fauna such as migratory waterfowl further strengthens the argument of winter occupation.

6.5 Discussion

Whether or not bison herds on the northern plains undertook a mass migration into the parklands during the winter months has long been a topic of debate. It was initially believed that the northern plains bison herds undertook significant migrations from the grasslands into the parklands at the onset of winter in search of superior forage (Morgan 1980:158). Both historical observations (Syms 1979:295-296) and empirical data (Chisholm *et al* 1986:203) can be used to support this hypothesis. By mapping the bison observations provided by Hind, Syms (1979:297) concludes that bison moved into southwestern and south-central Manitoba during the winter, and migrated back into northern North Dakota for the summer months. Analysis of the $^{13}C/^{12}C$ ratio in bison collagen indicates that at least some bison populations were utilizing both mixed prairie and parkland environments and this most likely represents seasonal movements (Chisholm *et al* 1986:203).

Some researchers contend that no migration took place. Hanson (1984) provides ecological evidence suggesting that North Dakota bison herds had no need for migration. Historical documentation and modern bison studies corroborate Hanson's (1984:111) suggestion that large and small herds of bison could be found in localized ranges year round. Malainey and Sherriff (1996) couple historical observation with archaeological data to show that the bison did not migrate out of the open grassland during the winter. Numerous historical observations place large bison herds in the open grassland during the winter months (Malainey and Sherriff 1996: 337-339). Seasonality studies from over twenty sites in the northern plains demonstrate that the northern grasslands were occupied during the winter months (Malainey and Sherriff 1996:348-351).

Others (Arthur 1975, Bamforth 1987) agree that although migration did take place, it was not a large-scale event, but rather small, isolated movements on a regional scale. Epp (1988) suggests that a dual dispersion strategy explains contradictory historical observations of bison present in both the grasslands and woodlands/parklands at various times of year. Small sedentary herds of bison remained on the open plains year round. During the winter, these herds could usually be found in wooded areas close to water, meanwhile, a larger herd would migrated into the aspen parkland ecotone during the winter and return to the grassland in summer (Epp 1988:315).

The location and proposed seasonality of archaeological sites present in the Lauder Sandhills provide insight regarding the bison migration controversy. Although researchers disagree on bison migration patterns, all insist that bison herds would be present in the southwest part of Manitoba during the winter months. The recognition of the Jackson site as a winter occupation does support the idea that bison were present in the Lauder Sandhills in large enough numbers to support an extended occupation. The recovery of several ice-gliders from the Twin Fawns site indicates that this Mortlach site is also most likely a winter occupation (Playford 2000). The identification of these winter sites does not necessarily mean that bison were absent from the area during the summer months. The Bradshaw site has tentatively been identified as a summer occupation (Nicholson and Hamilton 1997a:31). The detection of both winter and summer occupied sites in the same vicinity suggests that bison were present in this part of the province year round. It is impossible to determine from the available data if this scenario means that no migration occurred, if small regional migrations occurred, or if the bison herds practiced a dual dispersion strategy. It does seem to refute the idea that all bison regularly migrated onto the open plains during the summer and into the parklands during the winter.

6.6 Summary

Analysis of the Jackson site bison remains indicates that the site was occupied during the winter months. The dentition studies suggest that occupation occurred anytime between November and March, while the foetal remains point to a continuous occupation between December and early May.

Bison carpal and tarsal measurements reveal that both male and female/juvenile animals are present in the assemblage. Animals range in age anywhere from foetal to 9.6+ years. A four year old and a seven year old can tentatively be aged based upon epiphyseal fusion rates. The bison elements indicate that the site's occupants were employing an attritional hunting strategy.

Chapter 7
Taphonomy of the Jackson Site
Faunal Assemblage

7.1 Introduction

There are two main goals of any faunal analysis. The first is to establish the subsistence strategies of past groups and the second goal is determining the paleoecology of a region (Hesse and Wapnish 1985:05). In order to accurately achieve either goal, one must have a good knowledge of the formation process of the archaeological record. This can be accomplished through the study of taphonomy.

In 1940, Russian paleontologist I.A. Efremov created the term taphonomy from the Greek words *taphos* (burial) and *nomos* (laws) (Lyman 1994a:01). It is essentially the study of "the transition, in all details, of organics from the biosphere into the lithosphere or geological record." (Lyman 1994a:01). Lyman (1994a:05) defines two related goals of taphonomic research. The first goal is to "strip away" the taphonomic overprint in order to accurately reveal the prehistoric biotic community. The second goal is to determine the nature of the taphonomic overprint in order to be aware of the taphonomic mechanisms responsible for a given assemblage. By realizing the two goals of taphonomic research, one can address the two main goals of faunal analysis. Stripping away the taphonomic overprint allows a researcher to analyze a prehistoric biotic community and make inferences of past paleoecology. Understanding the taphonomic overprint enables archaeologists to ascertain which taphonomic processes and agent(s) have affected the assemblage and of those which were the result of human activity.

This examination of the Jackson site faunal assemblage focuses on the second goal of faunal analysis, human subsistence strategies. In such, the taphonomic analysis is concentrated on establishing the taphonomic processes affecting the assemblage, and determining the taphonomic agents. Given the intent of determining past subsistence strategies, it is also imperative to distinguish between culturally and naturally deposited animal remains (Lyman 1994a:07).

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7.2 Defining Bone Portions

One of the most notable characteristics of the Jackson site faunal assemblage is its highly fragmented nature. Three metatarsals were the only complete bison long bone elements recovered at the site. Even bone portions such as proximal and distal ends as well as midshafts are incomplete. Analyzing the assemblage with these criteria would result in an under representation of elements present at the site. In order to establish a more accurate estimate of the number of elements represented by the fragmented assemblage, anatomical features or landmarks are catalogued for each element as outlined by Morlan (1994a:800-801). The highest landmark count for each element is then used to establish the MNE. The MNE can then be used to represent the element in the calculation of MNI's and MAU's.

7.3 Skeletal Completeness

Almost all archaeological assemblages are at least partially fragmented. Morlan (1994a:805) devised a method of calculating the percentage completeness of each element using the following formula:

$$\% \text{ CN} = \frac{(PP)/(NISP)}{PD} \times 100\%$$

% CN = Percent Completeness
PP = Total number of Portion Preserved (sum of MNE values)
NISP = Sum of number of identified Specimens
PD = Number of Portions Defined

The percent completeness was calculated for the Jackson site bison elements (Figure 7.1). It is readily apparent that the most complete bones consist of the carpals, tarsals, phalanges, sesamoids as well as the patella and caudal vertebrae. When compared to other sites on the northern plains, the percent completeness of the Jackson site bison assemblage most closely resembles Occupation 1 of the Sanderson Site (Table 7.1). Still, several elements including the humerus, innominate, femur, tibia and metatarsal from the Jackson site are much less complete than those from the Sanderson site.
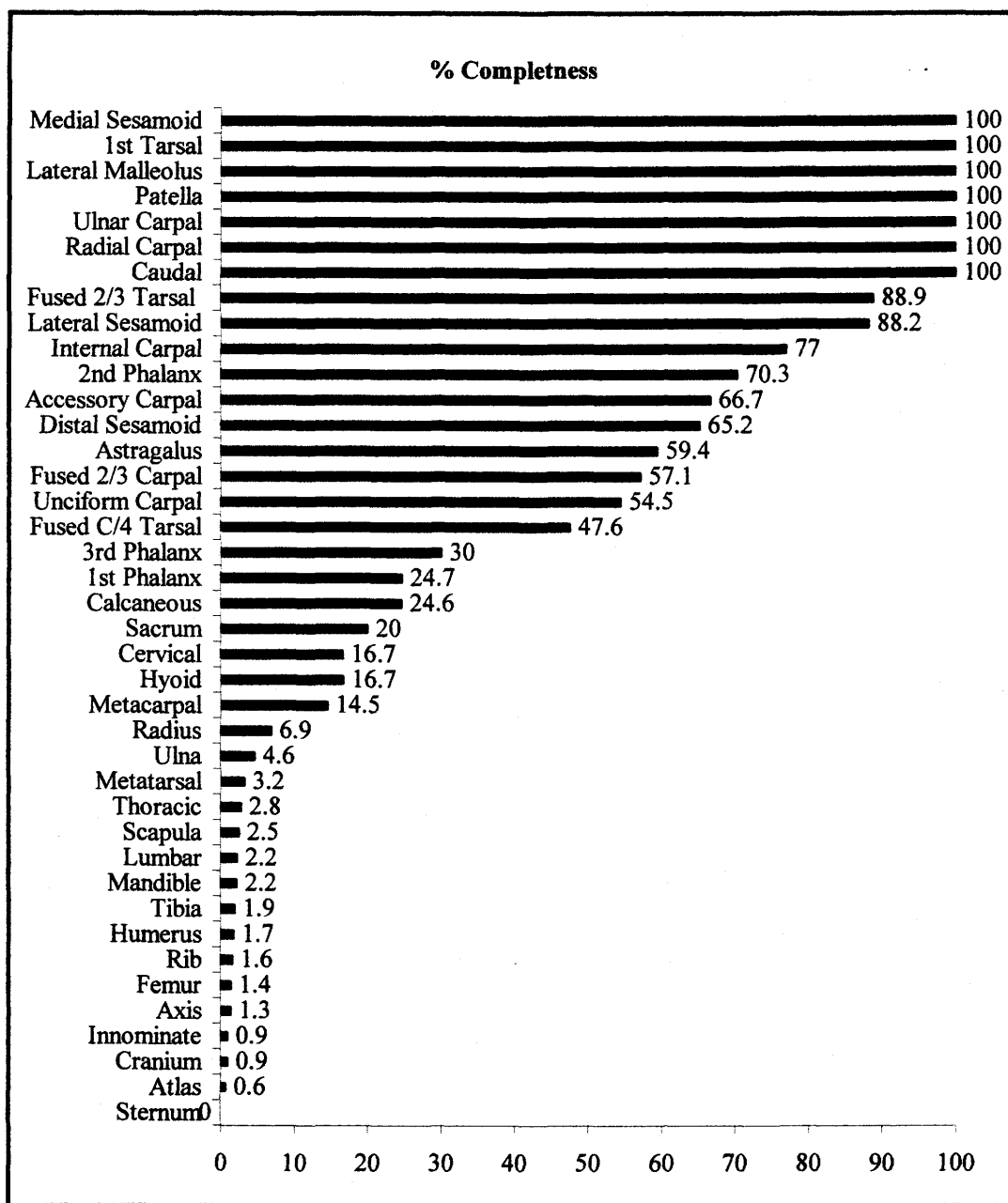
% Completness

Figure 7.1 Percent completeness of bison elements.

The percent completeness calculated for a variety of bison elements recovered at the Jackson Site prove that this faunal assemblage is highly fragmented, probably one of the most fragmented sites yet described on the northern plains.

Element	% Completeness				
	Jackson	Sanderson Occ1	Sanderson Occ2	Harder	Sjovold
Mandible	2.2	2.2	1.48	8.2	9.7
Scapula	2.5	1.88	1.25	21.4	24
Humerus	1.7	9.63	8.93	15.5	16.4
Radius	6.9	7.52	3.53	19.7	24.3
Ulna	4.6	9.58	11.5	27.3	28.1
Metacarpal	14.5	18.9	7.39	33	36
Innominate	0.9	10.9	4.17	19.6	22.3
Femur	1.4	9.09	10.2	11.7	20
Tibia	1.9	4.66	8.2	24.6	20
Calcaneous	24.6	18.7	37.7	49.6	89
Metatarsal	3.2	7.18	12.4	33.5	32.4

Table 7.1 Comparison of percent completeness between the Jackson site and the Sanderson occupations, Harder, and Sjovold sites (Data from Magee 1997:159).

7.4 Utility and Density

Determining the cause of the Jackson site fragmentation is essential to establishing past activity at the site. Fragmentation of a faunal assemblage can be a natural or cultural phenomenon. Humans tend to utilize elements based on their economic utility and elements with a greater economic utility are less likely to be preserved whole or preserved at all. Meanwhile, a variety of natural factors such as bone porosity, morphology, size and mineral density are linked to differential survivorship of elements that can also affect bone frequencies (Kreutzer 1992).

7.4.1 Bison Bone Utility Indices

Although it was a long held belief that skeletal frequencies in an archaeological site were the result of human butchery and subsistence practices, Binford (1978) wanted to provide actual information regarding the economic importance of individual elements. To achieve this goal, he measured the meat, marrow and grease collected from two domestic sheep (*Ovis aries*) and a caribou (*Rangifer tarandus*). A utility index for each species was constructed for meat, marrow and grease (Binford 1978:23-33). Binford (1978:72) then constructed a utility index that took all three factors into account. Next, a modified general utility index (MGUI) was constructed to account for butchering practices (Binford 1978:74).

The MGUI could be used to construct utility to curves that would explain the subsistence strategy followed at a particular site (Binford 1978:81). When skeletal elements of low economic value are recovered in higher frequencies than elements of high economic value, a reverse utility strategy is suggested. When elements of higher economic value are

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more numerous, a gourmet utility strategy is thought to have been followed. It has also been suggested that resulting utility curves may instead represent site type. Kill-butchering sites will usually contain low economic elements (reverse utility strategy) whereas habitation-consumption sites are expected to have relative high frequencies of high economic elements (gourmet utility strategy) (Lyman 1992:08).

Since Binford published his economic utility indices of sheep and caribou, other researchers have followed suit and created economic indices for a variety of species (Lyman 1992:07), including bison. Brink and Dawe (1989) developed two indices to evaluate the economic utility of bison bone in order to explain skeletal frequencies at Head-Smashed-In Buffalo Jump in Alberta. Emerson (1990) also created a series of bison utility indices to explain element frequencies in archaeological sites.

7.4.1.1 Brink and Dawe's Bison Economic Indices

In an attempt to analyze the bison assemblage from Head-Smashed-In Buffalo Jump, Brink and Dawe (1989) created their own utility indices for bison. Based on Binford's utility indices (1978), they produced two separate indices using data from three bison (Brink and Dawe 1989:125). To create their values, they measured the fatty acid content in the proximal, midshaft and distal portions of appendicular longbones (Brink and Dawe 1989:127). Mean volume data was obtained by measuring the articular ends from a series of bison appendicular elements in comparative collections (Brink and Dawe 1989:127-128).

With this data, Brink and Dawe (1989:134) created the grease index (GI) for proximal and distal ends of appendicular elements. The index values were derived by multiplying the percent fatty acids by the bone volume and dividing by 100 (Brink and Dawe 1989:134). Because marrow removal and grease rendering were likely related events, Brink and Dawe (1989:140) created a bone utility index (BUI) that combines the marrow and grease values into a single index and includes values for the midshaft. The BUI index was created by multiplying the percentage of fatty acids by the bone portion volume and dividing by 100. Shaft portion values were determined by combining the percent of fatty acid in the bone with the fatty acid percent in the marrow (Brink and Dawe 1989:140).

7.4.1.2 Emerson's Bison Economic Indices

Emerson (1990) created a series of bison economic utility indices based on the amount of edible resources for each carcass portion. Several weights were recorded for various parts from four bison of various age and sex. These weights included total meat and individual muscle, fat and other tissue, demuscled bone, bone marrow and bone grease, as

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well as dry bone. The marrow cavity volume, bone density and volume measurements were also noted (Emerson 1990:178).

Emerson (1990:615-617) takes into account age, sex and condition of the animal and presents a series of utility indices for single class, averaged, and mixed class assemblages. Single class indices are based on an individual bison and can be used to interpret assemblages dominated by a single type of bison (i.e. immature, male, female). The averaged indices were created by averaging all four bison values. This would be most useful when a mixed assemblage (i.e. males and females with immature individuals) is present. Finally, the mixed class combines values derived from two classes of animals such as females and immature individuals.

7.4.1.3 Bison Economic Indices and the Jackson Site Data

Three of Emerson's indices and both of Brink and Dawe's are used to evaluate the Jackson site bison assemblage. The average indices values are used for Emerson's utility indices because the Jackson site faunal assemblage contains elements from males, females and juveniles. Because this site is thought to contain both a small bison kill and associated processing area, treating the assemblage as a whole may obliterate evidence of patterned butchering/transport or site type. The skeletal elements left at the kill zone should consist mostly of low utility elements, while those recovered in the processing area should be elements of high economic utility. When treated as a whole, these elements might cancel each other and produce an unbiased utility curve. To address this issue, Block F was treated as a discrete area with an MNI of five individuals based on the presence of five right mandibular condyles. Block B, C, D and E faunal assemblages were grouped into one for the purpose of analyzing the processing area. An MNI of six individuals was indicated by the presence of six left M_2s. Blocks G to J are not included in this analysis because they are single unit blocks and their resulting bison assemblages are comparatively small. Also, it is uncertain what specific activities occurred in these blocks therefore their inclusion into the processing zone or kill is unwarranted.

A total of five bison economic indices were used to analyze the Jackson site bison assemblage. Two of these, the standardized modified averaged data total products model (S)MAVGTP (Emerson 1990) and the BUI (Brink and Dawe 1989) examine general economic utility. The bison element frequencies and corresponding (S)MAVGTP utility values (Table 1 Appendix IV) produce a weak but statistically significant negative correlation (Spearman's Correlation Coefficient r=-0.39, P<0.05; N=24). The BUI values and % MAU for the processing area (Table 2 Appendix IV) produce a similar weak but significant negative

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correlation (Spearman's Correlation Coefficient r=-0.48, P<0.05; N=18). Graphical representation of both indices (Figures 7.2 and 7.3) suggest an inverse utility curve where elements of low economic value are better represented than elements of higher economic value.

When % MAU's for the kill zone are plotted against utility values no statistically significant correlation exists. The Spearman's Correlation Coefficient for the bison kill %MAU and (S)MAVGTP values is approaching zero (r=-0.06, P<0.05; N=18) (Table 3 Appendix IV) suggesting no correlation between elements of high economic value and frequency. Figure 7.4 shows that elements with high economic values such as ribs, thoracic, cervical and lumbar vertebrae, the proximal femur and innominates are recovered in relatively high numbers. Elements of low economic utility like the cranium, atlas, axis, metapodials and carpals and tarsals are also represented by high frequencies.

The %MAU and the BUI values for the same assemblage exhibit a weak negative correlation (Spearman's Correlation Coefficient r=-0.35, P<0.05; N=18) but this is not statistically significant (Table 4 Appendix IV). The resulting graph (Figure 7.5) reveals what appears to be a reverse utility curve, implying that elements of high economic value are under represented.

In an attempt to understand specific processing activities occurring at the Jackson site, other economic indices were evaluated. Two indices assess the importance of grease rendering. Emerson's (1990) (S)MAVGGRE values plotted against the processing area %MAU produce a strong negative correlation (Spearman's Correlation Coefficient r=-0.69, P<0.05; N=16), suggesting that elements deemed high in grease content are not present in the assemblage (Table 5 Appendix IV). The resulting graph (Figure 7.6) suggests a reverse utility curve although relatively high frequencies of the innominate, distal humerus, proximal radius and central and fourth tarsal prevent a classic reverse utility curve.

Brink and Dawe's (1989) grease index (GI) also produces a negative correlation (Spearman's Correlation Coefficient r=-0.64, P<0.05; N=12) (Table 6 Appendix IV), with the resulting graph producing a reverse utility curve (Figure 7.7). Elements high in grease such as the femur, proximal tibia and proximal humerus are not represented in the assemblage while elements low in grease are represented. Several low grease elements like the distal tibia and distal metatarsal are under represented while the proximal radius was recovered in unexpected high numbers.
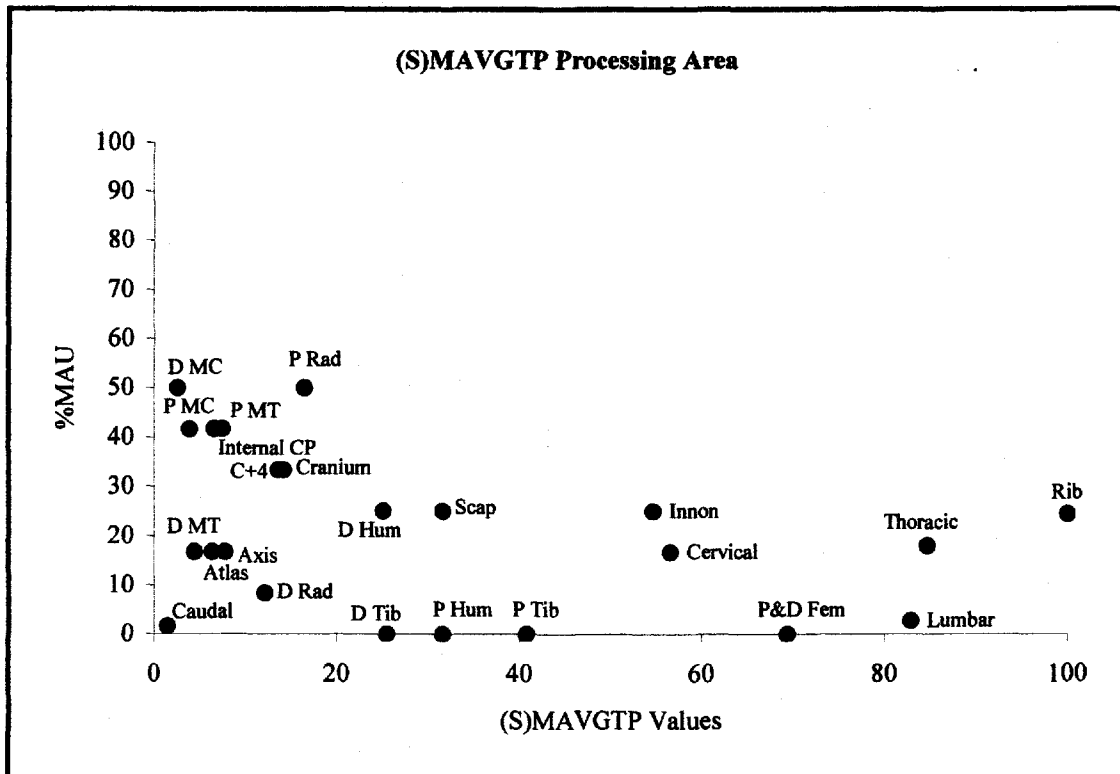
Figure 7.2 (S)MAVGTP economic utility plotted against % MAU for the processing area.
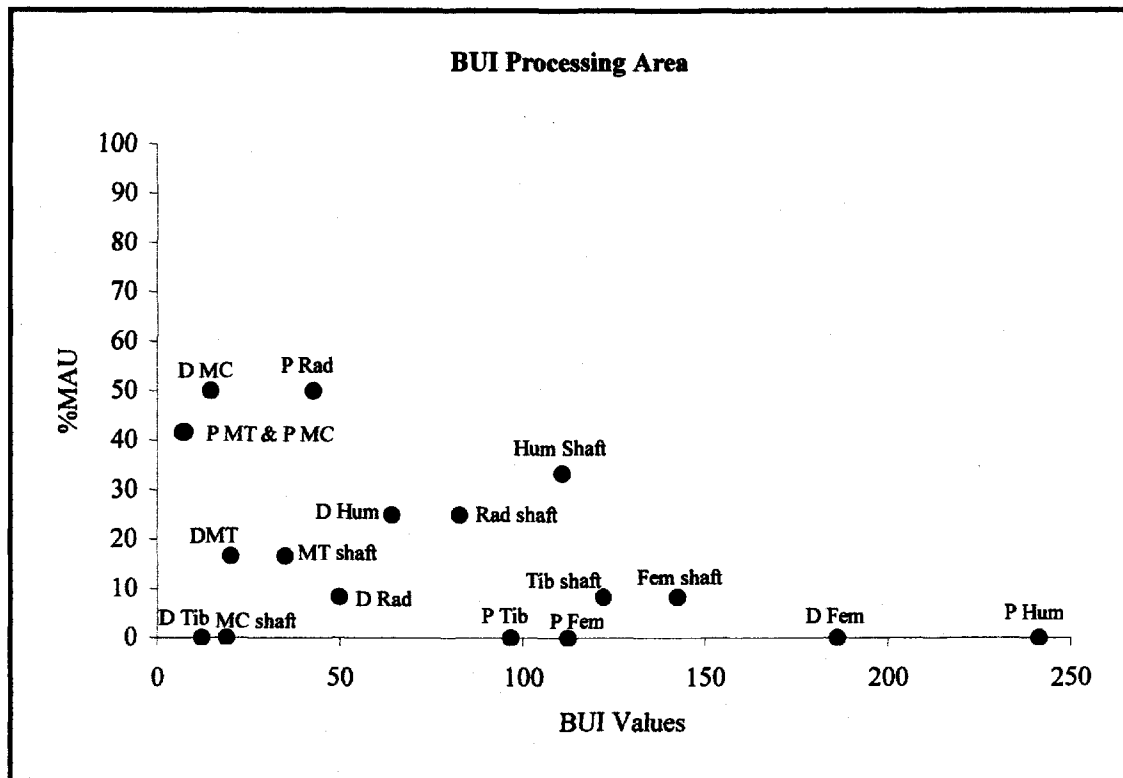
Figure 7.3 BUI economic utility plotted against % MAU for the processing area.

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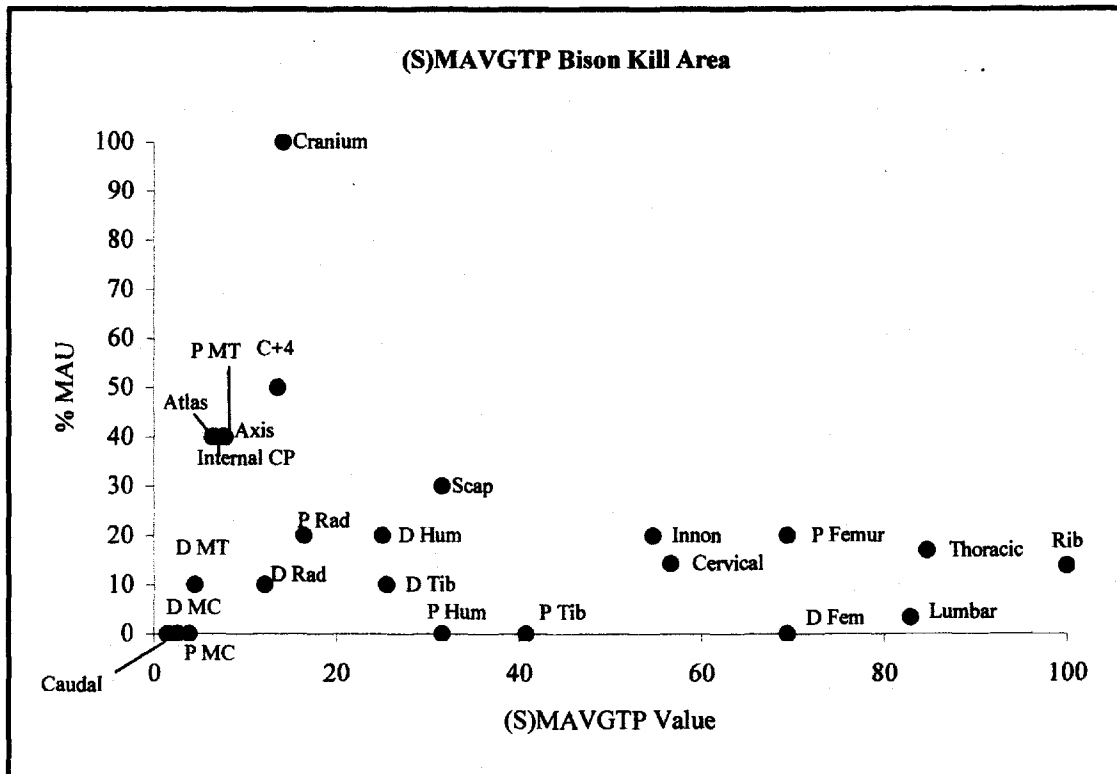
Figure 7.4 (S)MAVGTP economic utility plotted against % MAU for the bison kill area.
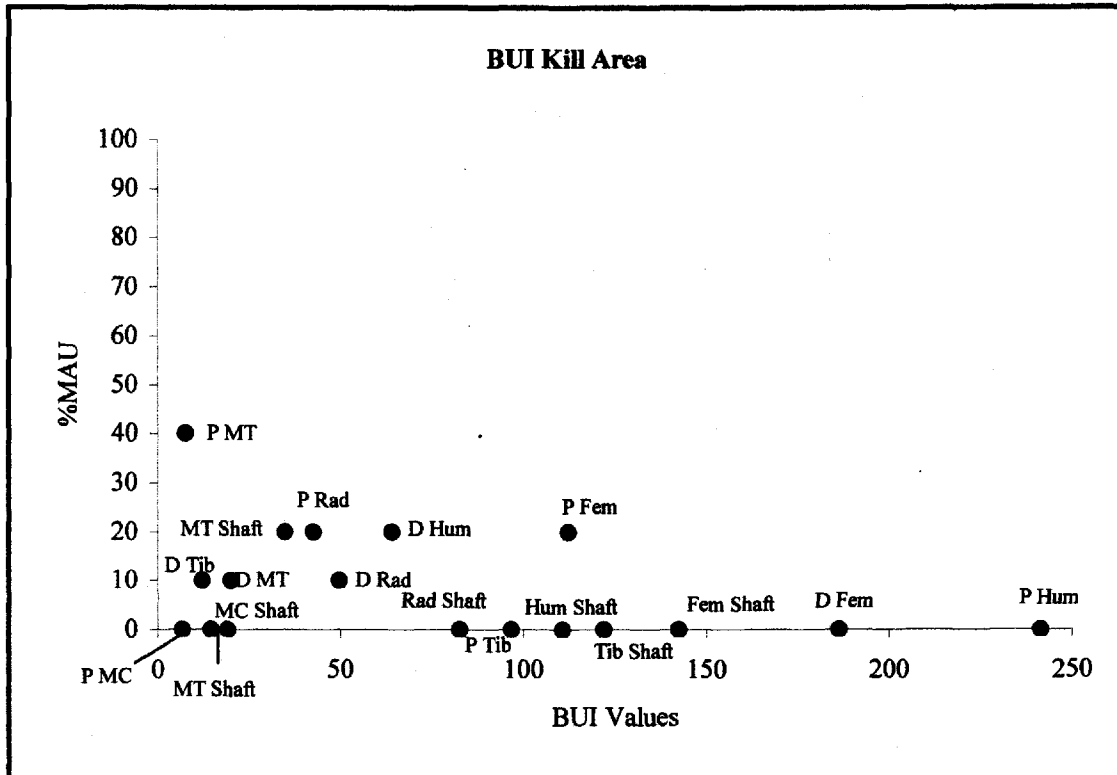
Figure 7.5 BUI economic utility plotted against % MAU for the bison kill area.

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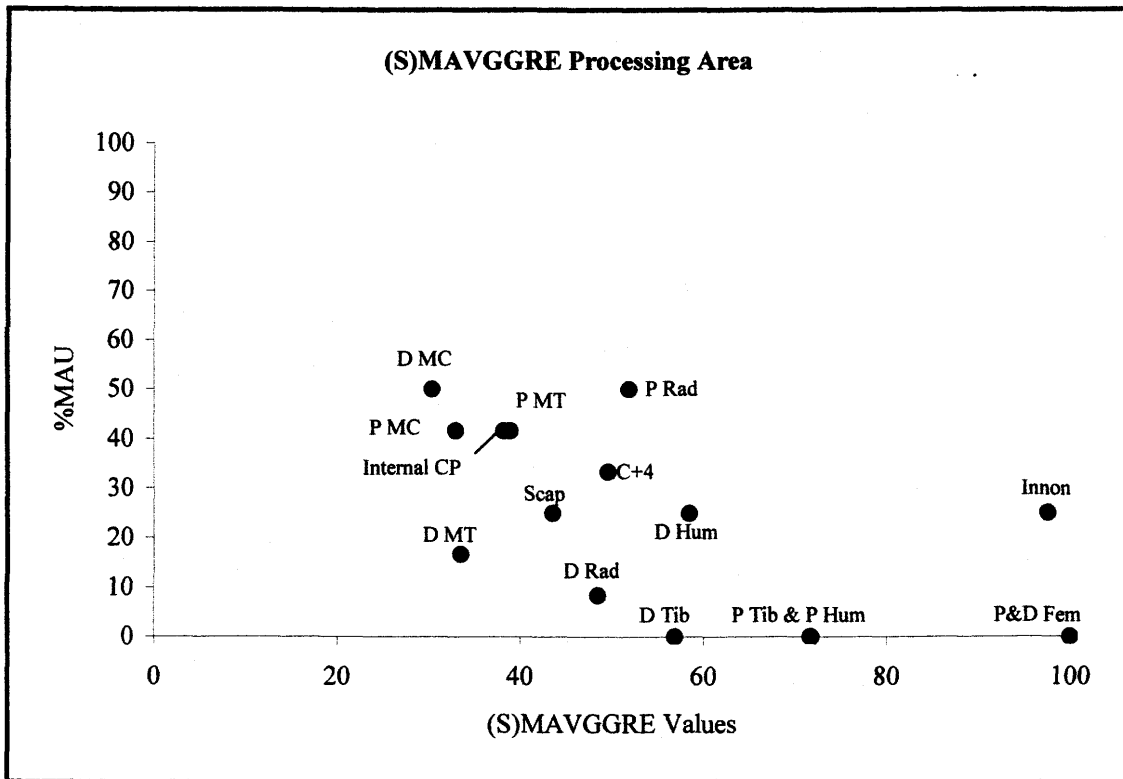
Figure 7.6 (S)MAVGGRE economic utility plotted against % MAU for the processing area.
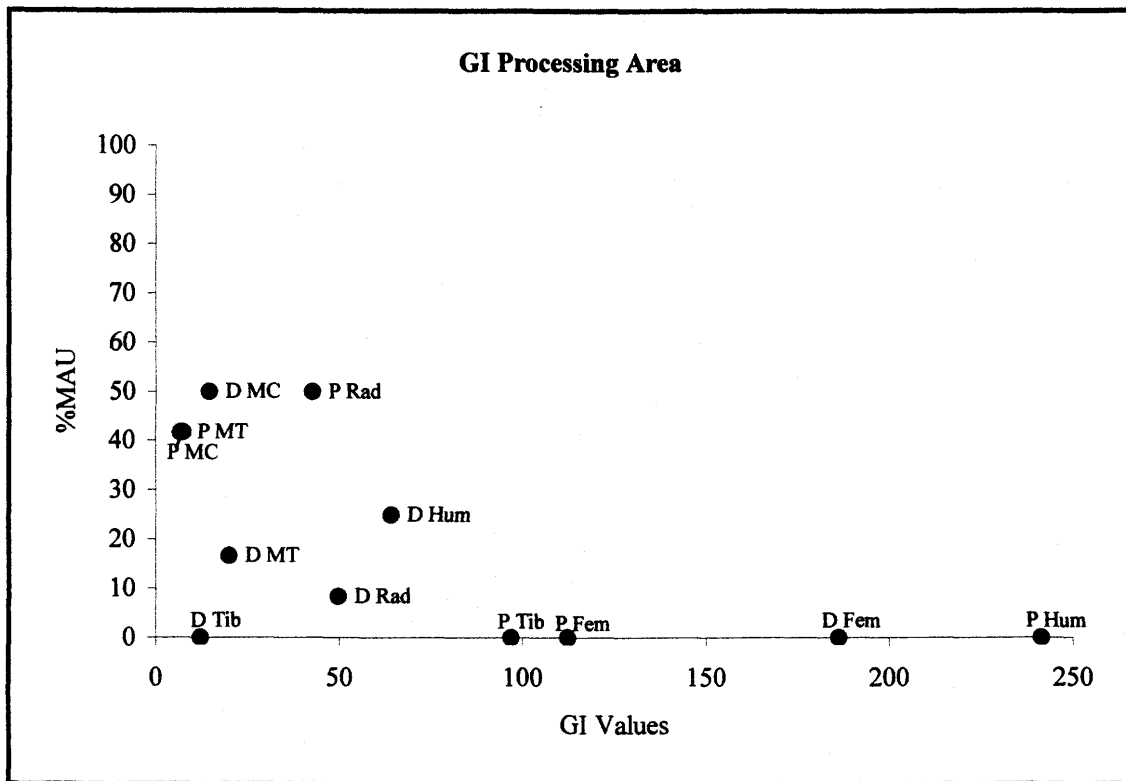
Figure 7.7 GI economic utility plotted against % MAU for the processing area.

When applied to the kill zone, neither the (S)MAVGGRE nor the GI values are statistically significant. The (S)MAVGGRE values and bison kill zone %MAU produce a Spearman Correlation Coefficient approaching zero (r=-0.08, P<0.05; N=16) (Table 7 Appendix IV). When plotted, this produces elements clustered in the middle of the graph (Figure 7.8).

The GI values ranked against the bison kill area %MAU produces a non-significant weak negative correlation (Spearman's Correlation Coefficient r=-0.2, P<0.05; N=12) (Table 8 Appendix IV). Figure 7.9 is a graphical representation.

A single utility index estimating the importance of marrow extraction was applied to the Jackson site data. When the (S)MAVGMAR values were ranked against the %MAU for the processing area (Table 9 Appendix IV), a significant negative correlation was produced (Spearman's Correlation Coefficient, r=-0.68, P<0.05; N=16). The resulting graph (Figure 7.10) indicates that although elements of high marrow content are generally not common, several elements with a moderate marrow yield are present in relatively high numbers.
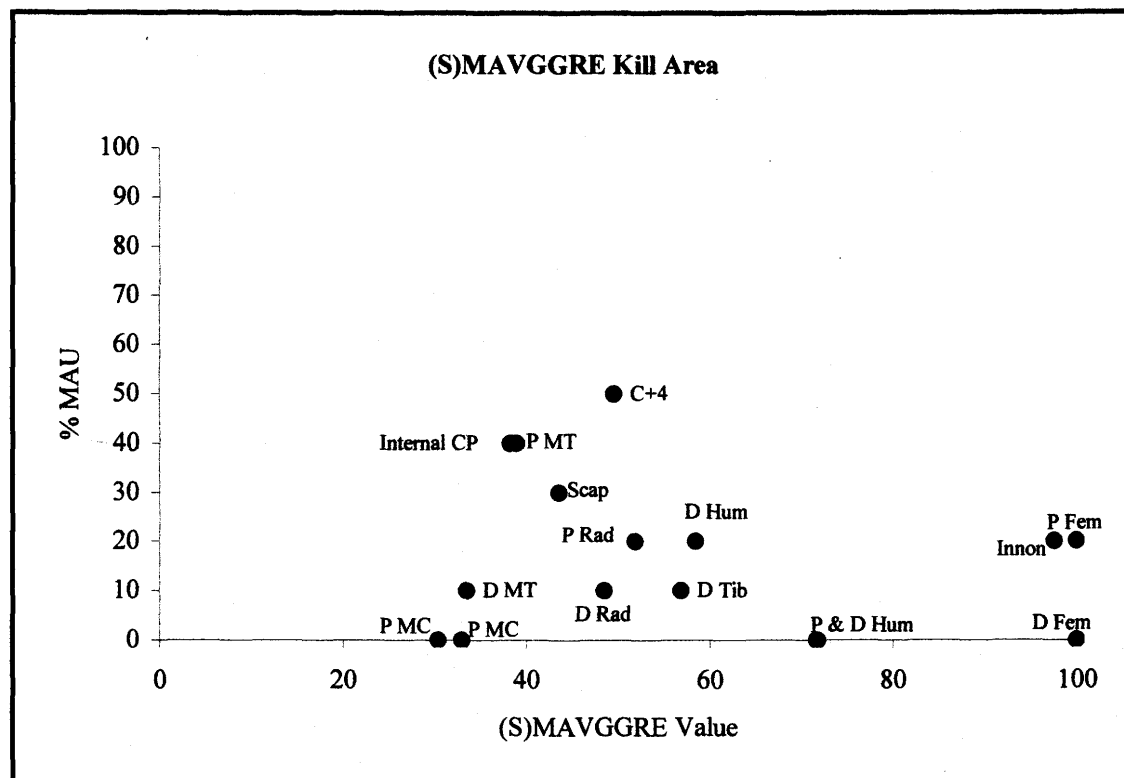
Figure 7.8 (S)MAVGGRE economic utility plotted against % MAU for the bison kill area.
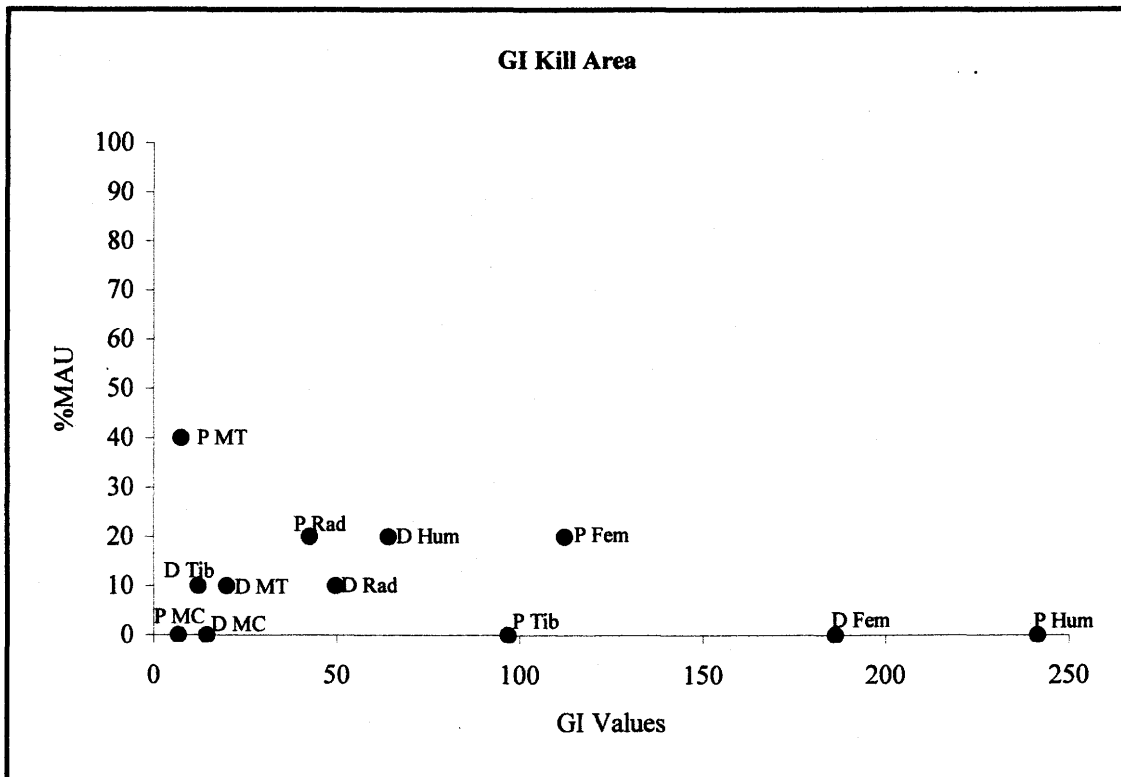
Figure 7.9 GI economic utility plotted against % MAU for the bison kill area.
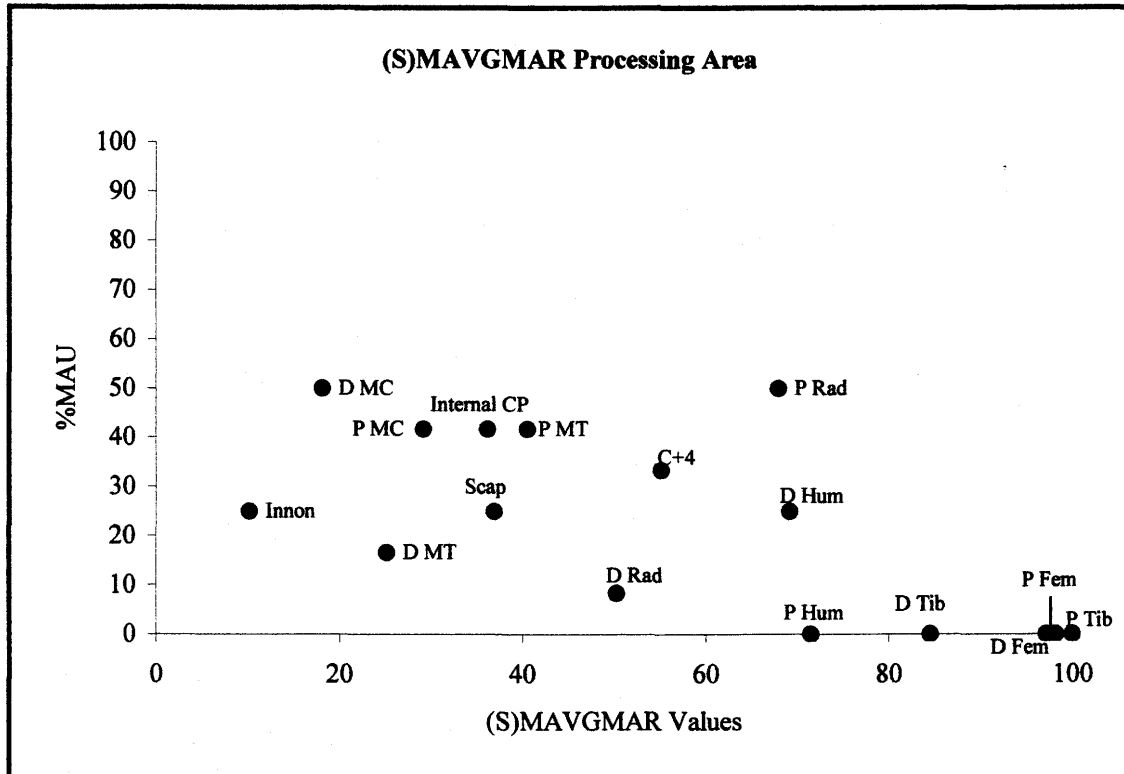
Figure 7.10 (S)MAVGMAR economic utility plotted against % MAU for the processing area.

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When compared to the kill area %MAU, the (S)MAVGMAR values produce no significant correlation (Spearman's Correlation Coefficient, r=-0.20, P<0.05, N=16) (Table 10 Appendix IV). Figure 7.11 shows no visible curve, implying that the selection of elements is unbiased in relation to their marrow content.
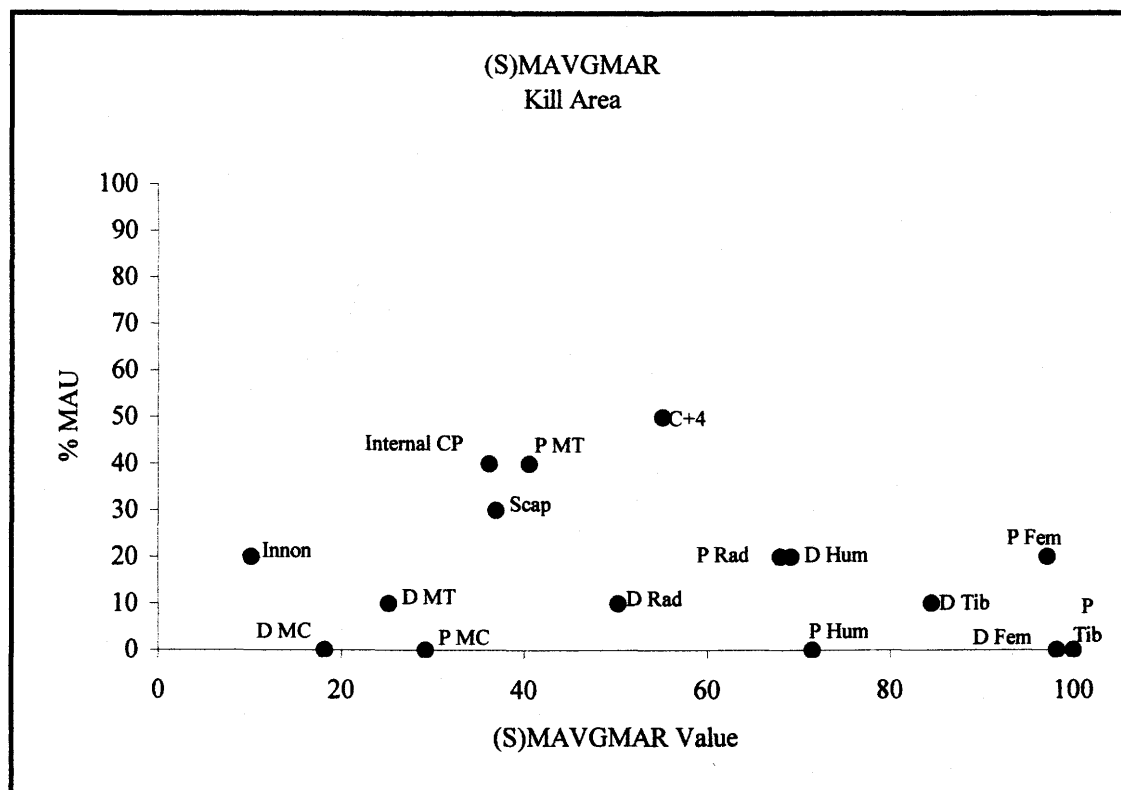
Figure 7.11 (S)MAVGMAR economic utility plotted against % MAU for the bison kill area.

7.4.1.4 Discussion

Both Emerson's (1990) and Brink and Dawe's (1989) bison economic utility indices were applied to the Jackson site processing and kill area assemblages in an attempt to obtain information regarding the butchering and transport decisions executed by the site's inhabitants. All index values had a statistically significant negative correlation when compared to the processing area %MAU. This indicates either a reverse utility subsistence strategy where carcass parts are utilized to the full potential (Binford 1978) or that this assemblage represents a kill-butchering area (Lyman 1992). Given the nature of the entire processing area faunal assemblage, it is very unlikely that this bison assemblage is part of a kill site. Instead, it is most probable that this part of the site was a locale of intensive bison

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processing. Emerson's (1990) grease and marrow index values are quite strongly negatively correlated with the %MAU for this area, suggesting grease and marrow extraction was a primary activity undertaken in this area.

Contrary to expectation, none of the bison economic utility values were statistically significant when compared to the bison kill area %MAU. This denotes an area where no apparent selection bias is being executed. This is unexpected in a kill area where one would expect elements of high economic utility to be missing and low economic elements left behind.

When the Block F faunal assemblage is examined in its entirety, the lack of statistical significance is not as atypical as it may first seem. As expected, a high frequency of low utility elements such as the atlas, axis, proximal metatarsal, C+4 tarsal and internal carpal is observed. Several elements of high economic utility are missing (i.e. distal femur, humerus) but unexpectedly, some are recovered in relatively high numbers. The presence of cervical and thoracic vertebrae, as well as the proximal femur and innominates certainly affected the statistical significance of the %MAU and index utility values. It is suggested here that block F is indeed part of a small primary bison kill as suggested by the recovery of low utility elements. Subsequent butchering and processing of the animal carcasses within the kill zone explains both the lack of, and recovery of, several grease and marrow rich elements. Elements with significantly high grease or marrow values were most likely processed. This is substantiated by the high percent of comminuted bone – unit 36 had the highest unidentifiable bone fragment count for the site.

In summary, several bison economic utility values were compared to the %MAU for the identified processing and bison kill areas. As expected, high frequencies of elements with low economic value were recovered from the processing area while elements with a high grease and marrow yield were relatively rare. Within the kill zone however, there appeared to be no selection strategy. If butchering and processing were occurring within the kill area as indicated by the comminuted bone, an unbiased selection strategy utility curve would result.

7.4.2 Bison Bone Density

In an attempt to explain skeletal frequencies, archaeologists used to assume that any differences were the result of human activity (Lyman 1985:222). It has since been proven that this is an erroneous assumption. Natural destructive and attritional processes differentially affect skeletal parts, producing quantitative patterns that are mistakenly attributed to human butchering and transporting of animal carcasses (Kreutzer 1992:271). Factors such as porosity, morphology, size, and mineral density contribute to the potential

survivorship of an element. The best understood of these factors is mineral density. Lyman (1984a) was the first to directly measure bone density using single-beam photon densitometry. By measuring the volume density of deer, pronghorn antelope and sheep elements, Lyman (1984a, 1985) showed that elements with higher mineral contents and therefore greater density were recovered in larger numbers than low-density elements.

Kreutzer (1992) argued that it is inappropriate to apply Lyman's deer element density data to bison. Differences in overall size, body part proportion and locomotion generate density differences in the pertinent elements, with bison elements often being denser. Kreutzer (1992:278-281) provides volume density data for 101 scan sites on most bison elements except the cranium, sternum, caudal vertebrae and sesamoids. The volume density of 12 modern bison skeletons was measured using a dual energy x-ray densiometer.

Kreutzer (1992:289) found that although deer and bison element densities were similar, bison cervical vertebrae, limb elements and mandibles were significantly denser than deer. She suggested that, "where significant rank-ordinal correlation exists between bone density and skeletal frequencies, quantitative patterns *may* be best attributed to density-mediated, differential survival of element parts, rather than to butchery and transport decisions." (Kreutzer 1992:289 emphasis in original). Lyman (1992:18) argued a similar point, stating that the relationship between the volume density and utility of a part is at least partly dictated by functional anatomical principles. There is a general inverse relationship between the volume density and the utility of the appendicular skeleton. As such, assemblages affected by density-mediated attrition may produce curves suggestive of the reverse-utility strategy (Lyman 1992:19).

Given that several of the bison economic utility indices produced reverse-utility strategy curves for the Jackson site data, it was necessary to determine if such curves are the product of human activity or were created because of density mediated factors. The processing and kill area bison assemblages were compared to volume density values for 91 scan sites. Scan sites were chosen based upon corresponding landmarks for each element, and those used for the Jackson site assemblage is presented in parenthesis after each landmark in Appendix II.

The %MAU values are compared to the volume density values from both the processing and the kill area (Appendix V). Both the processing and the kill zone %MAU's are weakly positively correlated with the corresponding volume density values. The processing area has a slightly more positive correlation (Spearman's Correlation Coefficient, $r=0.35$, $P<0.05$; $N=91$) than the kill area (Spearman's Correlation Coefficient, $r=0.30$, $P<0.05$;

N=91). Figures 7.12 and 7.13 are graphical representations of the bison bone volume density plotted against the %MAU for the processing area and the kill area respectively.

Although both the processing area and bison kill assemblages are weakly positively correlated with bison bone volume density, this information does not convey which taphonomic agent or agents, if any, are responsible for the bison bone frequencies in the assemblage. Other lines of evidence are needed to determine if differential transport/butchery as suggested by the utility indices, or density mediated destruction as suggested by the bison bone density data is the source of the bone frequencies seen in the bison assemblage (Lyman 1994:258). If density mediated destruction is the cause of the bone frequencies, the processes causing the destruction need to be identified.

Four methods have typically been used to determine if differential transport/butchery or density mediated destruction affected an assemblage. The different quantitative representation of skeletal parts can sometimes be used to distinguish between the two (Lyman 1985:226). It has just been shown that the different quantitative representation of bison elements cannot be used to distinguish between density mediated survival and human butchering. The recovery of foetal bison and non-bison elements does suggest that density mediated destruction is not the main source of the bison element frequencies. Bradley Novecosky and Peter Popkin (2001: personal communication) have undertaken a study to establish the volume densities of domestic and wild canid elements. As part of this research, the Jackson site canid assemblage was analyzed, and it was determined that the Jackson site canid elements were not affected by density mediated destruction. If the canid elements were not affected by density mediated factors, it is unlikely that natural taphonomic processes would have acted solely on the bison bone.

A second approach is to examine the degree of disarticulation, fragmentation and scattering (Lyman 1985:226). The Jackson site faunal assemblage is almost completely disarticulated and highly fragmented. The third approach is to investigate the geologic context of the remains (Lyman 1985:226). Fortunately, it is known that the assemblage being studied is a single component from an archaeological site. An examination for the presence or absence of butchering marks and carnivore marks is a final method for distinguishing differential transport/butchery from density mediated taphonomic processes (Lyman 1985:226). This is the most promising line of investigation for the Jackson site faunal assemblage.

Lyman (1985:226) advocates searching for carnivore or butchering marks, but analysis of the Jackson site faunal assemblage was expanded to include evidence of all visible
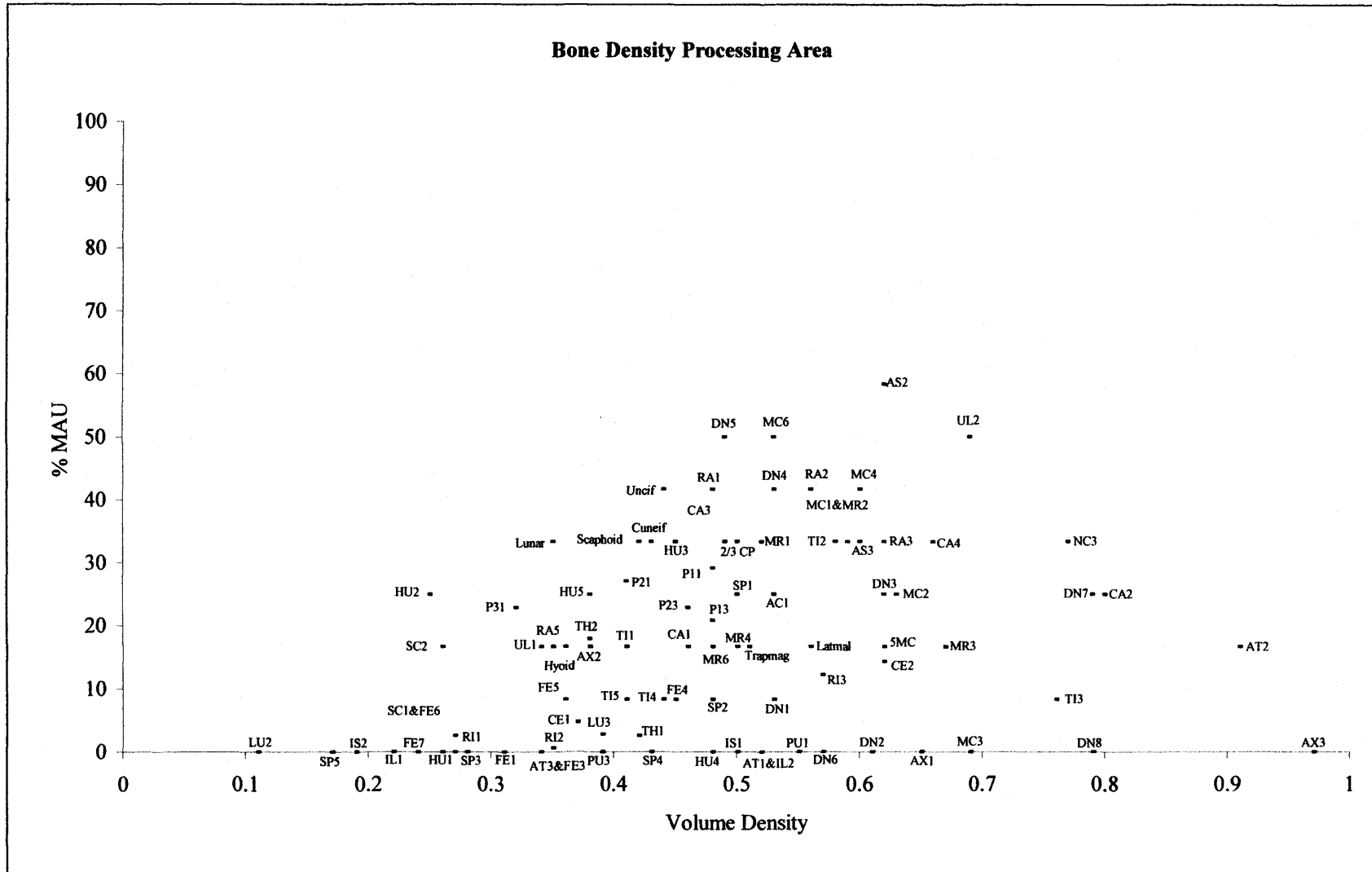
Figure 7.12 Bison element volume density values and associated %MAU from the processing area.
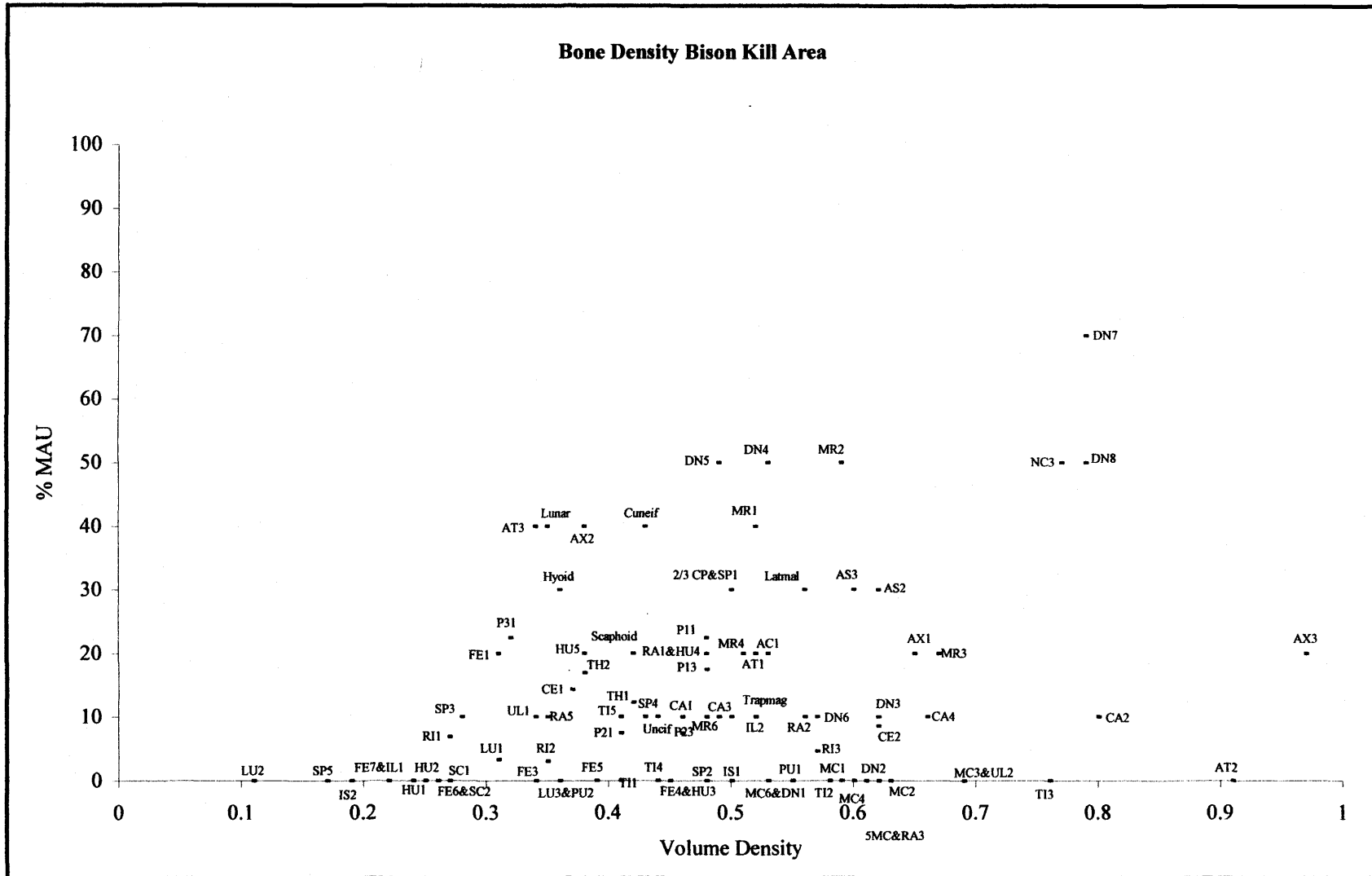
Figure 7.13 Bison element volume density values and associated % MAU values for the bison kill area.

taphonomic processes because carnivore attrition is not the sole cause of differential destruction. Trampling, weathering, fluvial transport and sediment loading are other causes (Grayson 1989:650). It is also necessary to establish the extent of human modification on the faunal assemblage.

The Jackson site faunal assemblage was analyzed for macroscopic evidence of a variety of taphonomic effects. A systematic analysis as advocated by Blumenschine *et al* (1996:505) was not undertaken given the time and effort this would have entailed. Instead, examination concentrated on identified bone specimens, although unidentified specimens were cursorily inspected for taphonomic traces. When modifications were noted, a hand lens or low-powered light microscope was often used to enhance examination.

Cultural and non-cultural modifications are present on the Jackson site faunal assemblage. Taphonomic traces attributed to a non-cultural agent include carnivore modification, weathering, abrasion and/or polish, and rootlet etching. Humans modify bone either intentionally or unintentionally. Unintentional modifications such as cut or percussion marks and bone fractures are byproducts of human behaviour when processing an animal carcass into consumable resources. Bone can be intentionally modified to create artifacts or tools (Lyman 1994:339). Formal bone tools are those that are intentionally modified from their original faunal form for a functional purpose (Weston 1993:83). Expediency tools are ones used with little or no prior modification, and usually are identified on the basis of use-wear attributes (Johnson 1985:223).

7.4.3 Natural Taphonomic Agents and Processes

7.4.3.1 Carnivore Modification

Binford (1981) studied bone modification and destruction caused by carnivorous animals. After analyzing 12,716 bone specimens recovered from Anaktuvuk dog yards in Alaska, he defined and described four types of tooth marks and bone breakage patterns created by dogs (Binford 1981:36). Punctures are created when bone collapses under tooth pressure, leaving an imprint. When bone is resistant to collapse, pits are created. Scoring is a linear scarring of the surface and happens when bone is turned against the teeth. These are distinguishable from cut marks because scoring follows the contour of the bone while cut marks do not. Furrows normally occur on cancellous bone tissue where the action of the canines and carnassials produce undulations. In extreme cases, the bone becomes 'scooped out' in which only a hole is left (Binford 1981:44-48). Dogs attempt to collapse the bone shaft only after the articular ends have been gnawed off. Two traits are considered characteristic of animal gnawing. Channeled bone is produced by, " puncturing the bone back

from the transverse edge, leaving a channel running parallel to the longitudinal axis of the bone." (Binford 1981:51). When gnawing on protrusions with the carnassial teeth, small chips are removed from the surrounding cortical bone, producing what Binford (1981:51) terms 'chipping back'.

Evidence of carnivore modification was present on specimens recovered from all blocks except one: block H. A single bison rib fragment from block G is pitted. An unidentified pitted bone fragment and a gnawed foetal element were recovered from block I, and a scored proximal bison metacarpal were identified in the block J assemblage. In block B, a bone fragment is pitted while another has score marks. Puncture marks are present on a bison rib head and acetabulum and an internal carpal has a series of carnivore teeth marks (Figure7.14).

As well, a bison calcaneous has both epiphyseal ends chewed off. In block C, eight bone fragments are pitted or punctured and a SC5 longbone fragment is pitted. A tibia fragment from a SC3 animal is pitted. A large canid ulna midshaft has pit, puncture and score marks while a scapula has puncture marks. Bison elements displaying evidence of carnivore gnawing include a punctured coronoid process, a pitted ulna midshaft and proximal radius, a scored radius midshaft segment, and a furrowed 2nd phalanx and rib head. In block D, several rib body fragments are pitted, scored or punctured. The 2nd phalanx and distal femur of a large canid has puncture marks while two bison 2nd phalanges are pitted and punctured. Other pitted bison elements include a proximal tibia fragment. A bison thoracic spine, lumbar centrum, as well as proximal and distal ulnae are all punctured. Furrowing is present on a distal ulna and a bison 1st phalanx that also has puncture marks. A bison medial sesamoid exhibits a puncture mark, pits and furrowing while an astragalus has both puncture and pitting marks. Three foetal bison elements recovered from block D have pit and score marks. In block E, one fragment had passed through a digestive tract and three others are pitted (Figure 7.15).

Figure 7.14 Bison internal carpal with carnivore teeth marks.
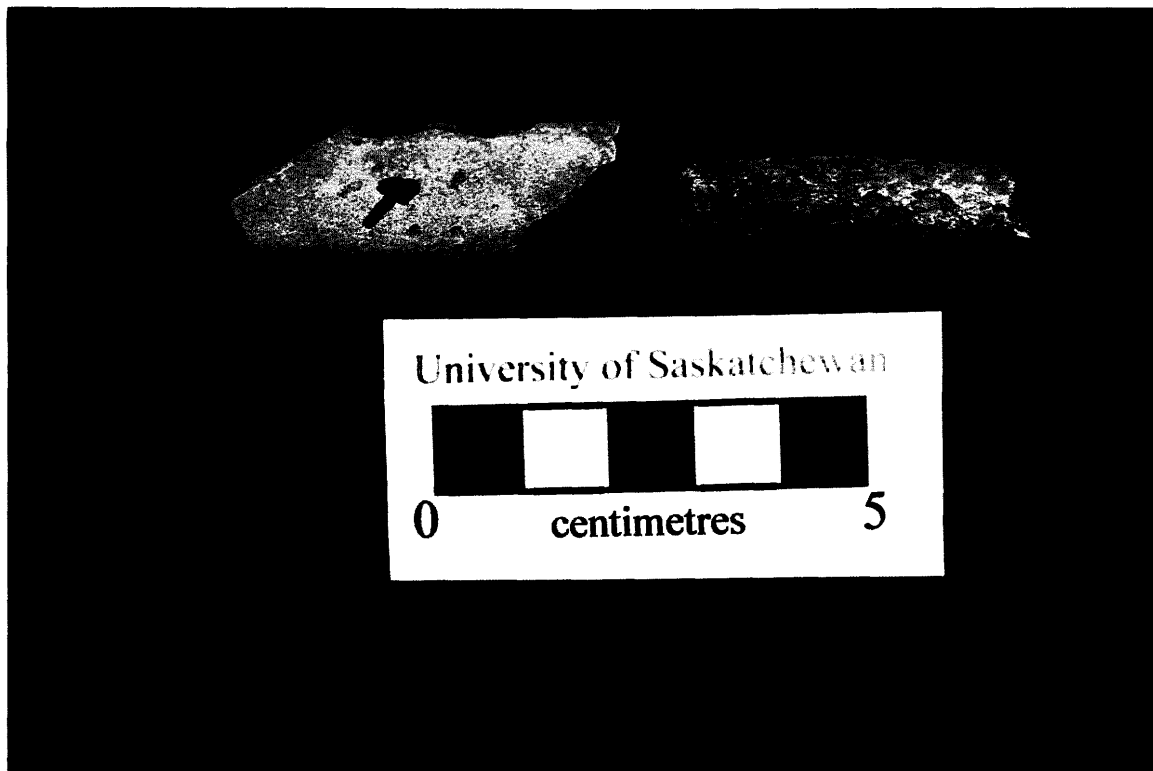
Figure 7.15 Pitted and digested bone fragments.

Appendicular fragments from a very large mammal are pitted. A large canid tibia.has had the epiphyseal ends gnawed off. A bison 1st phalanx, proximal mandible fragment, cervical vertebrae and astragalus have punctures while a cervical vertebra was punctured and furrowed. A calcaneous from this block has gnawed edges and score marks. From the kill area, a single rib body fragment displays evidence of digestion. Two unidentified bison appendicular elements are pitted. Several rib body fragments show pitting and or scoring while a hyoid and femur head have puncture marks. A proximal metatarsal is pitted and a proximal mandible has scoring marks.

In summary, a total of 77 specimens from the Vickers Focus occupation at the Jackson site exhibit visual evidence of carnivore modification. This translates to 0.04% of the assemblage, suggesting that carnivore modification was not a factor of density mediated destruction of the assemblage. However, the relative absence of carnivore gnaw marks is not absolute evidence that carnivore attrition did not take place. Blumenschine (1988:490) showed that limb elements previously broken for marrow extraction will have far fewer carnivore marks than unbroken elements. Dogs can even gnaw bones and leave no visible trace although this situation usually occurs at the onset of gnawing (Kent 1981). Carnivores can gnaw elements for an extended amount of time before density mediated attrition is visible in an assemblage (Lyman 1994a:277-278).

An examination of the relative frequency of element portions is another method of estimating the extent of carnivore attrition on a specific assemblage. Because canids prefer grease rich articular long bone ends with relatively thin cortical bone, Binford (1981:221) suggested that a comparison of the frequency of the proximal to the distal ends of certain elements will indicate whether an assemblage has been 'ravaged' by carnivores. When such comparisons are made with the Jackson site faunal assemblage (Figures 7.16 and 7.17) it appears that the assemblage would have been heavily affected by carnivore modification. However, it is difficult to unequivocally attribute the scarcity of the proximal humerus and the proximal tibia to carnivore attrition. These element portions are significantly less dense than the distal portions, and are also high in grease and marrow, making them attractive for human consumption. If the assemblage was as ravaged as the relationships between the distal and proximal longbone ends indicate, a much higher percentage of the assemblage should exhibit evidence of intensely gnawed elements. The majority of the carnivore modifications present on the site are pitting and scoring while furrowing and channeling are almost absent. Binford (1981:49) suggested that bones modified by dogs tend

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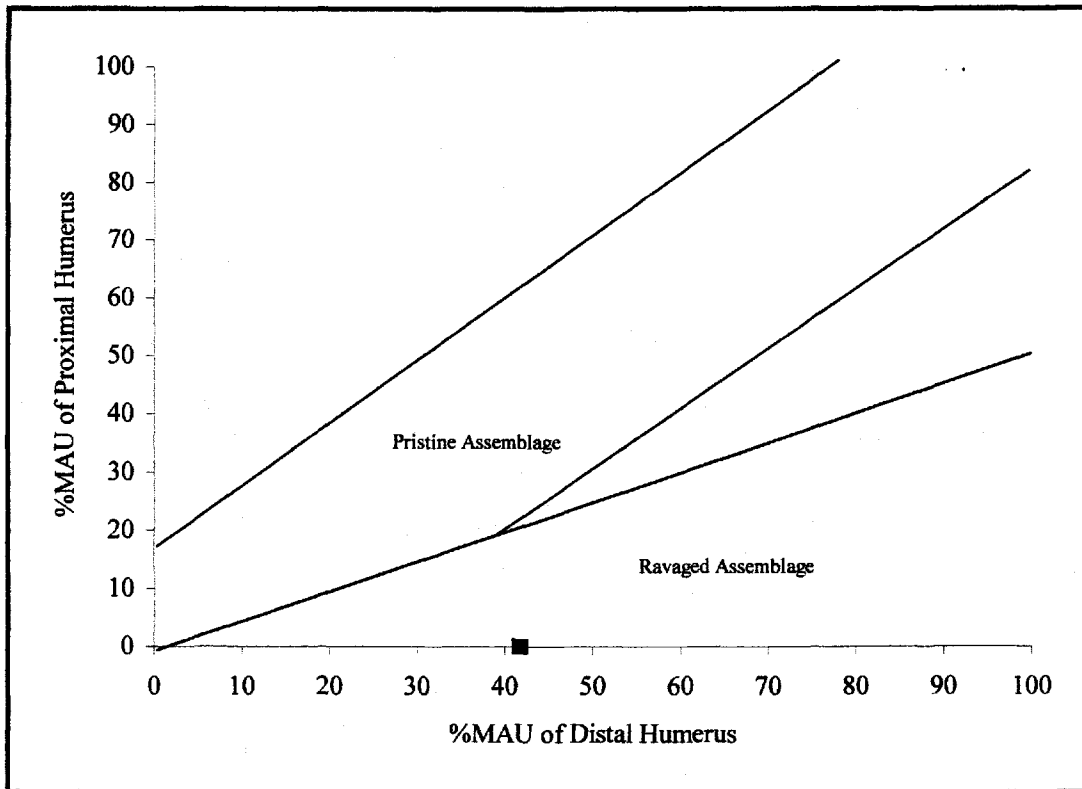
Figure 7. 16 Relationship between %MAU of the proximal and distal humerus.
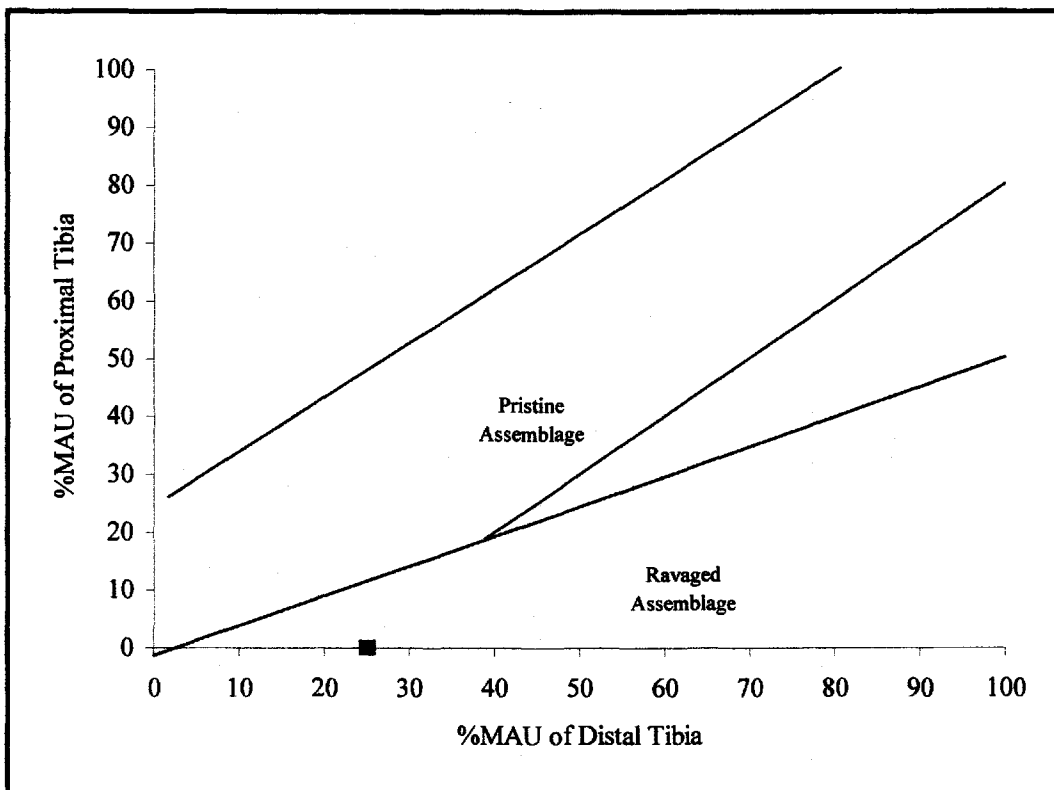
Figure 7.17 Relationship between % MAU and proximal and distal tibia.

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to have a higher percent of pitting and scoring as compared to wolf kills where furrowing, puncture marks and crenulated edges are more common. The rationale for this pattern is that domestic dogs will chew out of boredom while meat consumption is the primary activity at the wolf kills. If the Jackson site assemblage was modified by carnivores to the point of density mediated destruction, one would expect a higher percent of furrowing and channeling. Instead, the nature and extent of carnivore modification identified in the Jackson site faunal assemblage suggests that this assemblage was minimally modified by carnivorous animals, and density mediated destruction of bison elements was not caused by these animals.

7.4.3.2 Weathering

Weathering is a combination of chemical and physical processes that separate and destroy bone's organic and inorganic components (Behrensmeyer 1978:153). It is identified by a cracked, split, exfoliated, disintegrated or decomposed appearance (Fisher 1995:31). Behrensmeyer (1978:161) defined six stages of weathering for large mammals, with stage 0 being fresh, greasy bone and stage five being highly weathered, decomposing bone. Weathered bone identified in the Jackson site faunal assemblage was classified following Behrensmeyer's six stages (Table 7.2) and no stage 0 bone was present in the assemblage.

Two and a half percent of the assemblage has a weathered appearance. Blocks C and F have significantly more weathered bone than the rest of the assemblage. The majority of the block C weathered bone is lightly to moderately weathered (stages two and three) while the bone from the kill area is moderately to heavily weathered (stages three, four and five). This is consistent with field observations in which several identified bone elements excavated from the kill area fragmented upon removal. Although it is tempting to infer than blocks C and F were not buried as quickly as the rest of the site, this may not be correct. Lyman and

	Stage 1		Stage 2		Stage 3		Stage 4		Stage 5		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Block B	4	0.03	177	1.27	4	0.03	27	0.19	0	0	212	1.52
Block C	4	0.05	191	2.6	205	2.79	75	1.02	69	0.93	544	7.41
Block D	19	0.05	58	0.14	19	0.05	34	0.08	17	0.04	147	0.35
Block E	6	0.01	119	0.26	200	0.43	10	0.02	5	0.01	340	0.74
Block F	422	0.74	445	0.78	680	1.19	893	1.56	1020	1.79	3460	6.06
Block G	4	0.09	44	0.95	62	1.34	19	0.41	9	0.2	138	3
Block H	3	0.11	2	0.08	1	0.03	7	0.28	0	0	13	0.51
Block I	8	0.05	4	0.02	0	0	0	0	0	0	12	0.07
Block J	0	0	9	0.25	7	0.19	4	0.1	18	0.49	38	1.03
Total	470	0.24	1049	0.54	1178	0.6	1069	0.55	1138	0.59	4904	2.53

Table 7.2 Weathering stages presented by block.

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Fox (1989:313) illustrate those factors besides length of exposure prior to burial that affect weathering rates. Differential moisture, temperature and sun exposure can create differential weathering stages. As well, activities such as burning and boiling bone can alter bone structure which may create an artificial weathering indistinguishable from genuine weathering (Stiner and Kuhn 1995). Weathered bone is almost non-existent at the Jackson site except in blocks C and F where weathering has affected a small percent of these assemblages. It does not appear to be a major contributor to density mediated destruction of the Jackson site bone.

7.4.3.3 Rootlet etching

Rootlet etching consists of thin, sinuous, U-shaped shallow lines that are etched into bone surfaces by acids associated with plant roots. Rootlet etching itself is not destructive, but can increase the vulnerability of the immediately adjacent surface to erosion (Fisher 1995:43). A total of 407 specimens, or less than one percent of the faunal assemblage has visible rootlet etching (Table 7.3).

	B	C	D	E	F	G	H	I	J	Total
N	0	10	103	87	191	3	2	5	6	407
%	0	0.14	0.25	0.19	0.33	0.07	0.08	0.03	0.16	0.21

Table 7.3 Rootlet etching on the faunal assemblage presented by block.

7.4.3.4 Polish and Abrasion

Abrasion and polish are terms that have been used interchangeably in archaeological studies. Both involve the removal of bone, but polish results in a bone surface with a macroscopically detected gloss or sheen (Fisher 1995:33). Abrasion is the removal of bone edges and/or surfaces (Behrensmeyer et at 1989:100). Only a small percent of the entire Jackson site faunal assemblage (0.32) is abraded, and an even smaller percent (0.06) is polished (Table 7.4).

	B	C	D	E	F	G	H	I	J	Total
Abraded	0	8	11	8	580	9	0	1	4	621
Polished	6	8	32	27	31	1	3	5	2	115

Table 7.4 Polished and abraded bone presented by block.

It is significant that nearly all the abraded bone (93.4%) was recovered from block F. Most of these specimens are highly abraded, exhibiting rounded edges. Cancellous tissue has almost always been removed, and some specimens are polished or possess incipient polish along the edges. When examined with a low-powered light microscope, the cortical bone

surface is etched and/or pitted. Numerous striations are visible on a majority of the specimens. Most are small, unidentified bone fragments although some larger specimens are abraded. It is also noted that many appear to be slightly to moderately weathered.

A number of processes acting before, during, or after burial can cause bone to become polished, and/or abraded (Bromage 1984:173). Aeolian erosion and fluvial transport either with or without sediment contact can cause polish and/or abrasion. Soil turbation caused by freeze/thaw cycles, swelling and shrinking of clays, or tree falls can bring bone in contact with abrasive sediment (Fisher 1995:33-34). Even abrasion from shifting volcanic ash particles after a volcanic explosion can cause rounding and polishing on bone (Lyman 1984b:321). Chemical erosion from sediment can potentially cause abrasion (Fisher 1995:34). Bones broken while an animal was alive and survived may become polished or rounded due to contact between the broken bone surfaces (Oliver 1989:87). Binford (1981) notes that carnivores can create polish on bone by persistent licking. Trampling by large animals (including humans) is another means by which bone becomes abraded or polished (Gifford-Gonzalez 1989). The edges of fragmented bone may become round and polished when boiled (Lyman 1994a:382-383). Intentional modification of bone for use as tools, and resulting wear on intentionally or unaltered bone tools can create polish and/or abrasion (Lyman 1994a:344).

The Jackson site kill area abraded bone was studied in an attempt to discern the cause of the abrasion. Volcanic eruption, swelling and shrinking of clays, fluvial transport, and broken limbs can easily be rejected as causes of the abrasion. Even though some carnivore induced modification is evident at the site, the nature, location and frequency of the abrasion and polish is not consistent with carnivore modification that usually creates polish. It is doubtful that the size and number of trees in the area (and resulting tree falls) would have been sufficient to cause the degree of abrasion and polish present in the assemblage. Similarly, freeze/thaw cycles probably did not occur in adequate numbers. There is also no evidence that soil chemicals have modified the bone. The abrasion and polish observed on the block F faunal assemblage is not consistent with pot polish. This is a sheen restricted to the projecting ends of bone that has been boiled. It is thought to be caused by the contact between the pot sides and the bone, and generally occurs only on specimens larger than three centimetres (White 1992:122-124) .

The striking resemblance of the abraded specimens to formalized bone tools requires an explanation (Figure 7.18). To be recognized as a bone tool, Lyman (1984b:317-318) believes an artifact must possess certain criteria. One is that bones of only an appropriate
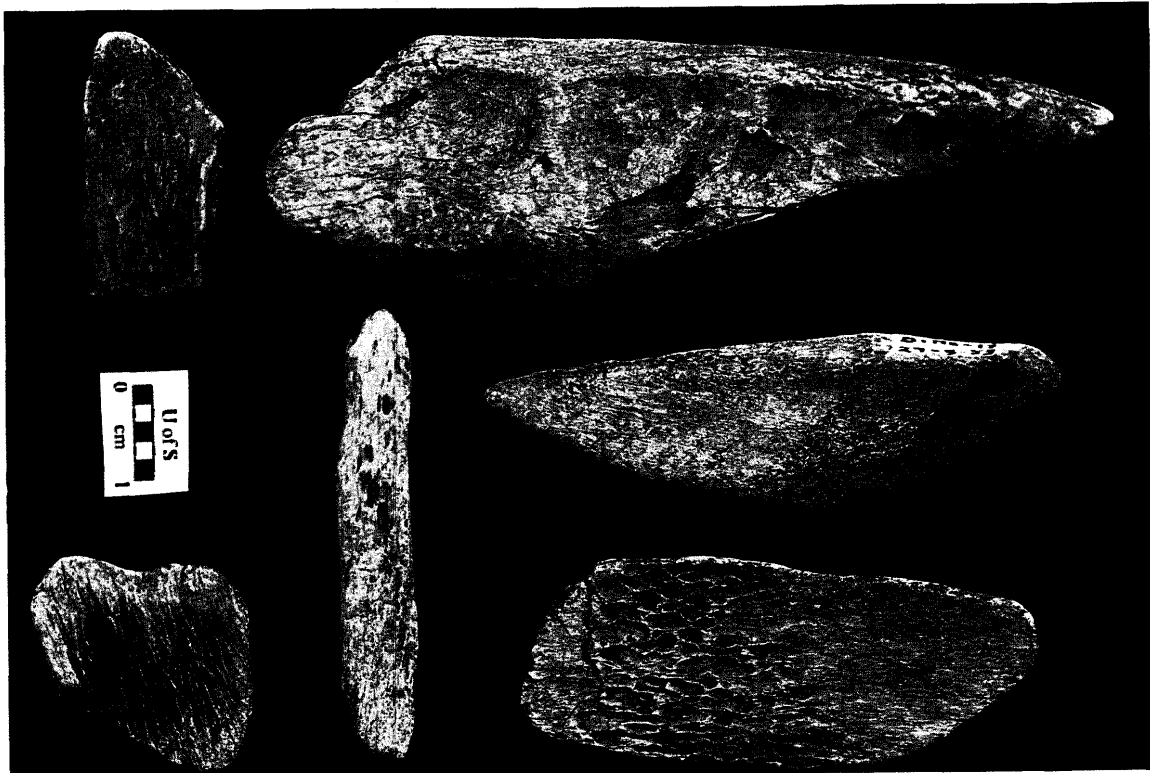
Figure 7.18 Abraded bone from block F.

structure, weight and strength are chosen. Modifications such as chipped fracture edges, ground fracture edges, seriated fracture edges and the accumulation of detritus may be visible. Use-wear modification should be present on the worked ends and/or edges. Wear polish, damage use flake scarring and rounded or worn surfaces can appear in various combinations with each other. If the abraded specimens are indeed bone tools, some of these criteria should be present.

A careful examination of the block F abraded bone verifies that the abrasion is not a function of bone tool use. Many are simply too small and fragile to be convincing bone tools. There is also a consistent lack of use-wear modification. Polish, abrasion and rounding is almost never restricted to potential working edges and instead are uniformly distributed across bone surfaces. Chipping and flaking are present on several specimens, and this may be a function of use-wear. However, it will be shown that other taphonomic processes have acted on the block F faunal assemblage that can mimic use-wear.

The modifications present on the block F assemblage are most likely due to trampling and possibly wind erosion. Trampling affects an assemblage by causing horizontal and vertical artifact movement (Gifford-Gonzalez *et al* 1985:808-810), bone fragmentation

(Lyman 1994a:379), and creating a variety of marks on bone (Brain 1967, Behrensmeyer *et at* 1986, 1989, Olsen and Shipman 1988). These marks include striations, polish and conchoidal flake scars (Fisher 1995:36). Striations are similar to cut marks but distinctive characteristics enable proper identification. Trampling striations are usually fine, shallow and are U-shaped. They are widely and evenly distributed across a bone surface and will be diversely orientated (Olsen and Shipman 1988:543). Flat, rounded or convex areas of bone are preferentially affected by trampling striations (Behrensmeyer *et al* 1986:770). Examining the frequency of bone with striations in an assemblage, the number of striations per specimen, as well as the location and orientation of such striations helps to clarify whether marks were caused by trampling (Olsen and Shipman 1988:550).

The block F abraded bone exhibits classic trampling features. Most have faint, shallow, diversely orientated U-shaped striations covering parts of, or the entire bone surface. As previously mentioned, the cortical bone on many is etched and pitted, modifications indicative of aeolian erosion (Johnson 1985:189). However, with aeolian abrasion, one would expect the striations to be limited to the exposed surface of the bone. The Jackson site examples tend to be pitted and etched along the cortical bone, regardless of bone orientation. Aeolian abrasion cannot be discounted as a cause of the abraded bone, especially given the site's location in the sandhills. However, if aeolian abrasion was the sole source of the block F abraded bone, one would expect the entire assemblage to display pitted and etched rounded bone, and this is not the case.

The likeness of the abraded specimens to those pictured in Brain (1967) suggests that the block F abraded bone was weathered prior to trampling. Brain (1967:98) shows that South African villagers discarded bones adjacent to a sandy waterhole visited daily by both humans and goats. The bones quickly became weathered, resulting in a soft chalky surface. "Disturbance of the sand by their hooves serves to constantly abrade the weathered surface of the bone as it develops, producing a smoothness and polish of the sort that one would normally associate only with human agency." (Brain 1967:98). It has been shown that the block F assemblage exhibited a relative high degree of weathering. The location of a historic cart trail that passed over the northern edge of the Jackson site was most likely the source of the trampling and the cause of the abraded bone.

7.4.4 Cultural Taphonomic Processes

7.4.4.1 Cut Marks

Cut marks made with stone tools possess distinctive characteristics that facilitate identification. They are V to U-shaped, elongate, have multiple fine parallel striations on the

cut mark wall, and sometimes posses shoulder effects or barbs. Shoulder effects are small striations parallel to the main striation, and barbs are small hooks at one end of the mark (Lyman 1994a:297).

When the context of a cut mark is considered, the activity responsible for the mark can sometimes be inferred. Context refers to the anatomical location and orientation of the mark (Lyman 1994a:297). Binford (1981:46-47) suggests that marks on large mammals are the result of three activities. Skinning marks occur on the shafts of lower leg limbs and phalanges as well as on the skull and lower margin of the mandible. Disarticulation marks will be visible on the edges or articular surfaces of long bone ends and on the surface of the vertebrae or innominate. Marks parallel to the long axis of the bone result from filleting.

An exhaustive analysis of the cut marks present on faunal remains from the Jackson site faunal assemblage was not undertaken. Few cut marks are present in the assemblage, and many are present on specimens that could not be identified to element and/or species. During analysis, no distinction was made between cut marks, scrape marks, and chop marks (Fisher 1995:12).

No cut marks are visible on bone recovered from blocks G and J. Only unidentified bone excavated in blocks H (N=3) and I (N=10) exhibited visible cut marks. Blocks B, C and E have a few specimens displaying cutmarks. Seven unidentified bone fragments, a bison mandibular midsection fragment and a rib head recovered in block B have incisions. Ten unidentified bone fragments in block C have cut marks, as does a bison rib body, a humerus midshaft and a proximal radius. Block E specimens with cutmarks include 13 unidentified bone fragments, and a bison maxilla fragment.

Blocks D and F have a relatively higher number of specimens with visible cutmarks. Twenty-four unidentified bone fragments in block D, and nine in block F have cutmarks. Cutmarks are visible on several bison elements in block D, including, four thoracic spines, 18 rib body fragments, a proximal scapula, a humerus midshaft, a proximal ulna, a femur midshaft, and a tibia midshaft fragment. Block F bison elements with cutmarks are two hyoids, a mandibular condyle, two thoracic spines, two rib heads, 13 rib body fragments, a scapula blade fragment, a humerus midshaft fragment, and a proximal metatarsal.

It is virtually impossible to deduce the butchering practices executed by the site's inhabitants by analyzing the visible cut marks. Cut marks are quite rare on the identified bison elements, and very few are consistently patterned. Incisions present on a bison mandible and maxilla fragments as well as a proximal metatarsal probably relate to skinning activities. Cut marks on a hyoid were likely produced during tongue extraction. Several rib

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heads exhibited cutmarks, as do several proximal forelimb elements and a mandibular condyle. These were most likely created during disarticulation. Marks generated during filleting or scraping the bone clean is visible on numerous rib body fragments and limb element midshafts. The sequencing of these events cannot be interpreted with the limited data.

The lack of cut marks may be due to several factors. Taphonomic processes such as trampling and weathering, both of which affected the assemblage, can change or obscure preexisting marks (Behrensmeyer *et al* 1986:769). Also, the method of analysis may not have been adequate to observe all butchering marks. Shipman and Rose (1983) contend that certain marks can only be identified with a scanning electron microscope. Others (Blumenschine *et al* 1996:504) believe that a hand lens or low-powered microscope, when used in strong incident light, is adequate to identify even inconspicuous marks. However, Blumenschine *et al* (1996:495) stipulate that , "The search for marks is conducted using a hand lens or light microscope under strong light, systematically examining all parts of the surface at different angles with respect to the incoming light for conspicuous and inconspicuous marks,". Analysis of the Jackson site assemblage focused on macroscopic examination, and inconspicuous marks may not have been identified so that the number of reported cut marks in the assemblage may be an under representation.

Another plausible explanation for the apparent lack of cut marks is the butchering and processing methods of the site inhabitants. Frison (1970:10-24; 1973:34-50) proposes that precontact native groups butchered bison carcasses by executing a series of cutting and chopping motions. Chopping, rather than cutting was the procedure used to disarticulate joints. It is also feasible that breaking elements for marrow, and further fragmentation due to grease rendering has obscured cut mark evidence. If elements were butchered using a technique reliant on chopping or crushing rather than cutting, bone breakage patterns should provide insight about the butchering techniques used at the site.

7.4.4.2 Bone Breakage Patterns

Consistent bone breakage patterns are present on several bison elements. There was a lack of complete crania in the site recoveries although two fragmented partial skulls and numerous fragments were excavated. The brain can be removed from the skull by smashing the base of the cranium and enlarging the foramen magnum, or by breaking the frontals between the horn cores (Keyser and Murray 1979:208). Alternatively, the skull is chopped or pounded during brain and nasal gristle removal (Frison 1973:86-88). The fragmented nature

of the skull elements at the Jackson site indicates that the Jackson site skulls were chopped or pounded to remove the brain and nasal gristle.

The mandibles display a consistent pattern of bone breakage. No whole mandibles were recovered, and the most complete mandible fragment was pathological. No mandible halves were recovered joined together, and none were associated with skulls. All coronoid and condylar processes had been broken from the ascending ramus, and in several cases, the coronoid and condylar processes had been separated. This situation commonly occurs when the mandible is removed from the skull by crushing the zygomatic arch and breaking the coronoid process or the entire ascending ramus. The ventral border on many of the Jackson site specimens had been removed in order to allow access to the pulp cavity (Keyser and Murray 1979:184). Several specimens are broken below the mandibular foramen, suggesting that the pteryoideus internus muscles had been removed (Keyser and Murray 1979:191).

Most of the vertebrae recovered were highly fragmented and butchering patterns are difficult to ascertain. The removal of the skull was likely accomplished by separating the axis and atlas vertebrae (Keyser and Murray 1979:181). This would account for the atlas and axis fragments at the site although other non-cultural processes such as weathering may have caused some of the fragmentation of these elements. Although no articulated vertebrae were found, several relatively complete cervical and thoracic elements were excavated from block F, indicating that part of the spinal column was left at the kill area. It is impossible to determine from the remaining elements if or how the spinal column had been separated. The majority of the remaining cervical vertebrae consist of centrums. The processes may have been subjected to density mediated destruction, or used in bone grease manufacture (McKeand 1995:298). The large number of thoracic spine fragments recovered from the boiling pit dump in block D indicates that the hump meat was removed by breaking the thoracic spinous process near the base (Frison 1970:20, Murray and Keyser 1979:186). Lumbar vertebrae are relatively rare at the site. Two centrums were recovered in the kill zone while a single process was excavated from block E. Lumbar vertebrae are often crushed during separation of the spinal column, and this would account for the scarcity of these elements at the site (Keyser and Murray 1979:185). Sacral elements are almost non-existent in the Jackson site assemblage. Severing the sacral ligaments and separation of the sacrum from the pelvis can result in a highly fragmented sacrum (McKeand 1995:299). Only four complete caudal vertebrae were found. This is not uncommon given that these elements are often left in the hide and removed when the occupants abandon the site (Brink and Dawe 1989:106).

All except a few ribs were broken as a result of butchering. A few specimens consisted of the head, tubercle and a portion of the shaft. Most were either fragmented shafts or heads with or without attached tubercles. Ribs are often removed from the spinal column by using a hammerstone or chopper to break the ribs off close to the vertebral column (Frison 1970:19). The relatively large number of rib heads recovered from the kill area suggests that the Jackson site inhabitants employed this method. The meat rich rib shafts were removed to the processing areas, as indicated by the large number of rib shaft fragments minus rib heads.

The scapula is another element that exhibits patterned bone breakage due to butchering. Almost all specimens were broken directly below the neck. The relative lack of complete blade portions suggest that these had been removed to the processing area with associated muscles (Frison 1973:39, Keyser and Murray 1979:187).

No complete proximal humeri were recovered at the Jackson site. The proximal humerus is often damaged during initial butchering (Frison 1970:14). The identification of three deltoid tuberosities from blocks D and E suggest that at least some were removed from the kill area and further processed for marrow and grease in the processing areas. The identification of midshaft landmarks on small fragments within the processing area supports this hypothesis.

The proximal radii are one of the more complete element portions represented. These were recovered throughout the site and most were consistently broken below the radial and medial tuberosities. This breakage pattern is most likely due to bone grease manufacturing, with the proximal portion relatively ignored because of it's low grease content. Comparatively, there are only two distal radii at the site.

The ulna is another element exhibiting a stylized butchering pattern. None were recovered whole, and most consisted of proximal portions without the olecranon. The olecranon is often fragmented when the triceps muscle is being removed (Keyser and Murray 1979:178). The distal end is detached when a hammerstone is used to break the ulna (Frison 1973:39).

The metacarpal elements were also consistently fractured in a similar manner. Complete proximal or distal ends were recovered, often broken just below the nutrient foramen. These elements are not usually fractured during butchery (Frison 1970, 1973) and none appear to have been used as tools. The location of the breaks is consistent with marrow extraction and bone grease manufacture.

Almost all carpal bones were complete and exhibit little evidence of butchering. It is interesting to note that carpals from block E however were fragmented but were could be

refitted. Breakage on some of these elements consist of rough, right angle breaks, suggestive of dry fracture (Johnson 1985:176).

Innominates are mainly identified by specimens with acetabulum landmarks. The pelvic bones are often chopped or crushed in order to remove muscle insertions, or elements are removed as a unit with the muscles (Keyser and Murray 1979:179).

Only two proximal femora were recovered. Both are femur heads broken at the neck, and both were excavated from block F. This suggests that the hindlimb was removed from the innominate by snapping the femur at the neck, with these femoral heads being discarded at the kill area. Identified midshaft landmarks in the processing area suggest that these element portions were processed for bone grease.

The lack of proximal tibia and the relative scarcity of patellae suggest that the patella was chopped loose and then used as a hand-hold for stripping the biceps femoris and the vastus lateralis muscles (Frison 1970:14).

The metatarsals exhibit a similar butchery pattern as the metacarpals. Complete elements were recovered from blocks B, D and F. The remaining specimens consist mostly of complete proximal or distal portions and a single midshaft landmark. The breakage pattern of these elements suggest that the midshafts were broken into for marrow extraction and the fragments were probably boiled for grease.

The majority of the tarsal bones were recovered complete, although some had been fractured. The only element with a consistent breakage pattern was the calcaneous. One unfractured element was removed from the kill zone, and several of the other calcaneii had the tuber calis removed (Figure 7.19). This portion of the element is chopped loose in order to strip the gastrocnemius muscle (Frison 1970:16). One calcaneous recovered from block C was split longitudinally but the small marrow cavity does not appear to have been scooped out. Another calcaneous recovered from block E has an unusual morphology (Figure 7.20). The tuber calis has been removed, and the remaining cortical bone has been worn or chipped away, leaving the cancellous tissue exposed. The function, or even the process by which this occurred is presently unknown.

The phalanges from the site were recovered in various stages of completeness, with approximately half the sample complete. A few first and second phalanges had been split, with the marrow cavity exposed (Figure7.21). The remaining fragmented phalanges usually consisted of identified proximal and distal ends.

Bison are not the only species that was butchered at the site. A semi-articulated canid vertebral column had the left processes broken off (Figure 7.22), possibly a result

Figure 7.19 Bison calcaneii with tuber calis removed.

Figure 7.20 Block E bison calcaneous with tuber calis removed and cancellous tissue exposed.

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Figure 7.21 Split phalanges with marrow cavities removed.

Figure 7.22 Semi-articulated canid vertebral column with left transverse processes broken, recovered from block D.

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of removing the ribs. Canids have long been considered a reliable food source to native groups on the plains, especially during times of nutritional stress such as winter when fat depletion in the diet could lead to protein poisoning (Synder 1991:370-372). Canid meat is more nutritious than bison with 247 cal/100 mg compared to 138 cal/100 mg for bison (Bozell 1988:105). It has also been shown (Magee 1997:183-185) that canids, both wild and domestic, maintain a relatively high fat content throughout the winter months which would be an important resource to groups inhabiting the plains during the winter.

7.4.4.3 Bone Tools

The recognition of formal bone tools at the Jackson site is relatively unproblematic. Several modified bone specimens in the Jackson site assemblage can only be bone tools (Figure 7.23). Two were recovered in block B. Artifact 308/13-3-124 is a small bone fragment that is highly polished and exhibits chipping along the edges. Another small bone fragment (374/14-1-1) is identified as a tool by the use wear along a blunted edge. This specimen is highly polished also. The block E assemblage contains five bone tools.
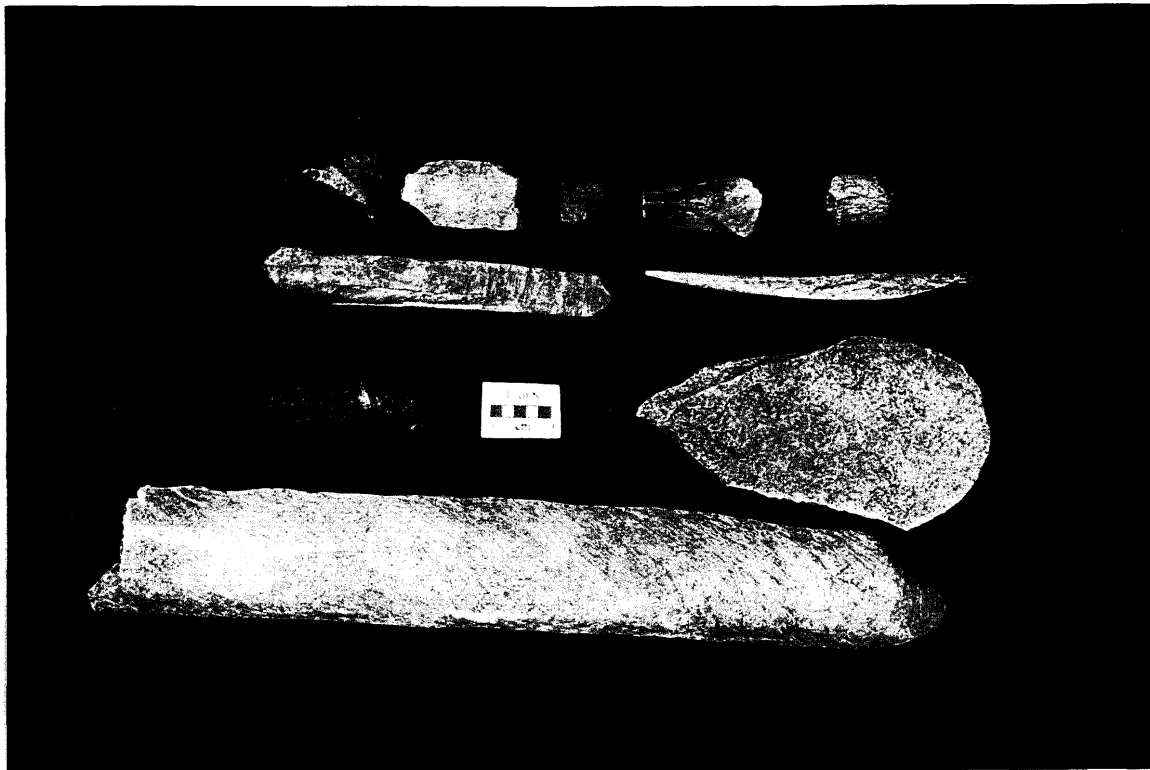
Figure 7.23 Formal bone tools from the Jackson site.

A small serrated bone scraper fragment (3030/24-4-69) is easily identified, as is a bone spatula tip (533/33-3-35). A fragment of cortical bone from a very large mammal exhibits extensive polishing and numerous incisions. A single burnt bone fragment is the only bone tool recovered from block G (783/29-5-38). It is highly polished and identified as a bone tool by the presence of a large incised groove. An awl (929/30-4-48) and a spatula (991/30-5-35) were identified in the block H assemblage.

Expediency tools were quickly created from bone elements with little or no modification. The elements were often procured from the animal being butchered and were discarded after the animal was processed (Johnson 1980:84). Johnson (1982:146) identifies four categories of expedience tools recovered in the Lubbock Lake and Bonfire shelter sites. These categories include; elements with a pointed tip, tools with a narrow to broad circular working edge, tools with scalloped margins, and those with a blunted tip produced by a fortuitous break. Expediency tools can either be intentionally shaped prior to use, or used without modification (Johnson 1982:147). Specimens not modified prior to use can be identified by the presence of use-wear modifications such as rounding, smoothing, micro-flaking and striations along the worked surface (Lyman 1984b:318). The proper identification of expedience tools is difficult because they often lack evidence of manufacture (Frison 1982c:160).

Identifying expediency tools within the Jackson site faunal assemblage is a difficult task. Frison (1970:26-33, 1973:30-34, 1982c:164) has identified a series of bison element expediency tools used during butchery and processing of bison carcasses. These tools are identified by their shape and use wear. As previously shown, weathering and trampling have created a series of pseudo-tools from the kill area. These taphonomic processes may have obliterated evidence of legitimate bone tools. One concentration of hindlimb elements found in unit 26 is reminiscent of an articulated tibia, tarsal bones and metatarsal chopper (Frison 1970:30). A careful examination of the Jackson site specimen did not reveal any visible use-wear modification although this may be a function of its location in the kill area. No other likely expediency tools were identified in the Jackson site assemblage.

7.5 Summary

An analysis of the taphonomic processes that affected the Jackson site faunal assemblage was undertaken in order to better understand the site's formational processes, and attempt to discern if the high fragmentation of the material was a result of natural or cultural taphonomic processes.

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The bison assemblages from the processing and kill area were compared to five different bison utility indices. None of the bison utility indices were statistically significant when compared to the kill area % MAU. All indices were negatively correlated with the processing area %MAU, with the grease and marrow extraction indices having the strongest negative correlation. The bison utility indices results suggest that bison processing occurred in the processing area while no selection bias occurred at the kill area. Because density mediated survival of elements can imitate a bulk utility strategy, both the processing area and the bison kill % MAU's were compared to bone volume density values. Both areas had a weak positive correlation with the %MAU and the bison bone volume density values.

An analysis of the taphonomic processes affecting the site suggest that human butchering was the main cause of the bison element frequencies. The recovery of very porous material such as foetal bone and non-dense canid remains suggest that density mediated destruction was not the cause of the bison bone element frequencies. Natural taphonomic processes such as carnivore modification, weathering, rootlet etching and trampling did affect the assemblage. Carnivore modification and rootlet etching had a minimal effect on the assemblage. Blocks C and F were more weathered than the rest of the site, and the block F bone had also been trampled but this affected only a small portion of the block F assemblage.

Cultural modifications of faunal remains consisted of cutmarks, bone breakage and bone tool manufacturing. Very few elements exhibited distinctive cutmarks. However, many bison elements displayed breakage patterns that are consistent with butchering techniques using chopping and stripping rather than cutting motions. This method of bison butchering, and subsequent processing of the elements are the causes of the high fragmentation of the faunal assemblage. Bone tool manufacture accounts for a minute portion of the bone modification.

Chapter 8

Vickers Focus and Mortlach
Subsistence Strategies

8.1 Introduction

Establishing the subsistence strategies followed by the Vickers Focus inhabitants is paramount for two reasons. No previous Vickers Focus faunal assemblage has been exhaustively analyzed, and statements concerning Vickers Focus subsistence strategies have been primarily based on pottery wares (Nicholson 1990, 1991, 1994, 1996, Nicholson and Gibson 1990, Nicholson and Malainey 1991, 1995 Nicholson and Hamilton 1997,1999). Secondly, Nicholson and Hamilton (1997:35) argue that as Vickers Focus people moved west, they abandoned their horticulture/forager subsistence for a more intensive forager strategy reliant on bison procurement. Nicholson and Hamilton (1999) imply that contact between Vickers Focus and Mortlach groups in southwestern Manitoba influenced the Vickers Focus, specifically, "Evidence for greater reliance upon bison – and improved success in bison procurement- at sites such as Jackson also support the idea of direct contact between Vickers people and Plains bison hunters such as Mortlach." (Nicholson and Hamilton 1999:24). A detailed analysis of the subsistence strategy followed by the Jackson site people can help verify or refute the cultural contact hypothesis.

A comparison of the subsistence strategies employed by the Vickers Focus as seen at the Jackson site, and those of near-by Mortlach groups should indicate whether or not contact between the groups did occur. If the Jackson site Vickers Focus people were influenced by Mortlach groups, the subsistence patterns of both groups should be similar. The Sanderson site (DhMs-12), a Mortlach occupation in southeastern Saskatchewan, provides a comparative faunal assemblage.

8.2 The Vickers Focus Subsistence Strategy at the Jackson Site

Understanding subsistence strategies involves attempts to ascertain how a site's inhabitants made a living in terms of animal-food subsistence (Lyman 1982:335). Central to the calculation of subsistence strategies is the distinction between culturally and naturally deposited bone. In order to deduce diet, remains must positively be the result of cultural subsistence processes (Lyman 1982, Stahl 1996, Thomas 1971).

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The bison remains from the Jackson site have already been shown to be the remnants of animals that were killed, butchered and processed by humans. The high percentage of bison remains recovered from the site attests that this species undoubtedly comprised the majority of the Vickers Focus people's diet. An analysis of bison utility indices, bison bone volume density data and taphonomic process of the Jackson site material suggests that the site inhabitants were intensively processing bison at the site. Muscles with little meat such as the pteryoideus internus and the gastrocnemius were being utilized. As well, elements with relatively little marrow and grease such as the mandible and phalanges were being systematically processed for these resources.

The bison population dynamics of the site show that the inhabitants were not actively procuring one sex over another, although the large number of foetal remains imply that female bison may have been actively sought for their fetuses. All foetal carcasses appear to have been processed, most likely for food. Ethnohistoric accounts detail the fondness native groups had for unborn bison (Ewers 1955:126, Fiddler in MacGregor 1966:81).

Cervids seem to have been of little importance in the Vickers Focus diet. No remains of elk or moose were identified although both species would have likely been available. It is possible that elk and/or moose are present in the assemblage but were so fragmented, the specimens could not be identified. It is unlikely, however, that all identifiable landmarks were destroyed. The recovery of only three deer elements, none with cultural modifications, indicates that this species was not a major component of the Vickers Focus diet.

Large canids (SC5) were utilized as a secondary resource. Very few butchering marks are present on the specimens recovered from the Jackson site, but the element frequencies and distributions are reminiscent of butchering units. Although the dietary contribution of canids to prehistoric diets is considered small (White 1955:170-171), there are numerous accounts of historic groups consuming large canids as food (Bozell 1988:98, Roe 1955:30, Thurman 1988:166).

The importance of smaller animals in the Vickers Focus diet is more difficult to discern. Distinguishing culturally deposited remains from naturally occurring specimens has led to the association of signatures with specific agents of accumulation (Stahl 1996:38). Assemblages accumulated by a variety of predators such as humans, carnivores and birds, have been compared to each other and to naturally formed assemblages in order to devise specific signatures for each agent of accumulation (Andrews 1990, Andrews and Nesbit Evans 1983, Butler 1993, Erickson 1987, Grayson 1991, Jones 1990, Morlan 1994b, Schmitt and Juell 1994, Semken and Falk 1991, Stahl 1996, Thomas 1971, Whyte 1991).

The three basic criteria of element distribution, element frequency and element modification can be used to establish the agent of accumulation. Naturally deposited carcasses are usually localized, relatively complete and unmodified (Shaffer 1992a:686). Non-human predators, however, can affect the distribution, frequency and modification of small animal bones, mimicking human utilization patterns (Andrews 1990; Jones 1990; Mellet 1974; Schmitt and Juell 1994; Shaffer 1992a; Stahl 1996; Wheeler and Jones 1989). Ideally, elements should show signs of human utilization. Webster (1999:200) advocates that specimens should match two or more of the following criteria: burning, cutmarks, bone breakage or association within or near hearth features.

When the small and micro vertebrate remains are examined with the above criteria, some species do appear to have been utilized as a food resource. Whether or not leporids were part of the diet is difficult to determine. The elements recovered from block G are undoubtedly intrusive and are not considered here. The remaining specimens appear to be part of the archaeological record although none exhibit distinguishable cultural modifications. The identification of forelimb and hindlimb elements from block D may be evidence that this individual had been processed, perhaps for meat or maybe for fur. Both the scapula and humerus are fragmented although it is impossible to determine the agent.

Large rodents were not a part of the Jackson site inhabitant's diet. A single beaver metatarsal with possible cutmarks was found in block E. It is impossible to establish the importance of this species based upon a single recovery, but given that only one element was recovered, it is unlikely that this species was a reliable food resource.

Small rodents may have been included in the diet. Northern pocket gopher remains were mostly recovered from blocks D and E. A single mandible was also present in block I. The block D mandible is burned, and associated with a processing area, suggesting that it was a utilized food resource. The block E specimens are not culturally modified but do appear to be part of the archaeological record. The innominate recovered from block E is unusually complete, as most small and micro-vertebrate remains throughout the site are usually fragmented. It is impossible to determine if the block E elements are culturally introduced or part of the background fauna.

Micro-rodents like the Meadow and the Gapper's red-backed vole may also have been used as food while the shrew does not appear to have been culturally introduced. A total of seven Meadow voles were recovered at the site, all from blocks D and E. All four mandibles in the block D assemblage are consistently broken behind the last molar, and two have been burned. The association of these specimens with the processing area is strong

evidence that they were being utilized as food. The block E maxillaries and mandibles are more complete and none display any cultural modifications. All appear to be part of the archaeological record. It is difficult to establish whether the block E specimens are culturally or naturally deposited. Three Red-backed voles were excavated at the site, again, all from blocks D and E. Two block D mandibles are consistently broken behind the tooth row while the third specimen consists of an incisor and M_1. One specimen is burned. Again, the block E mandibles and single maxilla appear to be part of the archaeological record but are not as fragmented and exhibit no other signs of cultural modification. The single shrew mandible is complete and slightly weathered. The recovery of this element from level two suggests that it might be part of the background fauna rather than the cultural assemblage.

Avians may have been periodically utilized by the makers of Vickers Focus pottery. No avian specimens in the Jackson site assemblage were complete enough to enable a species or even genus identification. At least three different sizes of bird were present. Once again, most of the avian remains were recovered from blocks D and E although a single rib shaft fragments from a SC3 (small-medium bird) was recovered in the kill area. This element did not have any cultural modifications. A SC4 (medium bird) long bone shaft and a SC2 (small bird) sternum were found in block D. Neither exhibit cultural modifications although both elements are fragmented. In block E, several SC3 elements including a distal radius, and long bone shafts are burned and may belong to an Anatinae. A single longbone shaft of a SC2 avian was also recovered from this block. It is difficult to ascertain whether these avian specimens are part of the background fauna or were culturally introduced to the site. Given the fragmentary nature and that some of the specimens are burned, this implies cultural utilization. Ericson (1987) shows that an over-representation of avian limb elements is suggestive of human debris. It is impossible to tell however, whether the animals were being used for food stuff, or for other resources such as feathers, beaks and claws (Parmalee 1985:83).

Other non-mammal species present in the archaeological assemblage include amphibians and reptiles. A Tiger salamander as well as a toad vertebrae were recovered in block D. An indeterminate frog/toad limb element was recovered in block E. None exhibit cultural modification although all seem to part of the archaeological record. Twenty garter snake vertebrae were excavated from blocks D, E, I and J. All blocks contain at least one burned element. The presence of amphibian and reptilian remains does not necessarily mean these species were used as food. Very little is presently known about the taphonomy of these

animals because so few are found in abundance in archaeological sites and almost none have been exhaustively studied (Lyman 1994a:450).

The importance of micro-vertebrates and floral resources cannot be ascertained from the current faunal assemblage. North American archaeologists typically utilize a 0.625 cm mesh during excavation, and this will bias a sample against small animal remains (Shaffer 1992b:134). The Jackson site matrix was passed through a smaller 0.3125 cm mesh and some micro-vertebrate elements were collected; however these consisted only of cranial and vertebral specimens. Fine screen or water floatation analyses could potentially increase the number and variety of micro-vertebrate elements and species, and would recover any floral remains such as seeds (Webster 1999:197-200). The recovery of micro-vertebrate limb elements, especially the phalanges may help clarify whether these species were being utilized as food at the Jackson site . Morlan (1994b:139) notes that the distal phalanges of micro-vertebrates are often charred when processed for food.

8.3 The Sanderson Site

The Sanderson site is a multi-component late fall/early winter Mortlach occupation found along the southern border of Lake McDonald in southeastern Saskatchewan. It is located within a riparian forest canopy immediately surrounded by marshlands within the mixed moist grasslands of the prairies (Magee 1997:30).

Several large blocks were excavated in arbitrary five cm levels. Matrix was passed through a six mm mesh screen while some material was also passed through a two mm mesh to recover smaller material (Magee 1997:33).

A portion of the Sanderson site's (block 7 west) faunal assemblage was the subject of Michael Magee's Master of Art's thesis in the Department of Anthropology and Archaeology at the University of Saskatchewan. A total of 173,097 faunal specimens weighing 422.2 kg were analyzed (Magee 1997).

8.4 Site Similarities

The Vickers Focus occupation at the Jackson site is compared to the Sanderson site faunal assemblage in order to discern similarities and differences in the subsistence strategies followed by the inhabitants of each site.

8.4.1 Species Utilization

Table 8.1 is a list of the species recovered from the two Mortlach occupations at the Sanderson site, and the Vickers Focus occupation at the Jackson site. It is readily apparent that bison comprises the bulk of both faunal assemblages, suggesting that bison resources comprised the majority of each diet. Like Jackson, the Sanderson site inhabitants were

Species	Sanderson				Jackson	
	Occupation 1		Occupation 2			
	NISP	MNI	NISP	MNI	NISP	MNI
Mammalian						
Bison bison	2014	12	1278	10	4149	8
Foetal Bison bison	?	?	?	?	95	4
Immature Bison bison	?	?	?	?	40	2
Cervus elaphus	-	-	3	1	-	-
Odocoileus sp.	-	-	-	-	4	1
Antilocapra americana	3	1	1	1	-	-
Canis lupus	92	2	67	3	-	-
Canis latrans	12	1	15	1	-	-
Canis sp.	14	2	14	1	107	2
Vulpes velox	10	3	15	2	-	-
Castor canadensis	5	1	-	-	1	1
Ondatra zibethicus Recent	1	1	-	-	-	-
Mustela vison	2	1	-	-	-	-
Mephitis mephitis	2	1	-	-	-	-
Taxidea taxus	2	1	-	-	-	-
Lepus townsendii	4	1	-	-	-	-
Lepus americanus	-	-	-	-	1	1
Lepus sp.	2	1	1	1	8	1
Spermophilus franklini	1	1	-	-	-	-
Spermophilus tridecemlineatus	1	1	-	1	1	1
Spermophilus richardsonii	12	1	4	1	-	-
Thomomys talpoides	-	-	-	-	4	4
Microtus pennsylvanicus	1	1	1	1	17	7
Clethrionomys gapperi	-	-	-	-	6	3
Sorex sp.	-	-	-	-	1	1
Avian						
Cygnus columbianus	4	1	-	-	-	-
Branta canadensis	12	1	1	1	-	-
Anas platyrhnchos	3	1	5	1	-	-
Anas discors	6	1	-	-	-	-
Accipitrid sp.	1	1	-	-	-	-
Phasianid sp.	2	1	-	-	-	-
Large Anatid	5	1	-	-	-	-
Amphibians						
Ambystoma tigrinum	-	-	-	-	2	1
Bufo sp.	-	-	-	-	1	1
Reptiles						
Thamnophis	-	-	-	-	20	1
Piscine	23	-	9	-	-	-

Figure 8.1 Summary of the Sanderson (Magee 1997) and Jackson site faunal.

procuring bison from nursery and bull herds (Magee 1997:120). If bison separate into nursery and bull herds during the winter months, the situation seen at both sites indicates that the inhabitants were procuring bison from a variety of sources.

It cannot be determined to what degree the Sanderson site occupants were utilizing foetal bison as this information is not presented. Magee (1997:107-108) simply notes that foetal elements were recovered, but were fragmented so development stages could not be determined. If foetal bison had been numerous in the Sanderson site occupations, presumably a more detailed description would have been presented, so it is assumed that foetal bison did comprise an important part of the Mortlach diet.

Large non-bison ungulates, which are completely absent in the Jackson site assemblage, are present in minute numbers at the Sanderson site. Elk remains in occupation two exhibit cutmarks, suggesting food utilization. No deer elements were found at the Sanderson site but antelope specimens were identified in both occupations.

The exploitation of both medium and large sized canids is evident at the Sanderson site. At least five swift foxes, some of which were burned could be identified in the Sanderson site occupations as could a large number of *Canis* sp. specimens. Magee (1997:20) interprets the lack of rib and limb elements, and the presence of cranial, mandibular, vertebral and distal limb elements as evidence that the animals were being butchered at the site. The segmented elements were then being removed from the site for preparation and consumption elsewhere. A similar situation appears at the Jackson site where a discarded canid vertebral element is associated with the processing area. A clustering of forelimb elements in block C and hindlimb elements in block D may represent areas of preparation, consumption or discard.

Immature canid remains are present in both sites. One immature animal is represented at Jackson by left and right mandibles with a variety of deciduous and permanent teeth. Specimens with a similar tooth eruption pattern are present in the Sanderson occupation (Magee 1997:146). These immature canids may have been utilized as a food resource although there is little cultural modification of the specimen. It is also possible that the sites occupants were controlling the dog population by killing off unwanted puppies (Wilson 1924:199-200).

Mustelids, although rare, are present in the Sanderson site occupations. None, however, appear culturally modified and it is difficult to determine if these species were utilized as a food resource, killed for their fur or are part of the background fauna. No mustelids were identified in the Jackson site assemblage.

Large rodents such as the beaver seem to have been unimportant to either group. This may be a function of site seasonality, with both sites being occupied during the colder months

when beaver may have been difficult to apprehend. Similarly, leporids were recovered in relatively small numbers from both sites, none with obvious cultural modifications.

Small and micro-rodent remains are present in both assemblages. Magee (1997:206) states that the ground squirrel and Meadow vole specimens at the Sanderson site exhibit evidence of roasting and, therefore, inferred human consumption. The presence of heat alteration on the distal limbs and incisors is suggestive of roasting. Some burned mandibles were recovered at the Jackson site, but no limb elements of micro-vertebrates were identified. The presence of heat alteration coupled with consistent bone breakage patterns on several mandibles is suggestive that ground squirrels, two species of voles and the northern pocket gopher were being prepared and consumed by the site's occupants.

The reliance on avian species either for food or for other resources is more apparent at the Sanderson site than it is at the Jackson site. Sanderson site specimens were complete enough to facilitate genus and often species identifications. The hawk phalanx is considered intrusive. Swan and Canada goose specimens were culturally modified, indicating some type of human utilization. It is impossible to determine if this utilization was dietary although the presence of a few fragmented avian elements recovered at Jackson site shows that both groups were procuring avian specimens in relatively small numbers.

8.4.2 Butchering Techniques

A comparison of the butchering techniques employed by the makers of Vickers Focus and Mortlach pottery might provide evidence of cultural continuity. Keyser and Murray (1979:174) argue that similarities or differences in the butchering techniques used at different sites reflect the cultural relationship of the groups inhabiting the sites. An attempt was made to establish if butchering patterns were culturally distinctive and could therefore be considered diagnostic. The results indicate that site occupants separated by time and space will have different techniques for butchering bison. Similarities between butchering practices are more often seen in separate components of the same group (Keyser and Murray 1979:214). If the Vickers Focus people had been influenced by makers of Mortlach pottery, especially in terms of bison procurement, one would expect to see similarities in the bison butchery practices at sites of each group.

Unfortunately, neither the Sanderson nor the Jackson site faunal assemblages lend themselves well to interpreting the bison butchering procedure, and only cautionary statements can be made. Both groups relied heavily on a chop and strip technique of muscle removal, rather than cutting. This is a common method of bison butchery during the Late Precontact period throughout the Northern Plains (Frison 1982c:159). Like the Jackson site

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assemblage, cutmarks are not common in the Sanderson site assemblage (Magee 1997:200). Magee (1997:202) attributes this to a butchery technique reliant on separating the limbs with smashing blows, and secondary processing activities such as marrow and grease extraction. The identical practice is seen at the Jackson site. Few cutmarks were recorded but consistent bone breakage patterns are indicative of stylized butchering employing a smashing technique.

A comparison of the bone breakage patterns present at the Jackson and Sanderson sites might confirm or contest if contact between these groups had taken place. Because both groups used a smash and strip butchering technique of muscle removal, element breakage patterns would indicate if similar butchering procedures were being executed. Such similarities would suggest interaction or even cultural continuity between the two groups. Unfortunately, the Sanderson site bison assemblage was not examined for stylized bison element breakage (Magee 1997), and it is impossible to make a detailed comparison between the two sites. Only one difference between the two sites can be inferred from the data provided by Magee (1997:200-202). The Sanderson site bison mandibles appear to have been cut loose from the skull rather than chopped loose as is seen at the Jackson site.

Some similarities can be inferred. After muscle removal, inhabitants of both sites were intensively processing bison bone for marrow and grease extraction. Magee (1997:205) declares that the extreme level of bone destruction seen at the Sanderson site is consistent with a starvation situation where even low utility items are destroyed during grease removal. There is evidence that the Vickers Focus occupants were under similar nutritional stress. Low yield muscles like the pteryoideus internus and the gastrocnemius had been utilized while marrow poor elements such as the phalanges had been processed.

8.4.3 Food Storage Practices

The Sanderson site inhabitants utilized frozen meat caches as a method of food storage, something that does not appear to have occurred at the Jackson site. The identification of fresh and dry fracture patterns on the bison elements at the Sanderson site is suggests that the inhabitants were processing previously frozen limbs (Magee 1997:233-243). Other signals of frozen limb butchery at the Sanderson site is the highly fragmented nature of the assemblage and the recovery of articulated limbs among the heavily processed assemblage (Magee 1997: 237,216).

The utilization of frozen meat caches by indigenous groups is not unfamiliar. Ethnohistorical accounts tell of Hidatsa informants butchering bison during the winter and caching articulated limb elements for future use (Wilson 1924:251). Binford (1978:145) records the utilization of frozen meat caches used by the Nunamiut. There is evidence from

other archaeological sites that meat freezing was a common storage practice, as early as Paleo-Indian times. Several Paleo-Indian bison kills (i.e. Agate Basin, Horner and Carter-Kerr/McGee) were inhabited during the winter months and the inhabitants froze bison meat in large butchered units. This is suggested by the lack of processing paraphernalia and the recovery of articulated limb elements (Frison 1982b:200). Late Precontact archaeological cultures tended to execute a different winter processing strategy. Late period communal bison kills are usually late summer or fall events. Surplus bison meat obtained during the kill was dried or made into pemmican for winter use (Frison 1982b:194). A cache site situated along the Assiniboin river valley about eight km east of Brandon was radiocarbon dated to 480±100 BP (SFU 73). No articulated bison elements were excavated. The high organic content of the soil indicates that the cache likely contained deboned or dried meat and perhaps skins (Nicholson 1985:179).

There is no evidence of frozen meat caching at the Jackson site. The assemblage is fragmented, but this is from the intensive processing of bison bone for marrow and grease, activities that likely occurred directly after kill and butchery. The majority of the bone breakage exhibited by the Jackson site material is consistent with fresh bone breakage. A small amount of bone does exhibit transverse fractures, but this usually occurs on bone that is known to have been weathered. Almost no articulated bison limb elements are present in the site. The only known concentrations are recovered from the kill area. A relatively large number of immature bison vertebrae simply represent a vertebral column while a concentration of hindlimb elements may represent either an expediency tool or discarded lower limb segment.

8.5 Summary

A comparison of the subsistence strategies employed by inhabitants of the Sanderson and Jackson sites was undertaken in an attempt to establish what, if any similarities existed between the two. At both sites, reliance on bison procurement was strong while other ungulates were relatively ignored. Evidence from the Jackson site suggests that these people were more intensively processing the bison carcasses as there was a higher fragmentation of bison elements, meat poor muscles appear to have been utilized and marrow and grease poor elements were processed.

The data unfortunately does not allow for a detailed comparison of bison butchering practices at the two sites. Some similarities were obvious even without a detailed comparison. Both groups employed a smash and strip technique of bison butchery commonly seen in Late Precontact sites. The only major difference detected was that the Sanderson

occupants removed the mandible from the jaw by a series of cuts while the Jackson site occupants likely smashed the zygomatic arch, breaking the mandible.

There are some difference in species utilization. The Sanderson site occupants did not seem to be utilizing foetal bison as actively as the Vickers Focus people. The sex structure of the Sanderson site indicates that females were present, but there is scanty evidence of foetal bison being used as a food source. Canids appear to have been utilized by both groups as a secondary food resource. The reliance on canids at the Sanderson site far exceeds that at the Jackson site.

Both groups seem to have been supplementing their diet with small and micro-animals. The extent to which small and micro-vertebrates contributed to the diets of these two groups cannot be determined without the recovery of fine screen or water floatation samples.

The main subsistence strategy difference between the Jackson and Sanderson site inhabitants is the preferred method of meat storage. Evidence from the Sanderson site indicates that the makers of Mortlach pottery utilized a system of primary butchered frozen hindlimb segments. No such evidence is present at the Jackson site. The Sanderson site occupants may have been familiar with this method of meat storage while the Jackson site occupants were not. The Vickers Focus people might have had more experience with the more commonly seen fall bison hunts which result in a surplus of bison meat which is then dried or made into pemmican for cold month storage. The Sanderson site frozen bison limbs may simply have been a result of logistics. There may not have been enough individuals to fully process the animals before the segments became frozen.

Chapter 9
Summary and Conclusions

The Jackson site is a large Late Precontact occupation in the Lauder Sandhills of southwestern Manitoba. A small Blackduck component is represented in the materials recovered from the southwest corner of the site. The remainder of the site yielded Vickers Focus pottery and is radiocarbon dated to about 1450 AD. No historic artifacts except an intrusive metal tack were excavated, suggesting that the site was occupied prior to the appearance of European trade goods.

Declining ground water levels in the Lauder Sandhills since European contact has affected the local environment. During the time of occupation, the Jackson site would have been in a series of closely spaced wetlands interspersed with woody vegetation. A high diversity of both floral and faunal resources would have been available to the site's inhabitants.

A total of 35 one m^2, and a single 1x 1.5 m excavation units were excavated between 1994 and 1997. An analysis of the faunal assemblage recovered from the Vickers Focus occupation at the site was the topic of this thesis. The faunal assemblage was analyzed by excavation block in order to discern species and/or element distribution patterns. A very small bison kill is located at the north end of the site in block F. Within this kill area, intensive processing of bison elements for marrow and/or grease was also being undertaken. A small waste disposal area is present in block B while blocks C and D are centred on processing areas. The remnants of a bison meat boiling pit were unearthed in block D. The block E faunal assemblage is reminiscent of a refuse area. Activities that occurred in or near blocks G, H, I and J are difficult to infer given the small nature of these excavation blocks.

The site was occupied over the winter months. Bison mandibular studies, in addition to analysis of the 95 foetal bison remains, indicate that an extended winter occupation of the site took place. The sex structure of the herd included males, females, and juveniles. This is unexpected because bison are thought to have divided into nursery and bull herds during the winter months. The recovery of both sexes is evidence that the site's inhabitants did not utilize a single large kill, but likely hunted smaller herds or even individual animals. This

also explains the recovery of foetal bone at several different stages of development. The identification of the Jackson site as a winter site in the southwestern corner of the province has implications for the suggested seasonal mass migrations of bison. It has been proposed that bison moved out of the grasslands into the parklands at the onset of winter in search of superior forage. The Lauder Sandhills would have been an attractive winter locale for bison, but the discovery of summer occupied sites in the same region suggests that bison were available in this area year round.

A variety of taphonomic processes have affected the assemblage to varying degrees. Bison utility indices imply that human utilization of the bison carcasses account for the majority of the fragmented remains while bison bone volume density studies indicated that the assemblage could alternatively been affected by density mediated factors. An analysis of the taphonomic processes affecting the assemblage revealed that natural agents such as carnivores, weathering, trampling and rootlet etching did indeed affect the assemblage but did not cause density mediated destruction. Instead, it was human butchering and processing activities that accounted for the bison bone element frequencies seen at the site.

The subsistence strategies and perhaps the butchering techniques of the Vickers Focus peoples are similar to those used by Mortlach people at the Sanderson. Both groups were heavily reliant on bison and employed a chopping and stripping butchery technique rather than cutting and sawing. Bison were intensively processed by both, but the Vickers Focus people had a more exhaustive processing technique in which muscles with little meat, and phalanx marrow cavities were utilized. This may be directly related to the group's readiness for winter. At the Sanderson site, there is evidence that these people employed frozen meat caches for winter storage while no such evidence exists at the Jackson site. Another major difference between the two groups is the Vickers Focus inhabitants' concentration on procuring foetal bison. This did not seem to be an important element of the Mortlach strategy, instead, a higher percent of canid remains was included in their diet.

The proposed subsistence shift for the Vickers Focus people from a horticulture/foraging to an intensive foraging strategy cannot be elucidated with the current information. The Jackson site evidence does indicate that the inhabitants of this site were heavily reliant on a bison procurement strategy although their diet was supplemented with a variety of other game including small and micro-vertebrates. The importance of these species cannot be determined without fine screen or water flotation samples. A faunal analysis of an eastern cluster Vickers Focus site is needed before comparisons between the eastern cluster sites and the *Makotchi-Ded Dontipi* Vickers Focus occupations can be made.

Three avenues of further investigation are recommended. Large block excavations, especially at the Jackson site would enable a more accurate interpretation of activity areas. Secondly, a faunal analysis of an eastern cluster Vickers Focus is necessary. This would allow for comparisons to be made between the eastern cluster and western cluster sites and deduce if a subsistence strategy shift did take place. Finally, fine screen or water flotation samples should be analyzed from both eastern and western Vickers Focus sites. This will enable provide a more complete picture of past subsistence strategies because the importance of micro-vertebrates as well as floral resources can be determined.

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Appendix I

The Flora and Fauna of the Lauder Sandhills

Table 1 Flora species of the Lauder Sandhills in southwestern Manitoba.

Latin Name	Common Name
Aceraceae	**Maple Family**
Acer negundo	Manitoba Maple
Adoxaceae	**Moschatel Family**
Adoxa moschatellina	Moschatel
Alismataceae	**Water-Plantain Family**
Alisma plantago-aquatica	Common Water-Plantain
Sagittaria cuneata	Arum-Leaved Arrowhead
Amaranthaceae	**Amaranth**
Amaranthus graecizans	Prostrate Amaranth
Amaranthus retroflexus	Red-Root Pigweed
Anacardiaceae	**Sumach Family**
Rhus radicans	Poison-Ivy
Apocynaceae	**Dogbane Family**
Apocynum androsaemifolium	Spreading Dogbane
Apocynum cannabinum	Indian-Hemp
Araceae	**Arum**
Acorus calamus	Sweet Flag
Araliaceae	**Wild Sarsaparilla**
Aralia nudicaulis	Wild Sarsaparilla
Asclepiadaceae	**Milkweed Family**
Asclepias ovalifolia	Dwarf Milkweed
Asclepias speciosa	Showy Milkweed
Asclepias syriaca	Silky Milkweed
Asclepias viridiflora	Green Milkweed
Balsaminaceae	**Touch-Me-Not Family**
Impatiens capensis	Spotted Touch-Me-Not
Impatiens noli-tangere	Western Jewelweed
Betulaceae	**Birch Family**
Betula glandulosa	Dwarf Birch
Betula occidentalis	River Birch
Betula papyrifera	White Birch/Paper Birch
Corylus americana	American Hazelnut
Corylus cornuta	Baked Hazelnut
Boraginaceae	**Borage Family**
Hackelia floribunda	Large-Flowered Stickseed
Lappula myosotis	Bluebur
Lithospermum arvense	Corn Gromwell
Lithospermum canescens	Hoary Puccoon
Lithospermum incisum	Narrow-Leaved Puccoon

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Mertensia lanceolata	Lance-Leaved Lungwort
Onosmodium molle	Western False Gromwell

Cactaceae — **Cactus**
Coryphantha vivipara	Pincushion Cactus
Opuntia polyacantha	Prickly-Pear Cactus

Campanulaceae — **Bluebell Family**
Campanula rotundifolia	Harebell

Cannabinaceae — **Hemp**
Humulus lupulus	Common Hop

Caprifoliaceae — **Honeysuckle Family**
Lonicera dioica	Twining Honeysuckle
Lonicera tatarica	Tatarian Honeysuckle
Symphoricarpos occidentalis	Snowberry
Viburnum lentago	Nannyberry
Viburnum opulus	High-Bush Cranberry
Viburnum rafinesquianum	Downy Arrowwood

Caryophyllaceae — **Pink Family**
Arenaria lateriflora	Gove Sandwort
Cerastium arvense	Mouse-Ear Chickweed
Lychnis drummondii	Drummond's Cockle
Silene cucubalus	Bladder Campion
Silene cserei	Smooth Catchfly
Stellaria longifolia	Long-Leaved Stitchwort
Stellaria longipes	Long-Stalked Stitchwort
Stellaria noctiflora	Night-Flowering Catchfly

Celastraceae — **Staff-Tree Family**
Celastrus scandens	Bittersweet

Ceratophyllaceae — **Hornwort**
Ceratophyllum	Demersum

Chenopodiaceae — **Goosefoot**
Atriplex patula	Orache
Axyris ambranthoides	Russian Pigweed
Chenopodium album	Lamb's-Quarters
Chenopodium fremontii	Fremont's Goosefoot
Chenopodium hybridum	Maple-Leaved Goosefoot
Chenopodium leptophyllum	Narrow-Leaved Goosefoot
Chenopodium rubrum	Red Goosefoot
Monolepis nuttalliana	Spear-Leaved Goosefoot

Cistaceae — **Rock-Rose Family**
Hudsonia tomentose	Sand-Heather

Compositae — **Composite Family**
Achillea millefolium	Yarrow
Achillea sibirica	Many-Flowered Yarrow
Agoseris glauca	False Dandelion

Ambrosia artemisiifolia	Common Ragweed
Ambrosia psilostachya	Perennial Ragweed
Ambrosia trifida	Great Ragweed
Antennaria sp.	Prairie Everlasting
Arctium lappa	Common Burdock
Arctium minus	Lesser Burdock
Arnica fulgens	Shining Arnica
Artemisia absinthium	Absinthe/Wormwood
Artemisia biennis	Biennial Wormwood
Artemisia campestris	Prairie Wormwood
Artemisia dracunculus	Linear-Leaved Wormwood
Artemisia frigida	Pasture Sage
Artemisia ludoviciana	Prairie Sage
Aster ciliolatus	Lindley's Aster
Aster conspicuus	Showy Aster
Aster ericoides	Many-Flowered Aster
Aster hesperius	Willow Aster
Aster junciformis	Rush Aster
Aster laevis	Smooth Aster
Aster ptarmicoides	White Upland Aster
Aster puniceus	Purple-Stemmed Aster
Aster simplex	Small Blue Aster
Aster umbellatus	Flat-Topped White Aster
Bidens ceruva	Smooth Beggar's Ticks
Bidens frondosa	Common Beggar's Ticks
Chrysopsis villosa	Hairy Golden-Aster
Cirsium arvense	Canada Thistle
Cirsium flodmanii	Flodman's Thistle
Crepis sp.	Hawk's-Beard
Crepis tectorum	Narrow-Leaved Hawk's Beard
Echinacea pallida	Purple Coneflower
Erigeron caespitosus	Fleabane
Erigeron canadensis	Horseweed
Erigeron glabellus	Smooth Fleabane
Erigeron philadelphicus	Philadelphia Fleabane
Erigeron strigosus	Daisy Fleabane
Eupatorium purpureum	Spotted Joe-Pye Weed
Grindelia squarrosa	Gumweed
Gutierrezia sarothrae	Broomweed
Haplopappus spinulosus	Spiny Ironplant
Helenium autumnale	Mountain Sneezeweed
Helianthus laetiflorus	Beautiful Sunflower
Helianthus maximiliani	Narrow-Leaved Sunflower
Helianthus nuttallii	Tuberous-Rotted Sunflower
Helianthus petiolaris	Prairie Sunflower
Heliopsis helianthoides	Rough False Sunflower
Hieracium scabriusculum	Canada Hawkweed
Iva xanthifolia	False Ragweed
Lactuca tatarica	Blue Lettuce
Liatris ligulistylis	Meadow Blazing-Star
Liatris punctata	Dotted Blaxing-Star
Lygodesmia juncea	Skeletonweed
Ratibida columnifera	Long-Headed Coneflower
Rudbeckia hirta	Black-Eyed Susan

Rudbeckia laciniata	Tall Coneflower
Senecio canus	Silvery Groundsel
Senecio congestus	Marsh Ragwort
Senecio integerrimus	Entire-Leaved Groundsel
Senecio pauperculus	Balsam Groundsel
Solidago canadensis	Canescent Goldenrod
Solidago gigantea	Late Goldenrod
Solidago graminifolia	Flat-Topped Goldenrod
Solidago missouriensis	Low Goldenrod
Solidago nemoralis	Showy Goldenrod
Solidago rigida	Stiff Goldenrod
Sonchus arvensis	Sow-Thistle
Tanacetum vulgare	Tansy
Taraxacum officinale	Dandelion
Tragopogon dubius	Goat's-Beard
Xanthium strumarium	Cocklebur

Convolvulaceae	**Convolvulus Family**
Convolvulus sepium	Morning Glory
Cuscuta sp.	Common Dodder

Cornaceae	**Dogwood Family**
Cornus stolonifera	Red-Osier Dogwood

Cruciferae	**Mustard**
Arabis divaricarpa	Purple Rock Cress
Arabis drummondii	Drummond's Rock Cress
Arabis hirsuta	Hirsute Rock Cress
Arabis holboelii	Holboel's Rock Cress
Capsella bursa-pastoris	Sheperd's Purse
Cardamine sp.	Bitter Cress
Descurainia pinnata	
Descurainia sophia	Flixweed
Descurainia sophioides	Northern Flixweed
Draba nemorosa	
Erysimum asperum	Western Wallflower
Erysimum cheiranthoides	Wormseed Mustard
Erysimum inconspicuum	Small-Flowered Prairie Rocket
Hesperis matronalis	Dame's-Rocket
Lepidium densiflorum	Pepper-Grass
Lesquerella ludoviciana	Sand Bladderpod
Rorippa islandica	Marsh Yellow Cress
Sisymbrium altissimum	Tumbling Mustard
Sisymbrium loesellii	Tall Hedge Mustard
Thlaspi arvense	Stinkweed

Cucurbitaceae	**Gourd Family**
Echinocystis lobata	Wild Cucumber

Cyperaceae	**Sedge Family**
Carex alopecoidea	Foxtail Sedge
Carex aquatilis	Water Sedge
Carex assiniboinesis	Assiniboia Sedge
Carex atherodes	Awned Sedge

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Carex backii	Back's Sedge
Carex brevior	
Carex deweyana	Dewey's Sedge
Carex disperma	Two-Seeded Sedge
Carex eburnea	Bristle-Leaved Sedge
Carex filifolia	Thread-Leaved Sedge
Carex granularis	Granular Sedge
Carex gravida	Heavy Sedge
Carex laeviconica	Smooth-Fruited Sedge
Carex nigromarginata	
Carex obtusata	Blunt Sedge
Carex pensylvanica	Sun-Loving Sedge
Carex praegracilis	Graceful Sedge
Carex prairea	Prairie Sedge
Carex praticola	
Carex richardsonii	Richardson's Sedge
Carex rosea	
Carex rostratra	Beaked Sedge
Carex retrosorsa	Turned Sedge
Carex sartwellii	Sartwell's Sedge
Carex siccata	Hay Sedge
Carex sprengelii	Sprengel's Sedge
Carex stenophylla	Low Sedge
Carex sychnocephala	Long-Beaked Sedge
Carex tenera	
Carex torreyi	Torrey's Sedge
Carex fulpinoidea	Fox Sedge
Cyperus schweinitzii	Sand Nut-Grass
Eleocharis acicularis	Needle Spike-Rush
Eleocharis erythropoda	
Eleocharis palustris	Creeping Spike-Rush
Scirpus atrovirens	Green Bulrush
Scirpus fluviatilis	River Bulrush
Scirpus lacustris	Stem Bulrush
Scirpus microcarpus	Small-Fruited Bulrush
Elaeagnaceae	**Oleaster Family**
Elaeagnus commutata	Common Silverberry
Gaura coccinca	Scarlet Gaura
Shepherdia argentea	Silver Buffalo-Berry
Shepherdia canadensis	Canada Buffalo-Berry
Equisetaceae	**Horse-Tail Family**
Equisetum arvense	Field Horsetail
Equisetum hyemale	Common Scouring-Rush
Equisetum laevigatum	Smooth Scouring-Rush
Equisetum palustre	Marsh Horsetail
Equisetum scirpoides	Dwarf Scouring-Rush
Ericaceae	**Heath Family**
Arctostaphylos uva-ursi	Common Bearberry

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Euphorbiaceae	**Spurge Family**
Euphorbia esula	Leafy Spurge
Euphorbia geyeri	Prostrate Spurge
Euphorbia glyptosperma	
Euphorbia serphyllifolia	Thyme-Leaved Spurge
Fumariaceae	**Fumitory**
Corydalsiaurea	Golden Corydalis
Fagaceae	**Oak**
Quercus macrocarpa	Bur Oak
Gentianaceae	**Gentian Family**
Gentiana amarella	Northern Gentian
Gramineae	**Grass Family**
Agropyron dasystachyum	Northern Wheatgrass
Agropyron intermedium	Intermediate Wheatgrass
Agropyron pectififorme	Crested Wheatgrass
Agropyron repens	Quack Grass
Agropyron smithii	Western Wheatgrass
Agrophyron trachycaulum	Slender Wheatgrass
Agrostis spp.	Bentgrass
Alopecurus aeaualis	Short-Awned Foxtail
Andropogon gerardii	Big Bluestem Grass
Andropogon scoparius	Little Bluestem Grass
Aristida longiseta	Red Three-Dawn
Beckmannia syzigachne	Slough Grass
Bouteloua curtipendula	Side-Oats Grama Grass
Bouteloua gracilis	Blue Grama Grass
Bromus ciliatus	Fringed Brome Grass
Bromus inermis	Smooth Brome Grass
Bromus purgans	Canada Brome Grass
Calamagrostis canadensis	Marsh Reed Grass/Bluejoint
Calamagrostis inexpansa	Northern Reed Grass
Calamagrostis neglecta	Narrow Reed Grass
Calamogrostis montanesis	Reed Bentgrass
Calamovilfa longifolia	Sand Grass
Danthonia spicata	Poverty Oat Grass
Echinochloa crusgalli	Barnyard Grass
Elymus canadensis	Canada Wild Rye
Elymus virginicus	Virginia Wild Rye
Festuca altaica	Rough Fescue
Festuca ovina	Rocky Mountain Fescue
Festuca rubra	Creeping Red Fescue
Glyceria borealis	Northern Manna Grass
Glyceria grandis	Tall Manna Grass
Glyceria striata	Fowl Manna Grass
Helictotrichon hookeri	Hooker's Oat Grass
Hordeum jubatum	Foxtail Barley
Koeleria cristata	June Grass
Leersia oryzoides	Rice Cut Grass
Muhlenbergia cuspidata	Prairie Muhly
Muhlenbergia racemosa	Marsh Muhly Grass

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Muhlenbergia richardsonis	Mat Muhly Grass
Oryzopsis asperifolia	White-Grained Mountain Rice Grass
Oryzopsis micrantha	Little-Seed Rice Grass
Panicum capillare	Witch Grass
Panicum leibergii	
Panicum virgatum	Switch Grass
Panicum wilcoxianum	Sand Millet
Phalaris arundinacea	Reed Canary Grass
Phleum pratense	Timothy
Poa arida	Plains Bluegrass
Poa compressa	Canada Bluegrass
Poa cusickii	Early Bluegrass
Poa palustris	Fowl Bluegrass
Poa pratensis	Kentucky Bluegrass
Schizachne purpurascens	Purple Oat Grass
Scolochloa festucacea	Spangletop/Whitetop
Setaria viridis	Green Foxtail
Spartina gracilis	Alkali Cord Grass
Spartina pectinata	Prairie Cord Grass
Sphenopholis obtusata	Prairie Wedge Grass
Sporobolus heterolepis	Prairie Dropseed
Stipa comata	Needle-and-Thread Spear Grass
Stipa spartea	Porcupine Grass
Stipa curtiseta	Western Porcupine Grass
Stipa viridula	Green Needle Grass

Haloragaceae　　　　　　　　**Mare's-Tail Family**
Myriophyllum spicatum　　　　Spiked Water-Milfoil

Hydrophyllaceae　　　　　　**Waterleaf Family**
Ellisia nyctelea　　　　　　　Waterpod

Imenispermaceae　　　　　　**Moonseed**
Menispermum canadense　　　Yellow Parilla

Iridaceae　　　　　　　　　**Iris Family**
Sisyrinchium montanum　　　Common Blue-Eyed Grass

Juncaceae　　　　　　　　　**Rush Family**
Juncus balticus　　　　　　　Wire Rush
Juncus bufonius　　　　　　　Toad Rush
Juncus dudleyi　　　　　　　Dudley's Rush
Juncus nodosus　　　　　　　Knotted Rush

Juncaginaceae　　　　　　　**Arrow-Grass Family**
Triglochin maritima

Labiatae　　　　　　　　　**Mint Family**
Agastache foeniculum　　　　Giant-Hyssop
Dracocephalum formosius　　Dragonhead
Dracocephalum virginianum　False Dragonhead
Galeopsis tetrahit　　　　　　Hemp-Nettle
Glechoma hederacea　　　　　Ground-Ivy
Leonurus cardiaca　　　　　Motherwort

Lycopus americanus	Water Horehound
Lycopus asper	Western Water Horehound
Lycopus uniflorus	Northern Water Horehound
Mentha arvensis	Field Mint
Monarda fistulosa	Wild Bergamot
Salvia sylvestris	Wood Sage
Scutellaria epilobiifolia	Marsh Skullcap
Stachys palustris	Hedge Nettle
Teucrium occidentale	Hairy Germander

Leguminosae — **Pea Family**

Amorphanana	Dwarf False Indigo
Amphicarpa bracteata	Hog-Peanut
Astragalus sp.	Milk-Vetch
Caragana arborescens	Common Caragana
Glycyrrhiza lepidota	Wild Licorice
Lathyrus sp.	Vetchling
Medicago falcata	Yellow Alfalfa
Medicago lupulina	Black Medick
Medicago sativa	Alfalfa
Melilotus alba	White Sweet-Clover
Melilotus officinalis	Yellow Sweet-Clover
Oxytropis campestris	Late Yellow Locoweed
Oxytropis lambertii	Lambert's Locoweed
Oxytropis splendens	Showy Locoweed
Petalostemon candidum	White Prairie-Clover
Petalostemon purpureum	Purple Prairie-Clover
Petalostemon villosum	Hairy Prairie-Clover
Psoralea argophylla	Silverleaf Psoralea
Psoralea esculenta	Indian Breadroot
Trifolium hybridum	Alsike Clover
Trifolium repens	White Clover
Vicia americana	American Vetch
Vicia cracca	Canada Pea
Vicia sativa	Spring-Vetch

Lenmaceae — **Duckweed**

Lemna minor	Lesser Duckweed
Lemna trisulea	Ivy-Leaved Duckweed

Lentibulariaceae — **Bladderwort Family**

Utricularia sp.	Bladderwort

Liliaceae — **Lily Family**

Allium cernuum	Nodding Onion
Allium stellatum	Pink-Flowered Onion
Allium textile	Prairie Onion
Asparagus officinalis	Asparagus
Disporum trachycarpum	Fairybells
Lilium philadelphicum	Western Red Lily
Maianthemum canadense	Wild Lily-of-the-Valley
Polygonatum biflorum	Common Solomon's Seal
Smilacina racemosa	Wild Spikenard
Smilacina stellata	Star-Flowered False Solomon's-Seal

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Smilax herbacea	Carrionflower
Trillium cernuum	Nodding Wakerobin
Zigadenus elegans	Smooth Camas

Linaceae — **Flax Family**
Linum perenne — Wild Blue Flax
Linum rigidum — Large-Flowered Yellow Flax

Loreliaceae
Lobelia kalmii — Kalm's Lobelia
Lobelia spicata — Spiked Lobelia

Malvaceae — **Mallow Family**
Malva sp. — Mallow
Sphaeralcea coccinea — Scarlet Mallow

Nyctaginaceae — **Four-O'clock**
Mirabilis hirsuta — Hairy Umbrella Wort
Mirabilis nyctaginea — Heart-Leaved Umbrella Wort

Oleaceae — **Olive Family**
Fraxinus pennsylvanica — Green Ash
Syringa vulgaris — Common Lilac

Onagraceae — **Evening-Primrose Family**
Circaea alpina — Enchanter's Nightshade
Epilobium angustifolium — Common Fireweed
epilobium glandulosum — Northern Willowherb
Guara coccinea — Scarlet Butterflyweed
Oenothera biennis — Yellow Evening-Primrose
Oenothera nuttalli — White Evening-Primrose
Oenothera serrulata — Shrubby Evening-Primrose

Ophioglossaceae — **Adder's-Tongue**
Botrychium virginianum — Rattlesnake-Fern

Orchidaceae — **Orchid Family**
Cypripedium calceolus — Yellow Lady's-Slipper

Oxalidaceae — **Wood-Sorrel Family**
Oxalix stricta — Yellow Wood-Sorrel

Phrymaceae — **Lopseed Family**
Phryma leptostachya — Lopseed

Pinaceae — **Pine**
Juniperus communis — Common Juniper
Juniperus horizontalis — Horizontal Juniper
Pinus sylvestris — Scot's Pine

Plantaginaceae — **Plantain Family**
Houstonia longifolia — Houstonia
Plantago elongata — Linear-Leaved Plantain
Plantago major — Common Plantain

Polemoniaceae	**Phlox Family**
Collomia linearis	Narrow-Leaved Collomia
Phlox hoodii	Moss Phlox
Polygalaceae	**Milkwort Family**
Polygala senega	Seneca Snakeroot
Polygala verticillata	Whorled Milkwort
Polygonaceae	**Buckwheat Family**
Eriogonum flavum	Yellow Umbrella Plant
Polygonum amphibium	Swamp Persicaria
Polygonum stipulaceum	
Polygonum aviculare	Doorweed
Polygonum coccineum	Swamp Persicaria
Polygonum convolvulus	Wild Buckwheat
Polygonum erectum	Striate Knotweed
Polygonum lapathafolium	Pale Persicaria
Polygonum persicaria	Lady's Thumb
Rumex sp.	Dock
Rumex crispus	Curly Dock
Rumex salicifolius	Narrow-Leaved Dock
Rumex venosus	Sand Dock
Polypodiaceae	**Fern**
Cystopteris fragilis	Fragile Fern
Matteuccia struthiopteris	Ostrich Fern
Primulaceae	**Primrose Family**
Androsace occidentalis	Western Pygmyflower
Androsace septentrionalis	Fairy Candelabra
Steironema ciliatum	Fringed Loosestrife
Pyrolaceae	**Wintergreen Family**
Chimaphila umbellata	Prince's Pine
Monotropa uniflora	Indian Pipe
Pyrola asarifolia	Common Pink Wintergreen
Pyrola elliptica	Common Shinleaf
Pyrol secunda	One-Sided Wintergreen
Ranunculaceae	**Crowfoot Family**
Actaea rubra	Red Baneberry
Anemone canadensis	Canada anemone
Anemone cylindrica	Thimble-Weed
Anemone multifida	Cut-Leaved Anemone
Anemone patens	Prairie Crocus Anemone
Anemone virginiana	Tall Anemone
Anemone quilegia	Wild Columbine
Caltha palustris	Marsh Marigold
Clematis virginiana	Bower Vine
Ranunculus abortivus	Smooth-Leaved Buttercup
Ranunculus cymbalaria	Seaside Buttercup
Ranunculus gmelinii	Small Yellow Water Crowfoot
Ranunculus macounii	Macoun's Buttercup
Ranunculus pensylvanicus	Bristly Buttercup

Ranunculus rhomboideus	Prairie Buttercup
Ranunculus sceleratus	Celery-Leaved Buttercup
Thalictrum dasycarpum	Tall Meadow-Rue
Thalictrum venulosum	Meadow-Rue

Rhamnaceae	**Buchthorn Family**
Rhamnus alnifolia	*Alder-Leaved Buckthorn*

Rosaceae	**Rose Family**
Agrimonia striata	Agrimony
Amelanchier alnifolia	Saskatoon
Chamaerhodos erecta	Chamaerhodos
Crataegus rotundifolia	Round-Leaved Hawthorn
Fragaria spp.	Strawberry
Geum aleppicum	Yellow Avens
Geum triflorum	Three-Flowered Avens
Potentilla anserina	Siverweed
Potentilla arguta	White Cinquefoil
Potentilla concinaa	Early Cinquefoil
Potentilla gracilis	Graceful Cinquefoil
Potentilla hippiana	Wolly Cinquefoil
Potentilla norvegica	Rough Cinquefoil
Potentilla pensylvanica	Prairie Cinquefoil
Potentilla rivalis	Brook Cinquefoil
Prunus americana	American Plum
Prunus nigra	Canada Plum
Prunus pensylvanica	Pincherry
Prunus viriginiana	Chokecherry
Rosa acicularis	Prickly Rose
Rosa arkansana	Prairie Rose
Rosa woodsii	Wood's Rose
Rubus idaeus	Red Raspberry
Rubus pubescens	Dewberry
Spiraea alba	Meadowsweet

Rubiaceae	**Madder Family**
Galium aparine	Cleavers
Galium boreale	Northern Bedstraw
Galium triflorum	Sweet-Scented Bedstraw
Houstonia longifolia	Long-Leaved Bluets

Salicaceae	**Willow Family**
Populus balsamifera	Balsam Poplar
Populus deltoides	Western Cottonwood
Populus tremuloides	Trembling Aspen
Populus hybrid	Walker Poplar
Salix bebbiana	Bebb's Willow/Beaked Willow
Salix discolor	Pussy Willow
Salix exigua	Sandbar Willow
Salix lutea	Yellow Willow
Salix petiolaris	Basket Willow

Santalaceae	Sandalwood Family
Comandra palida	Pale Comandra
Comandra umbellata	Bastard Toadflax

Saxifragaceae	Saxifrage Family
Heuchera richardsonii	Alumroot
Ribes americanum	Wild Black Currant
Ribes hudsonianum	Northern Black Currant
Ribes oxyacanthoides	Northern Gooseberry
Ribes setosum	Bristly Gooseberry
Ribes triste	Swamp Red Currant

Scrophulariaceae	Figwort Family
Castilleja sessiliflora	Downy Poaint
Linaria vulgaris	Toadflax
Mimulus ringens	Blue Monkeyflower
Orthocarpus luteus	Owl's-Clover
Pentemon albidus	White Beardtongue
Pentemon gracilis	Lilac-Flowered Beardtongue
Veronica peregrina	Hairy Speedwell

Selaginellaceae	Spikemoss Family
Selaginella densa	Prairie Selaginella

Solanaceae	Potato Family
Physalis virginiana	Ground-Cherry
Solanum triflorum	Wild Tomato

Sparganiaceae	Bur-Reed Family
Sparganium eurycarpum	Broad-Fruited Bur-Reed

Typhaceae	Cattail Family
Typha angustifolia	Narrow-Leaved Cattail
Typha glauca	
Typha latifolia	Common Cattail

Ulmaceae	Elm
Ulmus americana	American Elm

Umbelliferae	Parsley Family
Cicuta maculata	Water Hemlock
Cymopterus acaulis	Plains Cymopterus
Heracleum lanatum	Cow Parshnip
Lomatium foeniculaceum	Hairy-Fruited Parsley
Lomatium orientale	White-Flowered Parsley
Musineon divaricatum	Leafy Musineon
Osmorhiza longistylis	Sweet Cicely
Sanicula marilandica	Snakeroot
Sium suave	Water Parsnip
Zizia aptera	Heart-Leafed Alexander
Zizia aurea	Golden Alexander

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Urticaceae	**Nettle Family**
Laportea canadensis	Wood Nettle
Parietaria pensylvanica	American Pellitory
Urtica dioica	Stinging Nettle
Urtica dioica	
Verbenaceae	**Vervain Family**
Verbena bracteata	Bracted Vervain
Verbena hastata	
Violaceae	**Violet Family**
Viola adunca	Early Blue Violet
Viola canadensis	Western Canada Violet
Viola eriocarpa	Smooth Yellow Violet
Viola nephrophylla	
Viola pedatifida	Crowfoot Violet
Vitaceae	**Grape Family**
Parthenocissus inserta	Large-Toothed Virginia Creeper
Parthenocissus quinquefolia	Virginia Creeper
Vitis riparia	Riverbank Grape
Zosteracea	**Pondweed**
Potamogeton foliosus	Leafy Pondweed

References: Kerr and Wilkinson 1991, Hohn and Parsons 1993.

Table 2 Faunal species of the Lauder Sandhills of southwestern Manitoba.

Latin Name	Common Name
MAMMALS	
Antilocapridae	**Pronghorn**
Antilocapra americana	Pronghorn (Antelope)
Bovidae	**Bison, Goats, Muskox, and Sheep**
Bison bison	American Bison
Canidae	**Dogs, Wolves, and Foxes**
Canis familiaris	Domestic Dog
Canis latrans	Coyote
Canis lupus	Gray Wolf
Canis lupus nubilis	Buffalo Wolf
Vulpes vulpes	Red Fox
Vulpes velox	Swift Fox
Castoridae	**Beaver**
Castor canadensis	American Beaver
Cervidae	**Deer**
Alces alces	Moose
Cervus elaphus	Elk/Wapiti
Odocoileus hemionus	Mule Deer
Odocoileus virginianus	Whitetail Deer
Cricetidae	**Rats, Mice, and Voles**
Clethrionomys gapperi	Boreal Redback Vole
Microtus ochrogaster	Prairie Vole
Microtus pennsylvanicus	Meadow Vole
Ondatra zibethicus	Muskrat
Onychomys leucogaster	Northern Grasshopper Mouse
Peromyscus maniculatus	Deer Mouse
Erethizontidae	**New World Porcupines**
Erethizon dorsatum	Porcupine
Felidae	**Cats**
Lynx canadensis	Lynx
Lynx rufus	Bobcat
Geomyidae	**Pocket Gophers**
Thomomys talpoides	Northern Pocket Gopher
Leporidae	**Rabbits and Hares**
Lepus americanus	Snowshoe Hare
Lepus townsendii	Whitetail Jackrabbit
Sylvilagus floridanus	Eastern Cottontail
Mustelidae	**Weasels and their Allies**
Lutra canadensis	River Otter
Mephitis mephitis	Striped Skunk
Mustela erminea	Shorttail Weasel (Ermine)

Mustela frenata	Longtail Weasel
Mustela rixosa	Least Weasel
Mustela vison	American Mink
Taxidea taxus	American Badger

Procyonidae	**Raccoons and their Allies**
Procyon lotor	Raccoon

Sciuridae	**Ground Squirrels**
Citellus franklini	Franklin Ground Squirrel
Citellus richardsoni	Richardson Ground Squirrel
Citellus tridecemlineatus	Thirteen-Lined Ground Squirrel
Eutamias alpinus	Alpine Chipmunk
Glaucomys sabrinus	Northern Flying Squirrel
Marmota monax	Woodchuck
Sciurus carolinensis	Eastern Gray Squirrel
Tamiasciurus hudsonicus	Red Squirrel

Soricidae	**Shrews**
Blarina brevicauda	Shorttail Shrew
Microsorex hoyi	Pygmy Shrew
Sorex arcticus	Arctic Shrew
Sorex cinereus	Masked Shrew

Ursidae	**Bears**
Ursus americanus	Black Bear

Vespertillionidae	**Bats**
Eptesicus fuscus	Big Brown Bat
Lasionycteris noctivagans	Silver-Haired Bat
Lasiurus borealis	Red Bat
Lasiurus cinereus	Hoary Bat
Myotis keeni	Keen Myotis
Myotis lucifugus	Little Brown Myotis

REPTILES AND AMPHIBIANS

Ambystomidae	**Mole Salamanders**
Ambystoma tigrinum diaboli	Gray/Eastern Tiger Salamander

Bufonidae	**Toads**
Bufo americanus charlesmithi	Dwarf American Toad

Chelydridae	**Snapping Turtles**
Chelydra serpentina	Snapping Turtle

Colubridae	**Garter Snakes and their Allies**
Heterodon nasicus	Western Hog-Nosed Snake
Opheodrys vernalis	Western Smooth-Green Snake
Storeria occipitomaculata	Northern Red-Bellied Snake
Thamnophis rasix	Plains Garter Snake
Thamnophis sirtalis parietalis	Red-Sided Garter Snake

Hylidae	**Treefrogs and their Allies**
Hyla versicolor	Gray Treefrog
Pseudacris triseriata maculata	Boreal Chorus Frog
Pelobatidae	**Spadefoot Toads**
Scaphiopus bombifrons	Plains Spadefoot Toad
Ranidae	**True Frogs**
Rana pipiens pipiens	Northern Leopard Frog
Rana sylvatica	Wood Frog
Scincidae	**Skinks**
Eumeces septentrionalis septentrionalis	Northern Prairie Skink
Testudinidae	**Box and Water Turtles**
Chrysemys picta belli	Western Painted Turtle
FISH	
Cadidae	**Cod**
Lota lota	Burbot
Catostomidae	**Sucker**
Catostomus catostomus	Longnose Sucker
Catostomus commersoni	White Sucker
Moxostoma anisurum	Silver Redhorse
Moxostoma macrolepidotum	Shorthead Redhorse
Centrarchidae	**Sunfish**
Ambloplites rupestris	Rock Bass
Coregoninae	**Whitefish**
Coregonus clupeaformis	Lake Whitefish
Cottidae	**Sculpin**
Cottus cognatus	Slimy Sculpin
Cyprinidae	**Minnow and Carp**
Couesius plumbeus	Lake Chub
Hybognathus hankinsoni	Brassy Minnow
Notropis atherinoides	Emerald Shiner
Notropis blennius	River Shiner
Notemigonus crysoleucas	Golden Shiner
Notropis cornutus	Common Shiner
Notropis heterolepis	Blacknose Shiner
Notropis hudsonius	Spottail Shiner
Notropis stramineus	Sand Shiner
Pimephales promelas	Fathead Minnow
Platygobio gracilis	Flathead Chub
Rhinichthys atratulus	Blacknose Dace
Rhinichthys cataractae	Longnose Dace
Semotilus atromaculatus	Creek Chub
Semotilus margarita	Pearl Dace

Esocidae	**Pike**
Esox lucius	Northern Pike
Gasterosteidae	**Stickleback**
Culaea inconstans	Brook Stickleback
Pungitius pungitius	Ninespine Sticleback
Hiodontidae	**Mooneye**
Hiodon alosoides	Goldeye
Hiodon tergisus	Mooneye
Icaluridae	**Catfish**
Ictalurus nebulosus	Brown Bullhead
Noturus gyrinus	Tadpole Madtom
Percidae	**Perch**
Etheostoma exile	Iowa Darter
Etheostoma nigrum	Johnny Darter
Perca flavescens	Yellow Perch
Percina maculata	Blackside Darter
Stizostedion canadense	Sauger
Stizostedion vitreum	Walleye
Percopsidae	**Trout-Perch**
Percopsis omiscomaycus	Trout-Perch
Salmonidae	**Salmon**
Salmo gairdneri	Rainbow Trout

BIRDS

Accipitridae	**Ospreys, Eagles, Hawks and their Allies**
Accipiter cooperii	Cooper's Hawk
Accipiter gentilis	Goshawk
Accipiter striatus	Sharp-Shinned Hawk
Aquila chrysaetos	Golden Eagle
Buteo jamaicensis	Red-Tailed Hawk
Buteo lagopus	Rough-Legged Hawk
Buteo regalis	Ferruginous Hawk
Buteo swainsoni	Swainson's Hawk
Circus cyaneus	Northern Harrier (Marsh Hawk)
Pandion haliaetus	Osprey
Alaudidae	**Larks**
Eremophila alpestris	Horned Lark
Alcedinidae	**Kingfishers**
Ceryle alcyon	Belted Kingfisher
Anatidae	**Swans, Geese and Ducks**
Aix sponsa	Wood Duck
Anas acuta	Northern Pintail
Anas americana	American Wigeon
Anas clypeata	Northern Shovel
Anas discors	Blue-Winged Teal
Anas platyrhynchos	Mallard

Anas strepera	Gadwall
Anser caerulescens	Snow Goose
Aythya affinis	Lesser Scaup
Aythya americana	Redhead
Aythya collaris	Ring-Necked Duck
Aythya valisineria	Canvasback
Branta canadensis	Canada Goose
Bucephala albeola	Bufflehead
Bucephala clangula	Common Goldeneye
Lophodytes cucullatus	Hooded Merganser
Melanitta deglandi	White-Winged Scoter
Mergus merganser	Common Merganser
Oxyura jamaicensis	Ruddy Duck
Spatula clypeata	Shoveler

Apodidae
Chaetura pelagica

Swifts
Chimney Swift

Ardeidae
Ardea herodias
Botaurus lentiginosus
Ixobrychus exilis
Nycticorax nycticorax

Herons and Bitterns
Great Blue Heron
American Bittern
Least Bittern
Black-Crowned Night Heron

Bombycillidae
Bombycilla cedrorum

Waxwings
Cedar Waxwing

Caprimulgidae
Caprimulgus vociferus
Chordeiles minor

Goatsuckers
Whip-Poor-Will
Common Nighthawk

Cathartidae
Cathartes aura

American Vultures
Turkey Vulture

Certhiidae
Certhia americana

Creepers
Brown Creeper

Charadriidae
Charadrius vociferus

Plovers
Killdeer

Columbidae
Columba livia
Zenaida macroura

Pigeons and Doves
Rock Dove
Mourning Dove

Corvidae
Corvus brachyrhynchos
Corvus corax
Cyanocitta cristata
Pica pica

Jays, Magpies, and Crows
American Crow
Common Raven
Blue Jay
Back-Billed Magpie

Cuculidae
Coccyzus erythropthalmus

Cuckoos, Roadrunners and Anis
Black-Billed Cuckoo

Emberizidae

Sparrows, and their Allies

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Agelaius phoeniceus	Red-Winged Blackbird
Ammodramus bairdii	Baird's Sparrow
Ammodramus caudacutus	Sharp-Tailed Sparrow
Ammodramus leconteii	Le Conte's Sparrow
Ammodramus savannarum	Grasshopper Sparrow
Calamospiza melanocorys	Lark Bunting
Calcarius lapponicus	Lapland Longspur
Calcarius ornatus	Chestnut-Collared Longspur
Chondestes grammacus	Lark Sparrow
Dendroica castanea	Bay-Breasted Warbler
Dendroica coronata	Yellow-Rumped Warbler
Dendroica fusca	Blackburnian Warbler
Dendroica palmarum	Palm Warbler
Dendroica petechia	Yellow Warbler
Dendroica striata	Blackpoll Warbler
Dolichonyx oryzivorus	Bobolink
Euphagus cyanocephalus	Brewer's Blackbird
Geothlypis trichas	Common Yellowthroat
Icterus galbula	Northern Oriole
Icterus spurius	Orchard Oriole
Junco hyemalis	Dark Eyed Junco
Melospiza georgiana	Swamp Sparrow
Melospiza lincolnii	Lincoln's Sparrow
Melospiza melodia	Song Sparrow
Mniotilta varia	Black and White Warbler
Molothrus ater	Brown-Headed Cowbird
Oporonis philadelphia	Mourning Warbler
Passerculus sandwichensis	Savannah Sparrow
Passerina cyanea	Indigo Bunting
Pheucticus ludovicianus	Rose-Breasted Grosbeak
Pipilo erythrophthalmus	Rufous-Sided Towhee
Piranga olivacea	Scarlet Tanager
Pooecetes gramineus	Vesper Sparrow
Quiscalus quiscula	Common Blackbird
Seiurus aurocapillus	Ovenbird
Seiurus noveboracensis	Northern Waterthrush
Setophaga ruticilla	American Redstart
Spiza americana	Dickcissel
Spizella pallida	Clay-Colored Sparrow
Spizella passerina	Chipping Sparrow
Sturnella neglecta	Western Meadowlark
Vermivora celata	Orange-Crowned Warbler
Vermivora peregrina	Tennessee Warbler
Wilsonia pusilla	Wilson's Warbler
Xanthocephalus xanthocephalus	Yellow-Headed Blackbird
Zonotrichia albicollis	White-Throated Sparrow
Zonotrichia leucophrys	White-Crowned Sparrow
Zonotrichia querula	Harris's Sparrow

Falconidae	**Caracaras and Falcons**
Falco columbarius	Merlin (Pigeon Hawk)
Falco peregrinus	Peregrine Falcon
Falco sparverius	American Kestrel (Sparrow Hawk)
Fringillidae	**Finches**

Carduelis pinus	Pine Siskin
Carduelis tristis	American Goldfinch
Carpodacus purpureus	Purple Finch
Passer domesticus	House Sparrow

Gaviidae — **Loons**
Gavia immer — Common Loon

Gruidae — **Cranes**
Grus canadensis — Sandhill Crane

Haematopodidae — **Oystercatchers**
Recurvirostra americana — American Avocet

Hirundinidae — **Swallows**

Hirundo pyrrhonota	Cliff Swallow
Hirundo rustica	Barn Swallow
Progne subis	Purple Marten
Riparia riparia	Bank Swallow
Stelgidopteryx serripennis	Northern Rough-Winged Swallow
Tachycineta bicolor	Tree Swallow

Laniidae — **Shrikes**
Lanius ludovicianus — Loggerhead Shrike

Laridae — **Skuas, Gulls, Terns and Skimmers**

Chlidonias niger	Black Tern
Larus argentatus	Herring Gull
Larus californicus	California Gull
Larus delawarensis	Ring-Billed Gull
Larus philadelphia	Bonaparte's Gull
Larus pipixcan	Franklin's Gull
Sterna forsteri	Forster's Tern
Sterna hirundo	Common Tern

Mimidae — **Mockingbirds and Thrashers**

Dumetella carolinensis	Gray Catbird
Toxostoma rufum	Brown Thrasher

Motacillidae — **Wagtails and Pipits**
Anthus spragueii — Sprague's Pipit

Muscicapidae — **Kinglets, Thrushes, and their Allies**

Catharus fuscescens	Veery
Catharus ustulatus	Swainson's Thrush
Regulus calendula	Ruby-Crowned Kinglet
Sialia currocoides	Mountain Bluebird
Sialia sialis	Eastern Bluebird
Turdus migratorius	American Robin

Paridae — **Titmouse**
Parus atricapillus — Black-Capped Chickadee

Pelecanidae — **Pelicans**
Pelecanus erthrorhynchos — American White Pelican

Phalacrocoracidae	**Cormorants**
Phalacrocorax auritus	Double-Crested Cormorant
Phasianidae	**Partridges, Pheasants and their Allies**
Bonasa umbellus	Ruffed Grouse
Meleagris gallopavo	Wild Turkey
Perdix perdix	Gray Partridge
Phasianus colchicus	Ring-Necked Pheasant
Typmanuchus cupido	Greater Prairie Chicken
Tympanuchus phasianellus	Sharp-Tailed Grouse
Picidae	**Woodpeckers and Wrynecks**
Colaptes auratus	Northern Flicker
Dryocopus pileatus	Pileated Woodpecker
Melanerpes erythrocephalus	Red-Headed Woodpecker
Picoides pubescens	Downy Woodpecker
Picoides villosus	Hairy Woodpecker
Sphyrapicus varius	Yellow-Bellied Sapsucker
Podicipedidae	**Grebes**
Aechmophorus occidentalis	Western Grebe
Podiceps auritus	Horned Grebe
Podiceps caspicus	Eared Grebe
Podiceps grisegena	Red-Necked Grebe
Podilymbus podiceps	Pied-Billed Grebe
Rallidae	**Rails, Gallinules and Coots**
Fulica americana	American Coot
Porzana carolina	Sora
Scolopacidae	**Sandpipers, Phalaropes and their Allies**
Actitis macularia	Spotted Sandpiper
Bartramia longicauda	Upland Sandpiper
Calidris alba	Sanderling
Calidris bairdii	Baird's Sandpiper
Calidris fuscicollis	White-Rumped Sandpiper
Calidris himantopus	Stilt Sandpiper
Calidris melanotos	Pectoral Sandpiper
Calidris minutilla	Least Sandpiper
Calidris pusilla	Semipalmated Sandpiper
Catoptrophorus semipalmatus	Willet
Gallinago gallinago	Common Snipe
Limnodromus scolopaceus	Long-Billed Dowitcher
Limosa fedoa	Marbled Godwit
Numenius americanus	Long-Billed Curlew
Phalaropus tricolor	Wilson's Phalarope
Tringa flavipes	Lesser Yellowlegs
Tringa melanoleuca	Greater Yellowlegs
Tringa solitaria	Solitary Sandpiper
Strigidae	**Typical Owls**
Aegolius acadicus	Saw-Whet Owl
Asio otus	Long-Eared Owl
Asio flammeus	Short-Eared Owl
Bubo virginianus	Great Horned Owl
Otus asio	Screech Owl

Speotyto cunicularia	Burrowing Owl
Sturnidae	**Starlings**
Sturnus vulgaris	Common Starling
Trochilidae	**Hummingbirds**
Archilochus colubris	Ruby-Throated Hummingbird
Troglodytidae	**Wrens**
Cistothorus platensis	Marsh Wren
Troglodytes aedon	House Wren
Tyrannidae	**Tyrant Flycatchers**
Contopus borealis	Olive-Sided Flycather
Contopus virens	Eastern Wood-Pewee
Contopus sordidulus	Western Wood-Pewee
Empidonax alnorum	Alder Flycatcher
Empidonax minimus	Least Flycatcher
Empidonax traillii	Willow Flycatcher
Myiarchus crinitus	Great Crested Flycatcher
Sayornis phoebe	Eastern Phoebe
Sayornis saya	Say's Phoebe
Tyrannus tyrannus	Eastern Kingbird
Tyrannus verticalis	Western Kingbird
Vireonidae	**Vireos**
Vireo flavifrons	Yellow-Throated Vireo
Vireo gilvus	Warbling Vireo
Vireo olivaceus	Red-Eyed Vireo
Vireo philadelphicus	Philadelphia Vireo
Vireo solitarius	Solitary Vireo

References: Bjornson, Conant 1958, Ernst, Barbour and Lovich 1994, Godfrey 1966, Hurt and Grossenheider 1980, Scott and Crossman 1973, Weidl and Young 1991.

Appendix II
Calculations of Animal Units by Landmark

Table 1. Animal Units by Landmark for Blocks B, C, D and E of the Jackson site (DiMe-17).

	Block B				Block C				Block D			
	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU
Cranium												
Frontal	0	0	0	0	0	0	0	0	0	0	0	0
Horn core	0	0	0	0	0	0	0	0	0	0	0	0
Parietal	0	0	0	0	0	0	0	0	0	0	0	0
Occipital	0	0	0	0	0	0	0	0	0	0	0	0
Occipital condyle	0	0	0	0	0	0	0	0	0	0	0	0
Squamous temporal	0	0	0	0	0	0	0	0	0	0	0	0
Petrous temporal	0	0	0	0	0	0	0	0	0	0	0	0
Zygomatic temporal	0	0	0	0	0	0	0	0	0	0	0	0
Auditory meatus	0	0	0	0	0	0	0	0	0	0	0	0
Zygomatic	0	0	0	0	0	0	0	0	0	0	0	0
Nasal	0	0	0	0	0	0	0	0	0	0	0	0
Maxilla	0	0	0	0	0	0	0	0	0	0	0	0
Premaxilla	0	0	0	0	0	0	0	0	0	0	0	0
2nd premolar	0	0	0	0	0	0	0	0	0	0	0	0
3rd premolar	0	0	0	0	0	0	0	0	0	1	0.5	33.3
4th premolar	0	0	0	0	0	0	0	0	0	0	0	0
1st molar	0	0	0	0	0	0	0	0	1	0	0.5	33.3
2nd molar	0	0	0	0	0	1	0.5	33.3	0	0	0	0
3rd molar	0	0	0	0	0	0	0	0	0	0	0	0
Mandible												
Coronoid process (DN8)	0	0	0	0	0	0	0	0	0	0	0	0
Condylar process (DN7)	0	0	0	0	1	0	0.5	33.3	0	0	0	0
Ramus (DN6)	0	0	0	0	0	0	0	0	0	0	0	0
Mandibular foramen (DN7)	0	0	0	0	0	0	0	0	0	0	0	0
Mental foramen (DN2)	0	0	0	0	0	0	0	0	0	0	0	0
Diastema (DN2)	0	0	0	0	0	0	0	0	0	0	0	0
Symphysis (DN1)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Incisor/Canine	0	0	0	0	3	0	0.38	25.3	1	3	0.5	33.3
2nd premolar (DN3)	0	0	0	0	2	0	1.0	66.7	0	0	0	0
3rd premolar (DN3)	0	0	0	0	1	0	0.5	33.3	0	0	0	0
4th premolar (DN4)	0	0	0	0	1	0	0.5	33.3	0	0	0	0
1st molar (DN4)	1	0	0.5	50	1	0	0.5	33.3	0	0	0	0
2nd molar (DN5)	1	0	0.5	50	1	0	0.5	33.3	0	0	0	0
3rd molar (DN5)	1	0	0.5	50	2	0	1.0	66.7	0	0	0	0
Hyoid (Hyoid)	0	0	0	0	1	0	0.5	33.3	1	0	0.5	33.3
Rib												
Head (RI1)	0	1	0.04	4	0	1	0.04	2.7	2	0	0.08	5.3
Tubercle (RI2)	0	0	0	0	0	1	0.04	2.7	0	0	0	0
Body (RI3)	0	0	0	0	0	0	0	0	9	8	0.65	43.3
Atlas												
Prezygopophysis (AT3)	0	-	0	0	0	-	0	0	0	-	0	0
Postzygopophysis (AT3)	0	-	0	0	0	-	0	0	0	-	0	0
Alar foramen (AT2)	0	-	0	0	0	-	0	0	1	-	0.5	33.3
Dorsal tubercle (AT1)	0	-	0	0	0	-	0	0	0	-	0	0
Centrum (AT1)	0	-	0	0	0	-	0	0	0	-	0	0
Axis												
Prezygopophysis	0	-	0	0	0	-	0	0	0	-	0	0
Postzygopophysis (AX3)	0	-	0	0	0	-	0	0	0	-	0	0
Spinous process (AX2)	0	-	0	0	0	-	0	0	0	-	0	0
Dens (AX1)	0	-	0	0	0	-	0	0	0	-	0	0
Centrum (AX2)	1	-	1.0	100	0	-	0	0	0	-	0	0

Cervical												
Prezygopophysis (CE2)	0	-	0	0	0	-	0	0	0	-	0	0
Postzygopophysis (CE1)	0	-	0	0	0	-	0	0	0	-	0	0
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0
Neural spine	0	-	0	0	0	-	0	0	0	-	0	0
Transverse process	0	-	0	0	0	-	0	0	0	-	0	0
Centrum (CE2)	1	-	0.14	14	0	-	0	0	2	-	0.29	19.3
Thoracic												
Prezygopophysis	0	-	0	0	0	-	0	0	0	-	0	0
Postzygopophysis	0	-	0	0	0	-	0	0	1	-	0.04	2.7
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0
Neural spine (TH2)	0	-	0	0	0	-	0	0	10	-	0.77	51.3
Transverse process	0	-	0	0	0	-	0	0	1	-	0.04	2.7
Centrum (TH1)	0	-	0	0	0	-	0	0	2	-	0.15	10
Lumbar												
Prezygopophysis (LU1)	0	-	0	0	0	-	0	0	0	-	0	0
Postzygopophysis (LU2)	0	-	0	0	0	-	0	0	0	-	0	0
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0
Transverse process (LU3)	0	-	0	0	0	-	0	0	0	-	0	0
Centrum	0	-	0	0	0	-	0	0	0	-	0	0
Sacrum												
Medial crest (SC2)	0	-	0	0	0	-	0	0	1	-	1.0	66.7
Caudal	0	-	0	0	0	-	0	0	0	-	0	0
Scapula												
Glenoid cavity (SP1)	1	0	0.5	50	0	0	0	0	1	0	0.5	33.3
Corocoid process (SP1)	0	0	0	0	0	0	0	0	0	0	0	0
Acromion (SP2)	0	0	0	0	0	0	0	0	0	0	0	0
Acromion spine (SP2)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Neck (SP1)	1	0	0.5	50	0	0	0	0	1	0	0.5	33.3
Blade (SP4)	0	0	0	0	0	0	0	0	0	0	0	0
Superior border (SP3)	0	0	0	0	0	0	0	0	0	0	0	0
Inferior border (SP5)	0	0	0	0	0	0	0	0	0	0	0	0
Humerus												
Head (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Medial tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Proximal Shaft (HU2)	0	0	0	0	0	0	0	0	0	0	0	0
Deltoid tuberosity (HU2)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Teres major tuberosity (HU3)	0	0	0	0	0	0	0	0	0	0	0	0
Teres minor tuberosity (HU2)	0	0	0	0	0	0	0	0	0	0	0	0
Post lateral foramen (HU3)	0	0	0	0	2	0	1.0	66.7	0	1	0.5	33.3
Olecranon fossa (HU4)	0	0	0	0	0	0	0	0	0	0	0	0
Radial fossa (HU4)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral epicondyle (HU5)	0	0	0	0	0	1	0.5	33.3	0	0	0	0
Medial epicondyle (HU5)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (HU5)	0	0	0	0	0	1	0.5	33.3	0	0	0	0
Medial condyle (HU5)	0	1	0.5	50	0	1	0.5	33.3	0	0	0	0
Distal shaft	0	0	0	0	0	0	0	0	0	0	0	0
Radius												
Lateral glenoid cavity (RA1)	0	0	0	0	0	1	0.5	33.3	1	1	1.0	66.7
Medial glenoid cavity (RA1)	0	0	0	0	0	2	1.0	66.7	1	1	1.0	66.7
Radial tuberosity (RA2)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
Medial tuberosity (RA2)	0	0	0	0	0	2	1.0	66.7	1	1	1.0	66.7
Post lateral foramen (RA2)	0	0	0	0	0	0	0	0	0	1	0.5	33.3
Post shaft (RA3)	0	0	0	0	1	0	0.5	33.3	0	0	0	0
Ant shaft (RA3)	0	0	0	0	0	1	0.5	33.3	0	0	0	0
Radial carpal facet (RA5)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Internal carpal facet (RA5)	0	0	0	0	0	0	0	0	1	0	0.5	33.3

Ulna											
Olecranon process (UL1)	1	0	0.5	50	0	0	0	0	0	0	0	0
Anconeal process (UL2)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
Semilunar notch (UL2)	0	0	0	0	0	2	1.0	66.7	1	1	1.0	66.7
Radial process (UL2)	0	0	0	0	0	3	1.5	100	1	1	1.0	66.7
Shaft (RA3)	0	0	0	0	0	1	0.5	33.3	2	1	1.5	100
Styloid process (RA5)	0	0	0	0	0	0	0	0	2	0	1.0	66.7
Radial Carpal (Scaphoid)	0	0	0	0	0	0	0	0	1	2	1.5	100
Internal Carpal (Lunar)	0	1	0.5	50	0	0	0	0	0	2	1.0	66.7
Ulnar Carpal (Cuneif)	2	0	1.0	100	0	0	0	0	0	1	0.5	33.3
Unciform Carpal (Uncif)	1	0	0.5	50	0	0	0	0	0	0	0	0
Fused 2/3 Carpal (Trapmag)	0	0	0	0	0	0	0	0	0	0	0	0
Accessory Carpal	1	0	0.5	50	0	0	0	0	0	0	0	0
Metacarpal												
Carpal 2/3 facet (MC1)	0	0	0	0	0	0	0	0	0	2	1.0	66.7
Unciform carpal facet (MC1)	0	0	0	0	0	0	0	0	0	2	1.0	66.7
P ant foramen (MC2)	0	0	0	0	0	0	0	0	0	2	1.0	66.7
P post foramen (MC2)	0	0	0	0	0	0	0	0	0	2	1.0	66.7
Anterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0
Posterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0
D ant foramen (MC4)	1	0	0.5	50	0	0	0	0	0	0	0	0
D post foramen (MC4)	1	0	0.5	50	0	0	0	0	1	0	0.5	33.3
Medial condyle (MC6)	1	0	0.5	50	0	0	0	0	1	0	0.5	33.3
Lateral condyle (MC6)	1	0	0.5	50	0	0	0	0	1	0	0.5	33.3
5th Metacarpal (5MC)	0	0	0	0	0	0	0	0	0	1	0.5	33.3
Innominate												
Ilium blade (IL1)	0	0	0	0	0	0	0	0	0	0	0	0
Ilium shaft (Il2)	0	0	0	0	0	0	0	0	0	0	0	0
Ilio-ischial border (AC1)	0	0	0	0	0	0	0	0	0	0	0	0
Ischium shaft (IS1)	0	0	0	0	0	0	0	0	0	0	0	0
Ischium blade	0	0	0	0	0	0	0	0	0	0	0	0
Ischial tuber (IS2)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis shaft (PU1)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis Symphysis (PU2)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis acetabulum (AC1)	0	0	0	0	0	0	0	0	0	0	0	0
Ilium acetabulum (AC1)	1	0	0.5	50	0	0	0	0	0	0	0	0
Ischium acetabulum (AC1)	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Femur												
Head (FE1)	0	0	0	0	0	0	0	0	0	0	0	0
Greater trochanter (FE7)	0	0	0	0	0	0	0	0	0	0	0	0
Lesser trochanter (FE3)	0	0	0	0	0	0	0	0	0	0	0	0
Ant shaft (FE4)	0	0	0	0	0	0	0	0	0	0	0	0
Post medial foramen (FE5)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Linea aspera (FE4)	0	0	0	0	0	0	0	0	0	0	0	0
Supracondyloid fossa (FE5)	0	0	0	0	0	0	0	0	1	0	0.5	33.3
Trochlea (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Medial condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Medial epicondyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Patella	0	0	0	0	0	0	0	0	0	0	0	0

Tibia												
Medial condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0
Tibial tuberosity (TI1)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
Ant crest (TI2)	0	0	0	0	0	2	1.0	66.7	0	0	0	0
Post lateral foramen (TI2)	0	0	0	0	1	1	1.0	66.7	1	0	0.5	33.3
P post shaft (TI3)	0	0	0	0	0	0	0	0	0	0	0	0
D post shaft (TI4)	0	0	0	0	0	0	0	0	0	0	0	0
D ant shaft (TI4)	0	0	0	0	0	0	0	0	0	0	0	0
Medial groove (TI5)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral groove (TI5)	0	0	0	0	0	0	0	0	0	0	0	0
Medial malleolus (TI5)	0	0	0	0	1	0	0.5	33.3	0	0	0	0
Lateral Malleolus (Latmal)	0	0	0	0	0	0	0	0	0	0	0	0
Fused C/4 Tarsal (NC3)	1	0	0.5	50	0	1	0.5	33.3	1	1	1.0	66.7
Fused 2/3 Tarsal (2&3 CP)	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Calcaneous												
Epiphysis (CA1)	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Tuber calis (CA2)	2	0	1.0	100	0	1	0.50	33.3	0	0	0	0
Tarsal C/4 facet	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Fibular facet (CA4)	1	0	0.5	50	0	0	0	0	0	0	0	0
Sustentaculum (CA3)	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Astragalus												
P condyle (AS2)	1	0	0.5	50	0	2	1.0	66.7	0	1	0.5	33.3
D condyle (AS3)	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
1st Tarsal	1	0	0.5	50	0	1	0.5	33.3	0	0	0	0
Metatarsal												
Tarsal C/4 facet (MR1)	1	0	0.5	50	0	1	0.5	33.3	0	1	0.5	33.3
Tarsal 2/3 facet (MR1)	0	0	0	0	0	1	0.5	33.3	0	1	0.5	33.3
Tarsal 1 facet (MR1)	1	0	0.5	50	0	0	0	0	0	1	0.5	33.3
P ant foramen (MR2)	0	1	0.5	50	0	1	0.5	33.3	0	1	0.5	33.3
P post foramen (MR2)	0	0	0	0	0	1	0.5	33.3	0	1	0.5	33.3
Ant shaft (MR3)	0	0	0	0	0	0	0	0	0	1	0.5	33.3
Post shaft (MR3)	0	0	0	0	0	1	0.5	33.3	0	1	0.5	33.3
D ant foramen (MR4)	0	0	0	0	0	0	0	0	0	1	0.5	33.3
D post foramen (MR4)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
Medial condyle (MR6)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
Lateral condyle (MR6)	0	0	0	0	0	0	0	0	1	1	1.0	66.7
1st Phalanx												
P (P11)	1	-	0.13	13	2	-	0.25	16.7	4	-	0.5	33.3
D (P13)	1	-	0.13	13	1	-	0.13	8.7	4	-	0.5	33.3
2nd Phalanx												
P (P21)	0	-	0	0	5	-	0.63	42	5	-	0.63	42
D (P22)	0	-	0	0	5	-	0.63	42	5	-	0.63	42
3rd Phalanx												
P (P31)	1	-	0.13	13	4	-	0.5	33.3	4	-	0.5	33.3
D (P31)	0	-	0	0	1	-	0.13	8.7	0	-	0	0
Lateral Sesamoid	0	-	0	0	0	-	0	0	3	-	0.38	25.3
Medial Sesamoid	0	-	0	0	0	-	0	0	6	-	0.75	50
Distal Sesamoid	0	-	0	0	2	-	0.25	16.7	5	-	0.63	42

Table 2. Animal Units by Landmark for Blocks E, F, and G of the Jackson site (DiMe-17).

	Block E				Block F				Block G			
	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU
Cranium												
Frontal	0	0	0	0	0	0	0	0	0	0	0	0
Horn core	0	0	0	0	1	0	0.5	14.3	0	0	0	0
Parietal	0	0	0	0	0	0	0	0	0	0	0	0
Occipital	1	1	1.0	50	0	0	0	0	0	0	0	0
Occipital condyle	1	1	1.0	50	0	0	0	0	1	0	0.5	50
Squamous temporal	1	1	1.0	50	0	0	0	0	0	0	0	0
Petrous temporal	1	1	1.0	50	3	2	2.5	71.4	1	0	0.5	50
Zygomatic temporal	0	0	0	0	0	0	0	0	0	0	0	0
Auditory meatus	0	0	0	0	0	1	0.5	14.3	1	1	1.0	100
Zygomatic	0	0	0	0	0	0	0	0	0	0	0	0
Nasal	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Maxilla	1	0	0.5	25	0	0	0	0	0	0	0	0
Premaxilla	0	0	0	0	0	0	0	0	0	0	0	0
2nd premolar	1	0	0.5	25	3	2	2.5	71.4	0	0	0	0
3rd premolar	1	0	0.5	25	1	1	1.0	28.6	0	0	0	0
4th premolar	1	0	0.5	25	0	1	0.5	14.3	0	1	0.5	50
1st molar	1	0	0.5	25	2	2	2.0	57.1	1	0	0.5	50
2nd molar	1	1	1.0	50	1	0	0.5	14.3	1	0	0.5	50
3rd molar	0	0	0	0	1	2	1.5	42.9	1	0	0.5	50
Mandible												
Coronoid process (DN8)	0	0	0	0	1	4	2.5	71.4	1	0	0.5	50
Condylar process (DN7)	1	1	2.0	100	2	5	3.5	100	1	0	0.5	50
Ramus (DN6)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Mandibular foramen (DN7)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Mental foramen (DN2)	0	0	0	0	0	0	0	0	0	1	0.5	50
Diastema (DN1)	0	0	0	0	0	0	0	0	0	0	0	0
Symphysis	0	0	0	0	0	0	0	0	0	1	0.5	50
Incisor/Canine	0	0	0	0	6	2	1.0	28.6	0	0	0	0
2nd premolar (DN3)	1	0	0.5	25	0	1	0.5	14.3	0	1	0.5	50
3rd premolar (DN3)	2	0	1.0	50	0	1	0.5	14.3	0	0	0	0
4th premolar (DN4)	2	0	1.0	50	1	1	1.0	28.6	0	0	0	0
1st molar (DN4)	3	0	1.5	75	2	3	2.5	71.4	0	0	0	0
2nd molar (DN5)	4	0	2.0	100	1	4	2.5	71.4	1	0	0.5	50
3rd molar (DN5)	2	0	1.0	50	1	2	1.5	42.9	0	1	0.5	50
Hyoid (Hyoid)	0	0	0	0	1	2	2.5	71.4	0	0	0	0
Rib												
Head (RI1)	0	0	0	0	3	6	0.4	11.4	0	0	0	0
Tubercle (RI2)	0	0	0	0	0	4	0.2	5.7	0	0	0	0
Body (RI3)	1	1	0.08	4	2	4	0.2	5.7	0	0	0	0
Atlas												
Prezygopophysis (AT3)	0	-	0	0	2	-	1.0	28.6	0	-	0	0
Postzygopophysis (AT3)	0	-	0	0	2	-	1.0	28.6	0	-	0	0
Alar foramen (AT2)	0	-	0	0	0	-	0	0	0	-	0	0
Dorsal tubercle (AT1)	0	-	0	0	1	-	1.0	28.6	0	-	0	0
Centrum (AT1)	0	-	0	0	1	-	1.0	28.6	0	-	0	0
Axis												
Prezygopophysis	0	-	0	0	1	-	0.5	14.3	0	-	0	0
Postzygopophysis (AX3)	0	-	0	0	1	-	0.5	14.3	0	-	0	0
Spinous process (AX2)	0	-	0	0	1	-	1.0	28.6	0	-	0	0
Dens (AX1)	0	-	0	0	1	-	1.0	28.6	0	-	0	0
Centrum (AX2)	0	-	0	0	2	-	2.0	57.1	0	-	0	0

Cervical												
Prezygopophysis (CE2)	2	-	0.14	7	5	-	0.35	10	0	-	0	0
Postzygopophysis (CE1)	2	-	0.14	7	5	-	0.35	10	0	-	0	0
Neural arch	2	-	0.29	14.5	5	-	0.7	20	0	-	0	0
Neural spine	2	-	0.29	14.5	2	-	0.14	4	0	-	0	0
Transverse process	2	-	0.14	7	2	-	0.14	4	0	-	0	0
Centrum (CE2)	4	-	0.57	28.5	3	-	0.43	12.3	0	-	0	0
Thoracic												
Prezygopophysis	0	-	0	0	5	-	0.19	5.4	0	-	0	0
Postzygopophysis	0	-	0	0	7	-	0.27	7.7	0	-	0	0
Neural arch	0	-	0	0	3	-	0.23	6.6	0	-	0	0
Neural spine (TH2)	4	-	0.31	15.5	11	-	0.85	24.3	0	-	0	0
Transverse process	0	-	0	0	6	-	0.23	6.6	0	-	0	0
Centrum (TH1)	0	-	0	0	8	-	0.61	17.4	0	-	0	0
Lumbar												
Prezygopophysis (LU1)	0	-	0	0	1	-	0.08	2.3	0	-	0	0
Postzygopophysis (LU2)	0	-	0	0	0	-	0	0	0	-	0	0
Neural arch	0	-	0	0	1	-	0.17	4.9	0	-	0	0
Transverse process (LU3)	1	-	0.17	8.5	0	-	0	0	0	-	0	0
Centrum	0	-	0	0	1	-	0.17	4.9	0	-	0	0
Sacrum												
Medial crest (SC2)	0	-	0	0	0	-	0	0	0	-	0	0
Caudal	2	-	0.1	5	0	-	0	0	0	-	0	0
Scapula												
Glenoid cavity (SP1)	1	0	0.5	25	2	1	1.5	42.9	0	0	0	0
Corocoid process (SP1)	0	0	0	0	2	0	1.0	28.6	0	0	0	0
Acromion (SP2)	0	0	0	0	0	0	0	0	0	0	0	0
Acromion spine (SP2)	0	0	0	0	0	0	0	0	0	0	0	0
Neck (SP1)	0	0	0	0	2	0	1.0	28.6	0	0	0	0
Blade (SP4)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Superior border (SP3)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Inferior border (SP5)	0	0	0	0	0	0	0	0	0	0	0	0
Humerus												
Head (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Medial tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0
Proximal Shaft (HU2)	0	0	0	0	0	0	0	0	0	0	0	0
Deltoid tuberosity (HU2)	2	0	1.0	50	0	0	0	0	0	0	0	0
Teres major tuberosity (HU3)	0	0	0	0	0	0	0	0	0	0	0	0
Teres minor tuberosity (HU2)	0	0	0	0	0	0	0	0	0	0	0	0
Post lateral foramen (HU3)	1	0	0.5	25	0	0	0	0	0	0	0	0
Olecranon fossa (HU4)	0	0	0	0	0	2	1.0	28.6	0	0	0	0
Radial fossa (HU4)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Lateral epicondyle (HU5)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Medial epicondyle (HU5)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Lateral condyle (HU5)	1	0	0.5	25	0	2	1.0	28.6	0	0	0	0
Medial condyle (HU5)	1	0	0.5	25	0	2	1.0	28.6	0	0	0	0
Distal shaft	0	0	0	0	0	0	0	0	0	0	0	0
Radius												
Lateral glenoid cavity (RA1)	2	0	1.0	50	1	0	0.5	14.3	0	0	0	0
Medial glenoid cavity (RA1)	1	0	0.5	25	2	0	1.0	28.6	0	0	0	0
Radial tuberosity (RA2)	2	1	1.5	75	1	0	0.5	14.3	0	0	0	0
Medial tuberosity (RA2)	1	0	0.5	25	1	0	0.5	14.3	0	0	0	0
Post lateral foramen (RA2)	1	0	0.5	25	0	0	0	0	0	0	0	0
Post shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0
P ant shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0
Radial carpal facet (RA5)	0	0	0	0	0	0	0	0	0	0	0	0
Internal carpal facet (RA5)	0	0	0	0	1	0	0.5	14.3	0	0	0	0

Ulna

Olecranon process (UL1)	1	0	0.5	25	0	1	0.5	14.3	0	0	0	0
Anconeal process (UL2)	1	0	0.5	25	0	0	0	0	0	0	0	0
Semilunar notch (UL2)	1	0	0.5	25	0	0	0	0	0	0	0	0
Radial process (UL2)	1	0	0.5	25	0	0	0	0	0	0	0	0
Shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0
Styloid process (RA5)	0	0	0	0	0	0	0	0	0	0	0	0
Radial Carpal (Scaphoid)	0	1	0.5	25	1	1	1.0	28.6	0	0	0	0
Internal Carpal (Lunar)	1	1	1.0	50	3	1	2.0	57.1	1	0	0.5	50
Ulnar Carpal (Cuneif)	1	0	0.5	25	1	3	2.0	57.1	0	0	0	0
Unciform Carpal (Uncif)	2	2	2.0	100	1	0	0.5	14.3	0	0	0	0
Fused 2/3 Carpal (Trapmag)	1	1	1.0	50	1	0	0.5	14.3	0	0	0	0
Accessory Carpal	2	0	1.0	50	0	0	0	0	0	0	0	0

Metacarpal

Carpal 2/3 facet (MC1)	1	1	1.0	50	0	0	0	0	0	0	0	0
Unciform carpal facet (MC1)	2	0	1.0	50	0	0	0	0	0	0	0	0
P ant foramen (MC2)	1	0	0.5	25	0	0	0	0	0	0	0	0
P post foramen (MC2)	0	0	0	0	0	0	0	0	0	0	0	0
Anterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0
Posterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0
D ant foramen (MC4)	2	1	1.5	75	0	0	0	0	0	0	0	0
D post foramen (MC4)	2	1	1.5	75	0	0	0	0	0	0	0	0
Medial condyle (MC6)	2	2	2.0	100	0	0	0	0	0	0	0	0
Lateral condyle (MC6)	2	2	2.0	100	0	0	0	0	0	0	0	0
5ᵗʰ Metacarpal (5MC)	1	0	0.5	25	0	0	0	0	0	0	0	0

Innominate

Ilium blade (IL1)	0	0	0	0	0	0	0	0	0	0	0	0
Ilium shaft (IL2)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Ilio-ischial border (AC1)	0	0	0	0	0	0	0	0	0	0	0	0
Ischium shaft (IS1)	0	0	0	0	0	0	0	0	0	0	0	0
Ischium blade	0	0	0	0	0	0	0	0	0	0	0	0
Ischial tuber (IS2)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis shaft (PU1)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis Symphysis (PU2)	0	0	0	0	0	0	0	0	0	0	0	0
Pubis acetabulum (AC1)	0	1	0.5	25	0	1	0.5	14.3	0	0	0	0
Ilium acetabulum (AC1)	0	0	0	0	1	0	0.5	14.3	0	0	0	0
Ischium acetabulum (AC1)	0	1	0.5	25	1	1	1.0	28.6	0	0	0	0

Femur

Head (FE1)	0	0	0	0	1	1	1.0	28.6	0	0	0	0
Greater trochanter (FE7)	0	0	0	0	0	0	0	0	0	0	0	0
Lesser trochanter (FE3)	0	0	0	0	0	0	0	0	0	0	0	0
Ant shaft (FE4)	0	1	0.5	25	0	0	0	0	1	0	0.5	50
Post medial foramen (FE5)	0	0	0	0	0	0	0	0	0	0	0	0
Linea aspera (FE4)	0	0	0	0	0	0	0	0	0	0	0	0
Supracondyloid fossa (FE5)	0	0	0	0	0	0	0	0	0	0	0	0
Trochlea (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Medial condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Medial epicondyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0
Patella	1	0	0.5	25	0	0	0	0	1	0	0.5	50

Tibia												
Medial condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0
Tibial tuberosity (TI1)	0	0	0	0	0	0	0	0	0	0	0	0
Ant crest (TI2)	0	0	0	0	0	0	0	0	0	0	0	0
Post lateral foramen (TI2)	0	1	0.5	25	0	0	0	0	0	0	0	0
P post shaft (TI3)	0	1	0.5	25	0	0	0	0	0	0	0	0
D post shaft (TI4)	0	0	0	0	0	0	0	0	0	0	0	0
D ant shaft (TI4)	0	1	0.5	25	0	0	0	0	0	0	0	0
Medial groove (TI5)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
Lateral groove (TI5)	0	0	0	0	0	1	0.5	14.3	0	0	0	0
Medial malleolus	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Malleolus (Latmal)	2	0	1.0	50	1	2	1.5	42.9	1	0	0.5	50
Fused C/4 Tarsal (NC3)	0	0	0	0	2	3	2.5	71.4	0	0	0	0
Fused 2/3 Tarsal (2&3 CP)	0	2	1.0	50	1	2	1.5	42.9	1	0	0.5	50
Calcaneous												
Epiphysis (CA1)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
Tuber calis (CA2)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
Tarsal C/4 facet	1	1	1.0	50	0	1	0.5	14.3	1	0	0.5	50
Fibular facet (CA4)	2	1	1.5	75	0	1	0.5	14.3	1	0	0.5	50
Sustentaculum (CA3)	1	1	1.0	50	0	1	0.5	14.3	1	0	0.5	50
Astragalus												
P condyle (AS2)	2	1	1.5	75	2	1	1.5	42.9	1	0	0.5	50
D condyle (AS3)	1	1	1.0	50	2	1	1.5	42.9	1	0	0.5	50
1st Tarsal	2	1	1.5	75	0	2	1.0	28.6	0	0	0	0
Metatarsal												
Tarsal C/4 facet (MR1)	0	1	0.5	25	0	2	1.0	28.6	1	0	0.5	50
Tarsal 2/3 facet (MR1)	0	1	0.5	25	1	3	2.0	57.1	2	0	1.0	100
Tarsal 1 facet (MR1)	1	0	0.5	25	0	2	1.0	28.6	1	0	0.5	50
P ant foramen (MR2)	0	1	0.5	25	1	4	2.5	71.4	1	0	0.5	50
P post foramen (MR2)	1	0	0.5	25	0	2	1.0	28.6	1	0	0.5	50
Ant shaft (MR3)	0	0	0	0	0	2	1.0	28.6	1	0	0.5	50
Post shaft (MR3)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
D ant foramen (MR4)	0	0	0	0	0	2	1.0	28.6	1	0	0.5	50
D post foramen (MR4)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
Medial condyle (MR6)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
Lateral condyle (MR6)	0	0	0	0	0	1	0.5	14.3	1	0	0.5	50
1st Phalanx												
P (P11)	7	-	0.88	44	9	-	1.13	32.3	1	-	0.13	13
D (P13)	4	-	0.5	25	7	-	0.88	25.1	1	-	0.13	13
2nd Phalanx												
P (P21)	3	-	0.38	19	3	-	0.38	10.9	3	-	0.38	38
D (P22)	1	-	0.13	6.5	3	-	0.38	10.9	3	-	0.38	38
3rd Phalanx												
P (P31)	2	-	0.25	12.5	9	-	1.13	32.3	1	-	0.13	13
D (P31)	0	-	0	0	8	-	1.0	28.6	1	-	0.13	13
Lateral Sesamoid	7	-	0.88	44	4	-	0.5	14.3	0	-	0	0
Medial Sesamoid	7	-	0.88	44	7	-	0.88	25.1	1	-	0.13	13
Distal Sesamoid	2	-	0.25	12.5	3	-	0.38	10.9	2	-	0.25	25

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Table 3. Animal Units by Landmark for Blocks H, I, J, and the entire Jackson site (DiMe-17).

	Block H				Block I				Block J				Site			
	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU	L	R	Total MAU	% MAU
Cranium																
Frontal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Horn core	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Parietal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Occipital	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Occipital condyle	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1.5	25
Squamous temporal	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Petrous temporal	0	0	0	0	0	0	0	0	0	0	0	0	5	3	4.0	66.7
Zygomatic temporal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auditory meatus	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2.5	41.7
Zygomatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nasal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Maxilla	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Premaxilla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2nd premolar	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
3rd premolar	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
4th premolar	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1.5	25
1st molar	0	0	0	0	0	0	0	0	0	0	0	0	5	2	3.5	58.3
2nd molar	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2.5	41.7
3rd molar	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Mandible																
Coronoid process (DN8)	1	0	0.5	100	1	0	0.5	100	0	0	0	0	4	4	4.0	66.7
Condylar process (DN7)	0	0	0	0	0	0	0	0	0	0	0	0	5	6	5.5	91.7
Ramus (DN6)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Mandibular foramen (DN7)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Mental foramen (DN2)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Diastema (DN2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphysis (DN1)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Incisor/Canine	0	0	0	0	1	0	0.5	100	0	0	0	0	11	5	2.0	33.3
2nd premolar (DN3)	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2.5	41.7
3rd premolar (DN3)	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2.0	33.3
4th premolar (DN4)	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2.5	41.7
1st molar (DN4)	0	0	0	0	0	0	0	0	0	0	0	0	7	3	5.0	83.3
2nd molar (DN5)	0	0	0	0	0	0	0	0	0	0	0	0	8	4	6.0	100
3rd molar (DN5)	0	0	0	0	0	0	0	0	0	0	0	0	6	3	4.5	75
Hyoid (Hyoid)	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2.5	41.7
Rib																
Head (RI1)	0	0	0	0	0	0	0	0	0	0	0	0	5	8	0.5	8.3
Tubercle (RI2)	0	0	0	0	0	1	0.04	8	0	0	0	0	0	6	0.2	3.3
Body (RI3)	1	0	0.04	8	0	0	0	0	1	0	0.04	8	14	13	0.5	8.3
Atlas																
Prezygopophysis (AT3)	0	-	0	0	0	-	0	0	0	-	0	0	2	-	1.0	16.7
Postzygopophysis (AT3)	0	-	0	0	0	-	0	0	0	-	0	0	2	-	1.0	16.7
Alar foramen (AT2)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	0.5	8.3
Dorsal tubercle (AT1)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	1.0	16.7
Centrum (AT1)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	1.0	16.7
Axis																
Prezygopophysis	0	-	0	0	0	-	0	0	0	-	0	0	1	-	0.5	8.3
Postzygopophysis (AX3)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	0.5	8.3
Spinous process (AX2)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	1.0	16.7
Dens (AX1)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	1.0	16.7
Centrum (AX2)	0	-	0	0	0	-	0	0	0	-	0	0	3	-	3.0	50

Cervical																
Prezygopophysis (CE2)	0	-	0	0	0	-	0	0	0	-	0	0	7	-	0.5	8.3
Postzygopophysis (CE1)	0	-	0	0	0	-	0	0	0	-	0	0	7	-	0.5	8.3
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0	7	-	1.0	16.7
Neural spine	0	-	0	0	0	-	0	0	0	-	0	0	4	-	0.6	10
Transverse process	0	-	0	0	0	-	0	0	0	-	0	0	4	-	0.3	5
Centrum (CE2)	0	-	0	0	0	-	0	0	0	-	0	0	10	-	1.4	23.3
Thoracic																
Prezygopophysis	0	-	0	0	0	-	0	0	0	-	0	0	5	-	0.2	3.3
Postzygopophysis	0	-	0	0	0	-	0	0	0	-	0	0	8	-	0.3	5
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0	3	-	0.2	3.3
Neural spine (TH2)	0	-	0	0	0	-	0	0	0	-	0	0	25	-	1.9	31.7
Transverse process	0	-	0	0	0	-	0	0	0	-	0	0	7	-	0.3	5
Centrum (TH1)	0	-	0	0	0	-	0	0	0	-	0	0	10	-	0.8	13.3
Lumbar																
Prezygopophysis (LU1)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	0.08	1.3
Postzygopophysis (LU2)	0	-	0	0	0	-	0	0	0	-	0	0	0	-	0	0
Neural arch	0	-	0	0	0	-	0	0	0	-	0	0	1	-	0.2	3.3
Transverse process (LU3)	0	-	0	0	0	-	0	0	0	-	0	0	2	-	0.2	3.3
Centrum	0	-	0	0	0	-	0	0	0	-	0	0	3	-	0.5	8.3
Sacrum																
Medial crest (SC2)	0	-	0	0	0	-	0	0	0	-	0	0	1	-	1.0	16.7
Caudal	0	-	0	0	0	-	0	0	0	-	0	0	2	-	0.1	1.7
Scapula																
Glenoid cavity (SP1)	0	0	0	0	0	0	0	0	0	0	0	0	5	1	3.0	50
Corocoid process (SP1)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1.0	16.7
Acromion (SP2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acromion spine (SP2)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Neck (SP1)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2.0	33.3
Blade (SP4)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Superior border (SP3)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Inferior border (SP5)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humerus																
Head (HU1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medial tuberosity (HU1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proximal Shaft (HU2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deltoid tuberosity (HU2)	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1.5	25
Teres major tuberosity (HU3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teres minor tuberosity (HU2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Post lateral foramen (HU3)	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2.0	33.3
Olecranon fossa (HU4)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	16.7
Radial fossa (HU4)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Lateral epicondyle (HU5)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	16.7
Medial epicondyle (HU5)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Lateral condyle (HU5)	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2.0	33.3
Medial condyle (HU5)	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2.5	41.7
Distal shaft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radius																
Lateral glenoid cavity (RA1)	0	0	0	0	0	0	0	0	0	1	0.5	100	4	3	3.5	58.3
Medial glenoid cavity (RA1)	0	0	0	0	0	0	0	0	0	1	0.5	100	4	4	4.0	66.7
Radial tuberosity (RA2)	0	0	0	0	0	0	0	0	0	1	0.5	100	4	3	3.5	58.3
Medial tuberosity (RA2)	0	0	0	0	0	0	0	0	0	1	0.5	100	3	4	3.5	58.3
Post lateral foramen (RA2)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Post shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Ant shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Radial carpal facet (RA5)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Internal carpal facet (RA5)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3

Ulna															
Olecranon process (UL1)	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1.5	25
Anconeal process (UL2)	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1.5	25
Semilunar notch (UL2)	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2.5	41.7
Radial process (UL2)	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3.0	50
Shaft (RA3)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Styloid process (RA5)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1.0	16.7
Radial Carpal (Scaphoid)	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3.0	50
Internal Carpal (Lunar)	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5.0	83.3
Ulnar Carpal (Cuneif)	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4.0	66.7
Unciform Carpal (Uncif)	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
Fused 2/3 Carpal (Trapmag)	0	1	0.5	100	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Accessory Carpal	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1.5	25
Metacarpal																
Carpal 2/3 facet (MC1)	0	0	0	0	0	0	0	0	1	0	0.5	100	2	3	2.5	41.7
Unciform carpal facet (MC1)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
P ant foramen (MC2)	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1.5	25
P post foramen (MC2)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	16.7
Anterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Posterior shaft (MC3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D ant foramen (MC4)	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2.0	33.3
D post foramen (MC4)	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2.5	41.7
Medial condyle (MC6)	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
Lateral condyle (MC6)	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
5th Metacarpal (5MC)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Innominate																
Ilium blade (IL1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilium shaft (Il2)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Ilio-ischial border (AC1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ischium shaft (IS1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ischium blade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ischial tuber (IS2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pubis shaft (PU1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pubis Symphysis (PU2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pubis acetabulum (AC1)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	16.7
Ilium acetabulum (AC1)	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1.5	25
Ischium acetabulum (AC1)	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2.5	41.7
Femur																
Head (FE1)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Greater trochanter (FE7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser trochanter (FE3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ant shaft (FE4)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Post medial foramen (FE5)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Linea aspera (FE4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supracondyloid fossa (FE5)	0	0	0	0	0	0	0	0	1	0	0.5	100	2	0	1.0	16.7
Trochlea (FE6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medial condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medial epicondyle (FE6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patella	0	0	0	0	0	0	0	0	0	1	0.5	100	2	1	1.5	25

Tibia																
Medial condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral condyle (TI1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tibial tuberosity (TI1)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.0	16.7
Ant crest (TI2)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.0	16.7
Post lateral foramen (TI2)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
P post shaft (TI3)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
D post shaft (TI4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D ant shaft (TI4)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Medial groove (TI5)	0	0	0	0	1	0	0.5	100	0	0	0	0	2	1	1.5	25
Lateral groove (TI5)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	8.3
Medial malleolus (TI5)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.5	8.3
Lateral Malleolus (Latmal)	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
Fused C/4 Tarsal (NC3)	0	0	0	0	0	1	0.5	100	0	0	0	0	4	6	5.0	83.3
Fused 2/3 Tarsal (2&3 CP)	0	0	0	0	0	0	0	0	0	0	0	0	3	5	4.0	66.7
Calcaneous																
Epiphysis (CA1)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Tuber calis (CA2)	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2.5	41.7
Tarsal C/4 facet	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3.0	50
Fibular facet (CA4)	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3.0	50
Sustentaculum (CA3)	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3.0	50
Astragalus																
P condyle (AS2)	0	0	0	0	0	0	0	0	0	0	0	0	6	5	5.5	91.7
D condyle (AS3)	0	0	0	0	0	0	0	0	0	0	0	0	5	3	4.0	66.7
1st Tarsal	0	0	0	0	0	0	0	0	0	0	0	0	3	4	3.5	58.3
Metatarsal																
Tarsal C/4 facet (MR1)	0	0	0	0	0	0	0	0	0	0	0	0	2	5	3.5	58.3
Tarsal 2/3 facet (MR1)	0	0	0	0	0	0	0	0	0	0	0	0	3	6	4.5	75
Tarsal 1 facet (MR1)	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3.0	50
P ant foramen (MR2)	0	0	0	0	0	0	0	0	0	0	0	0	2	8	5.0	83.3
P post foramen (MR2)	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3.0	50
Ant shaft (MR3)	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2.0	33.3
Post shaft (MR3)	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2.0	33.3
D ant foramen (MR4)	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2.0	33.3
D post foramen (MR4)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Medial condyle (MR6)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
Lateral condyle (MR6)	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2.0	33.3
1st Phalanx																
P (P11)	0	-	0	0	0	-	0	0	0	-	0	0	24	-	3.0	50
D (P13)	0	-	0	0	0	-	0	0	0	-	0	0	18	-	2.3	38.3
2nd Phalanx																
P (P21)	0	-	0	0	0	-	0	0	1	-	0.13	26	20	-	2.5	41.7
D (P22)	0	-	0	0	0	-	0	0	1	-	0.13	26	18	-	2.3	38.3
3rd Phalanx																
P (P31)	0	-	0	0	1	-	0.13	26	1	-	0.13	26	23	-	2.9	48.3
D (P31)	0	-	0	0	1	-	0.13	26	1	-	0.13	26	12	-	1.5	25
Lateral Sesamoid	0	-	0	0	1	-	0.13	26	0	-	0	0	15	-	1.9	31.7
Medial Sesamoid	2	-	0.25	50	1	-	0.13	26	0	-	0	0	24	-	3.0	50
Distal Sesamoid	0	-	0	0	1	-	0.13	26	0	-	0	0	15	-	1.9	31.7

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Appendix III
Faunal Distribution Maps
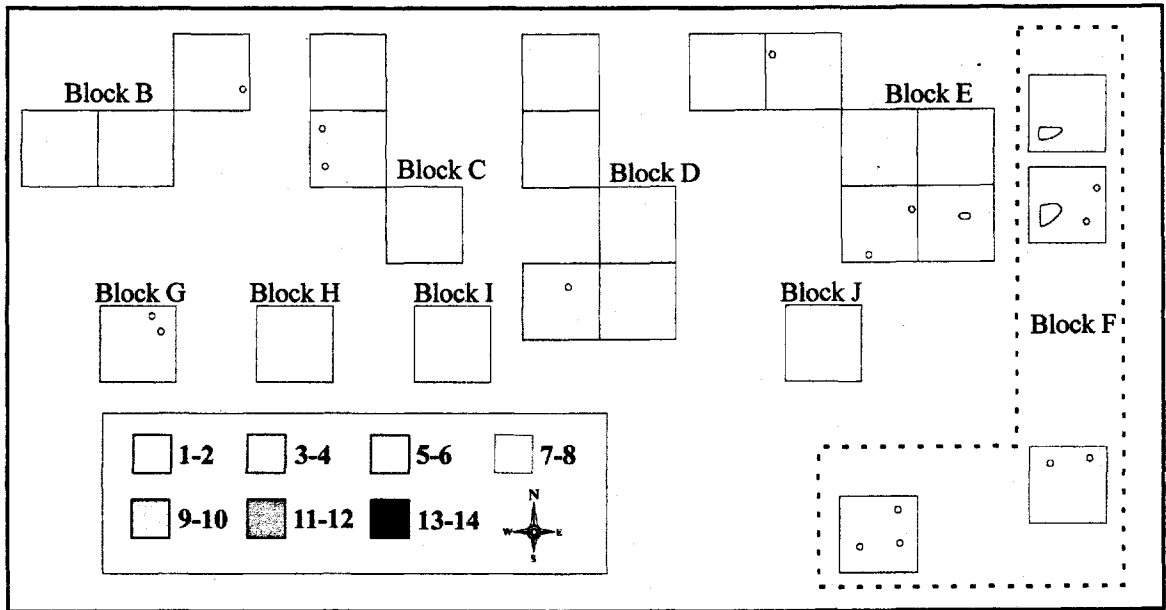
Figure 1. Distribution of bison cranial elements.
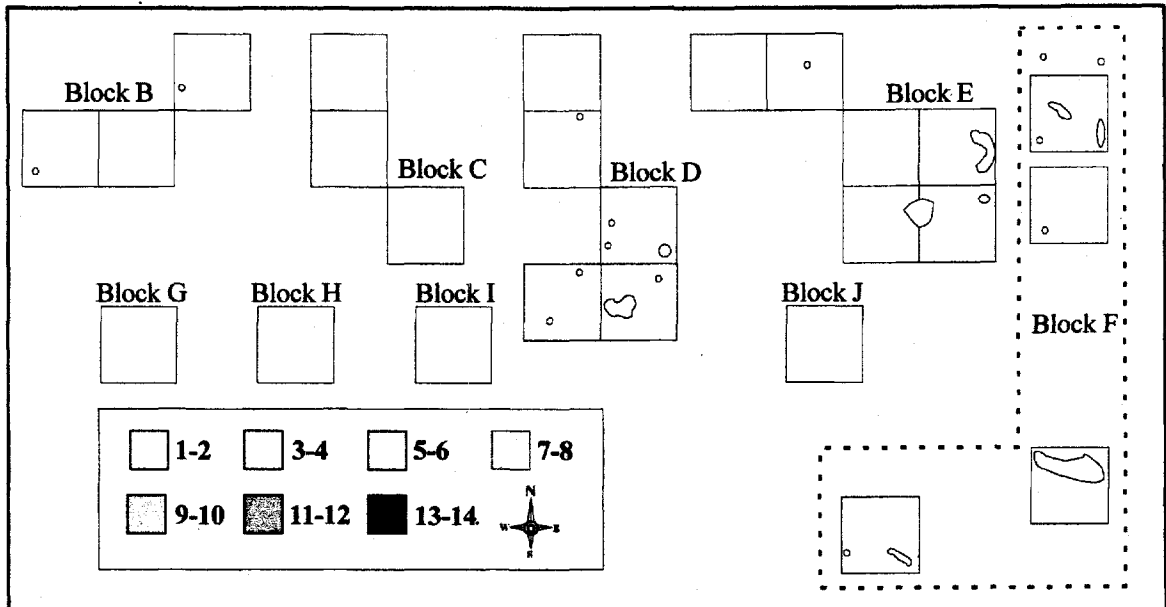
Figure 2. Distribution of bison vertebral elements.
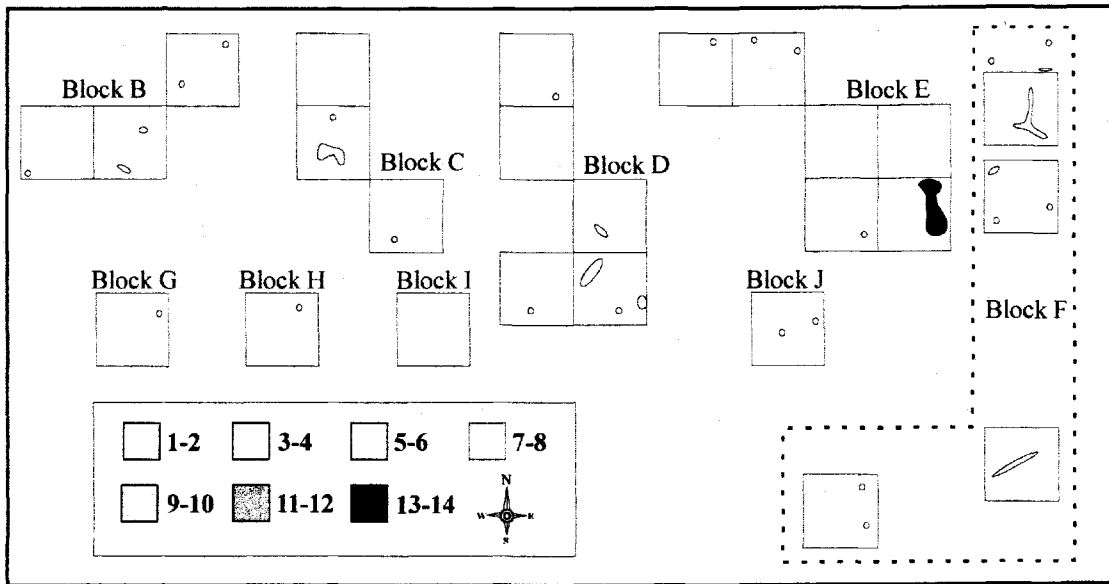
Figure 3. Distribution of bison forelimb elements.
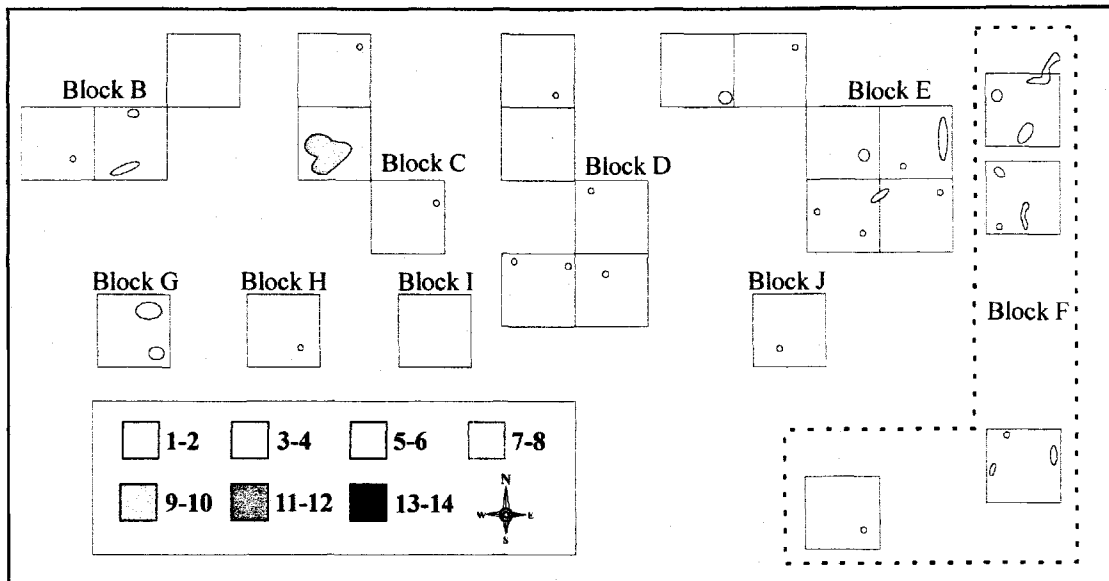
Figure 4. Distribution of bison hindlimb elements.

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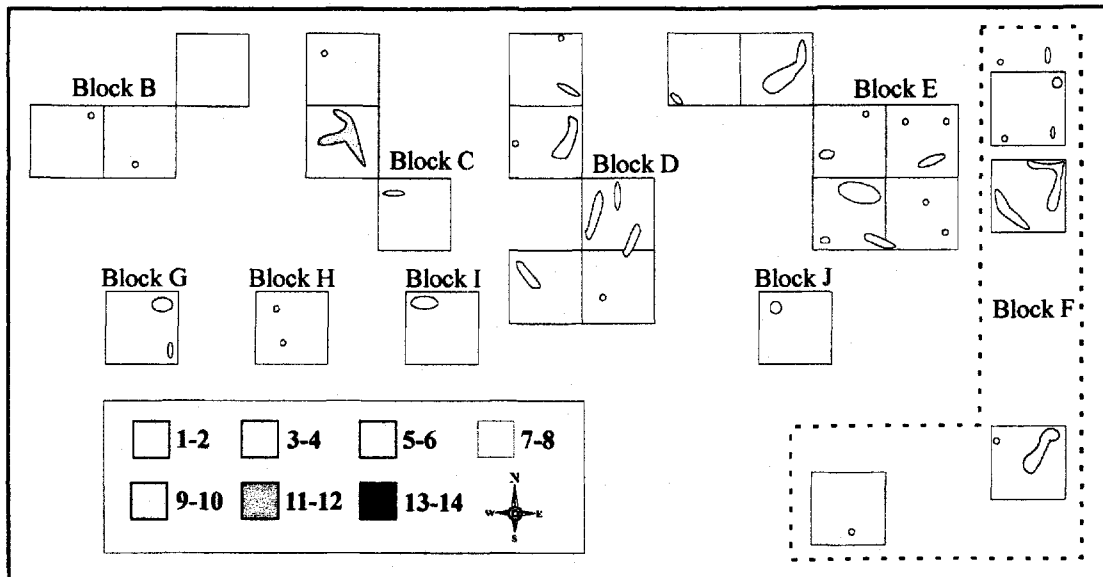
Figure 5. Distribution of bison phalanges and sesamoids.
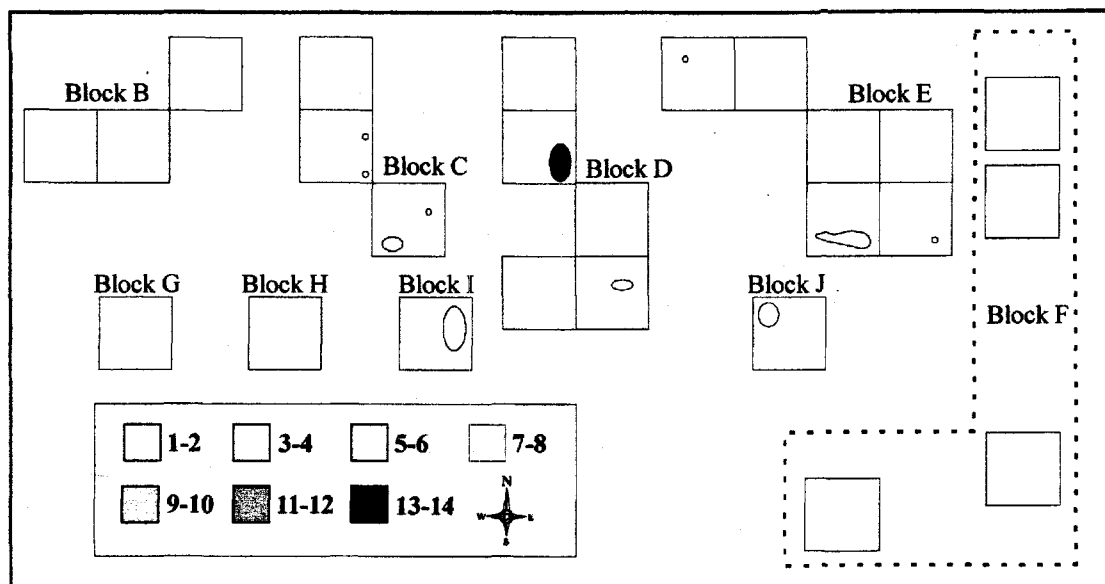
Figure 6. Distribution of canid remains.
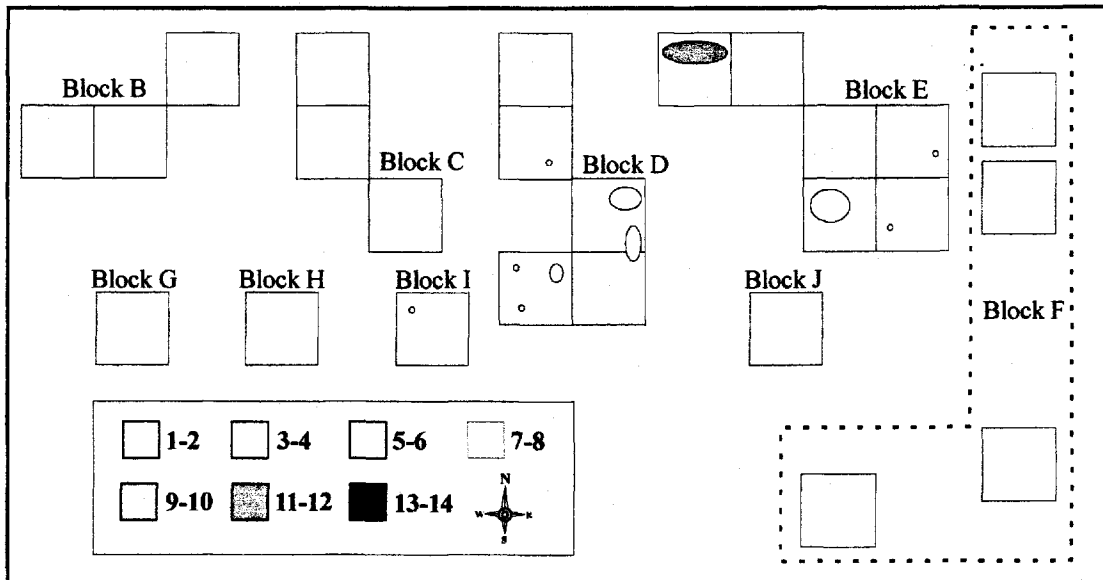
Figure 7. Distribution of rodent remains.
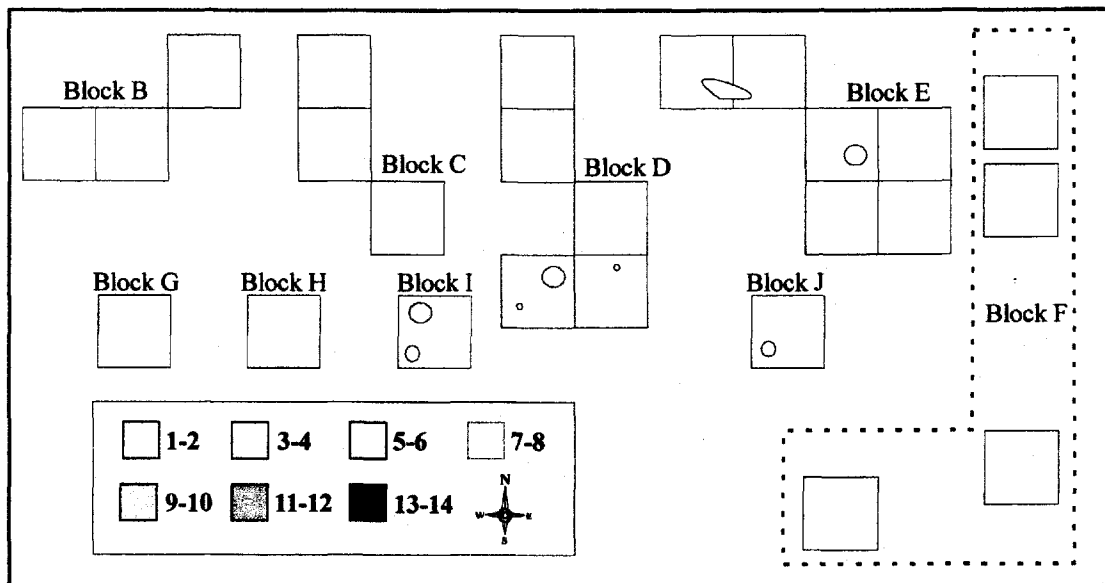
Figure 8. Distribution of amphibian and reptile remains.

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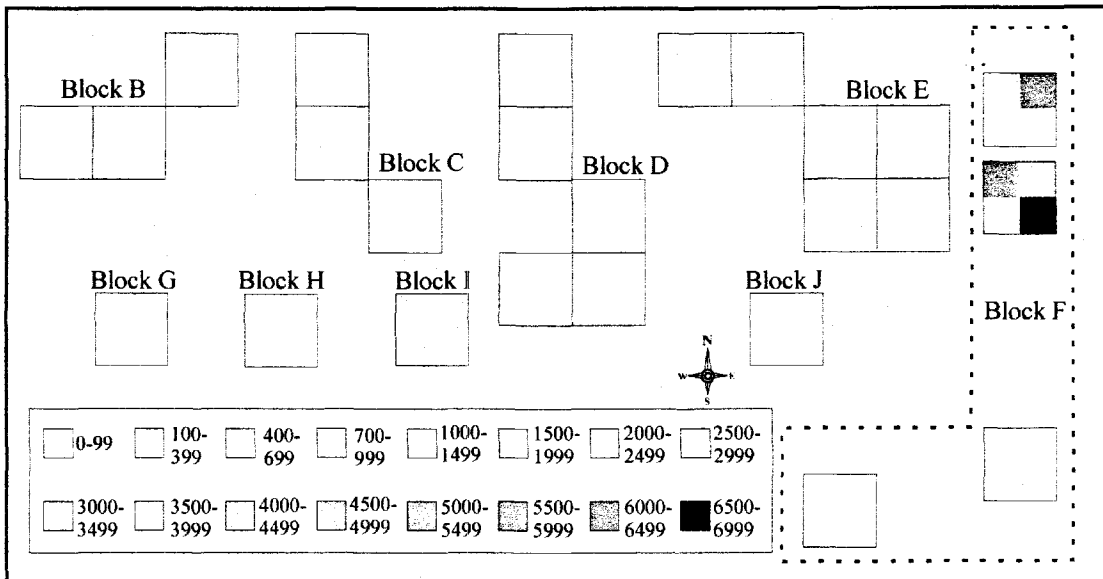
Figure 9. Distribution of burned unidentified faunal remains.
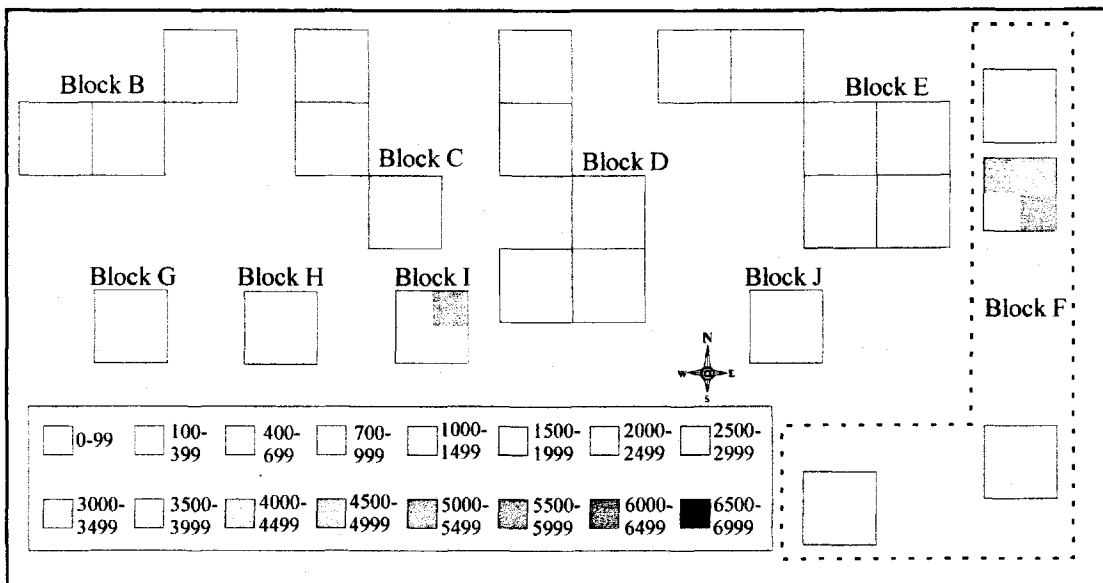
Figure 10. Distribution of unburned unidentified faunal remains.

Figure 11. Distribution of bison foetal remains.

Appendix IV
Bison Economic Utility Indices

Element	% MAU	% MAU Rank	(S) MAVGTP	(S) MAVGTP Rank
Cranium	33.33	6.5	14.2	14
Rib	24.36	11	100	1
Atlas	16.67	4.5	6.4	20
Axis	16.67	14.5	7.8	17
Cervical vertebrae	16.67	14.5	56.6	6
Thoracic vertebrae	17.95	12	84.7	2
Lumbar vertebrae	2.78	18	82.9	3
Caudal vertebrae	1.67	19	1.5	24
Scapula	25.00	9	31.6	9.5
P Humerus	0.00	22	31.6	9.5
D Humerus	25.00	9	25.1	12
P Radius	50.00	1.5	16.5	13
D Radius	8.33	17	12.1	16
Internal carpal	41.67	4	6.6	19
P Metacarpal	41.67	4	3.9	22
D Metacarpal	50.00	1.5	2.6	23
Innominate	25.00	9	54.7	7
P Femur	0.00	22	69.4	4.5
D Femur	0.00	22	69.4	4.5
P Tibia	0.00	22	40.8	8
D Tibia	0.00	22	25.5	11
C+4 tarsal	33.33	6.5	13.6	15
P Metatarsal	41.67	4	7.5	18
D Metatarsal	16.67	14.5	4.5	21

Table 1. Processing area % MAU and associated (S)MAVGTP values.

Element	%MAU	%MAU Rank	BUI Values	BUI Rank
P Humerus	0.00	15.5	241.48	1
Humerus shaft	33.33	5	110.8	6
D Humerus	25	6.5	64.12	9
P Radius	50.00	1.5	42.71	11
Radius Shaft	25	6.5	82.71	8
D Radius	8.33	11	49.73	10
P Metacarpal	41.67	3.5	6.76	18
Metacarpal Shaft	0.00	15.5	19.07	14
D Metacarpal	50.00	1.5	14.58	15
P Femur	0.00	15.5	112.41	5
Femur Shaft	8.33	11	142.43	3
D Femur	0.00	15.5	186.3	2
P Tibia	0.00	15.5	96.82	7
Tibia Shaft	8.33	11	122.11	4
D Tibia	0.00	15.5	12.22	16
P Metatarsal	41.67	3.5	7.44	17
Metatarsal Shaft	16.67	8.5	34.92	12
D Metatarsal	16.67	8.5	20.07	13

Table 2. Processing area % MAU and associated BUI values.

Element	% MAU	% MAU Rank	(S) MAVGTP	(S) MAVGTP Rank
Cranium	100.00	1	14.2	14
Rib	13.85	14	100	1
Atlas	40.00	4.5	6.4	20
Axis	40.00	4.5	7.8	17
Cervical vertebrae	14.29	13	56.6	6
Thoracic vertebrae	16.92	12	84.7	2
Lumbar vertebrae	3.33	18	82.9	3
Caudal vertebrae	0.00	21.5	1.5	24
Scapula	30.00	7	31.6	9.5
P Humerus	0.00	21.5	31.6	9.5
D Humerus	20.00	9.5	25.1	12
P Radius	20.00	9.5	16.5	13
D Radius	10.00	16	12.1	16
Internal carpal	40.00	4.5	6.6	19
P Metacarpal	0.00	21.5	3.9	22
D Metacarpal	0.00	21.5	2.6	23
Innominate	20.00	9.5	54.7	7
P Femur	20.00	9.5	69.4	4.5
D Femur	0.00	21.5	69.4	4.5
P Tibia	0.00	21.5	40.8	8
D Tibia	10.00	16	25.5	11
C+4 tarsal	50.00	2	13.6	15
P Metatarsal	40.00	4.5	7.5	18
D Metatarsal	10.00	16	4.5	21

Table 3. Bison kill area % MAU and associated (S)MAVGTP values.

Element	%MAU	%MAU Rank	BUI Values	BUI Rank
P Humerus	0	13.5	241.48	1
Humerus shaft	0	13.5	110.8	6
D Humerus	20	3.5	64.12	9
P Radius	20	3.5	42.71	11
Radius Shaft	0	13.5	82.71	8
D Radius	10	7	49.73	10
P Metacarpal	0	13.5	6.76	18
Metacarpal Shaft	0	13.5	19.07	14
D Metacarpal	0	13.5	14.58	15
P Femur	20	3.5	112.41	5
Femur Shaft	0	13.5	142.43	3
D Femur	0	13.5	186.3	2
P Tibia	0	13.5	96.82	7
Tibia Shaft	0	13.5	122.11	4
D Tibia	10	7	12.22	16
P Metatarsal	40	1	7.44	17
Metatarsal Shaft	20	3.5	34.92	12
D Metatarsal	10	7	20.07	13

Table 4. Bison kill area % MAU and associated BUI values.

Element	% MAU	% MAU rank	(S)MAVGGRE	(S)MAVGGRE Rank
Scapula	25.00	8.00	43.6	11
P Humerus	0.00	14.00	71.8	4
D Humerus	25.00	8.00	58.5	6
P Radius	50.00	1.50	51.9	8
D Radius	8.33	11.00	48.5	10
Internal carpal	41.67	4.00	38.2	13
P Metacarpal	41.67	4.00	33	15
D Metacarpal	50.00	1.50	30.4	16
Innominate	25.00	8.00	97.6	3
P Femur	0.00	14.00	100	1.5
D Femur	0.00	14.00	100	1.5
P Tibia	0.00	14.00	71.7	5
D Tibia	0.00	14.00	56.9	7
C+4 tarsal	33.33	6.00	49.6	9
P Metatarsal	41.67	4.00	38.9	12
D Metatarsal	16.67	10.00	33.5	14

Table 5. Processing area % MAU and associated (S)MAVGGRE values.

Element	%MAU	%MAU Rank	GI value	GI rank
P Humerus	0	10	241.48	1
D Humerus	25.00	5	64.12	5
P Radius	50.00	1.5	42.71	7
D Radius	8.33	7	49.73	6
P Metacarpal	41.67	3.5	6.76	12
D Metacarpal	50.00	1.5	14.58	9
P Femur	0	10	112.41	3
D Femur	0	10	186.3	2
P Tibia	0	10	96.82	4
D Tibia	0	10	12.22	10
P Metatarsal	41.67	3.5	7.44	11
D Metatarsal	16.67	6	20.07	8

Table 6. Processing area % MAU and associated GI values.

Element	% MAU	% MAU rank	(S)MAVGGRE	(S)MAVGGRE
Scapula	30	4	43.6	11
P Humerus	0	14	71.8	4
D Humerus	20	6.5	58.5	6
P Radius	20	6.5	51.9	8
D Radius	10	10	48.5	10
Internal CP	40	2.5	38.2	13
P Metacarpal	0	14	33	15
D Metacarpal	0	14	30.4	16
Innominate	20	6.5	97.6	3
P Femur	20	6.5	100	1.5
D Femur	0	14	100	1.5
P Tibia	0	14	71.7	5
D Tibia	10	10	56.9	7
C+4 TS	50	1	49.6	9
P Metatarsal	40	2.5	38.9	12
D Metatarsal	10	10	33.5	14

Table 7. Bison kill area % MAU and associated (S)MAVGGRE values.

Element	%MAU	%MAU Rank	GI value	GI rank
P Humerus	0	10	241.48	1
D Humerus	20	3	64.12	5
P Radius	20	3	42.71	7
D Radius	10	6	49.73	6
P Metacarpal	0	10	6.76	12
D Metacarpal	0	10	14.58	9
P Tibia	0	10	96.82	4
D Tibia	10	6	12.22	10
P Femur	20	3	112.41	3
D Femur	0	10	186.3	2
P Metatarsal	40	1	7.44	11
D Metatarsal	10	6	20.07	8

Table 8. Bison kill area % MAU and associated GI values.

Element	% MAU	% MAU Rank	(S)MAVGMAR value	(S)MAVGMAR rank
Scapula	25.00	8	36.9	.11
P Humerus	0	14	71.5	5
D Humerus	25.00	8	69.2	6
P Radius	50.00	1.5	68	7
D Radius	8.33	11	50.3	9
Internal carpal	41.67	4	36.2	12
P Metacarpal	41.67	4	29.2	13
D Metacarpal	50.00	1.5	18.2	15
Innominate	25.00	8	10.2	16
P Femur	0	14	97.2	3
D Femur	0	14	98.2	2
P Tibia	0	14	100	1
D Tibia	0	14	84.5	4
C+4 tarsal	33.33	6	55.2	8
P Metatarsal	41.67	4	40.6	10
D Metatarsal	16.67	10	25.2	14

Table 9. Processing area % MAU and associated (S)MAVGMAR values.

Element	% MAU	% MAU Rank	(S)MAVGMAR value	(S)MAVGMAR rank
Scapula	30	4	36.9	11
P Humerus	0	14	71.5	5
D Humerus	20	6.5	69.2	6
P Radius	20	6.5	68	7
D Radius	10	10	50.3	9
Internal carpal	40	2.5	36.2	12
P Metacarpal	0	14	29.2	13
D Metacarpal	0	14	18.2	15
Innominate	20	6.5	10.2	16
P Femur	20	6.5	97.2	3
D Femur	0	14	98.2	2
P Tibia	0	14	100	1
D Tibia	10	10	84.5	4
C+4 tarsal	50	1	55.2	8
P Metatarsal	40	2.5	40.6	10
D Metatarsal	10	10	25.2	14

Table 10. Bison kill % MAU and associated (S)MAVGMAR values.

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Appendix V
Bison Element Volume Density

Element	Scan site	Volume Density	Volume Density Rank	Processing Area		Kill Area	
				%MAU	%MAU Rank	%MAU	%MAU rank
Mandible	DN1	0.53	31.5	8.33	57	0.00	74.5
	DN2	0.61	19	0.00	78.5	0.00	74.5
	DN3	0.62	16	25.00	29.5	10.00	42.5
	DN4	0.53	31.5	41.67	7	50.00	4
	DN5	0.49	42.5	50.00	3	50.00	4
	DN6	0.57	25.5	0.00	78.5	10.00	42.5
	DN7	0.79	4.5	25.00	29.5	70.00	1
	DN8	0.79	4.5	0.00	78.5	50.00	4
Hyoid	HYOID	0.36	69.5	16.67	44.5	30.00	14.5
Rib	RI1	0.27	81.5	2.56	63.5	6.92	54
	RI2	0.35	73	0.64	65	3.08	57
	RI3	0.57	25.5	12.18	53	4.62	55
Atlas	AT1	0.52	35	0.00	78.5	20.00	25
	AT2	0.91	2	16.67	44.5	0.00	74.5
	AT3	0.34	75	0.00	78.5	40.00	9
Axis	AX1	0.65	12	0.00	78.5	20.00	25
	AX2	0.38	66	16.67	44.5	40.00	9
	AX3	0.97	1	0.00	78.5	20.00	25
Cervical	CE1	0.37	68	4.76	61	14.29	33
	CE2	0.62	16	14.29	52	8.57	51
Thoracic	TH1	0.42	58.5	2.56	63.5	12.31	34
	TH2	0.38	66	17.95	37	16.92	32
Lumbar	LU1	0.31	78.5	0.00	78.5	3.33	56
	LU2	0.11	91	0.00	78.5	0.00	74.5
	LU3	0.39	63.5	2.78	62	0.00	74.5
Sacrum	SC1	0.27	81.5	0.00	78.5	0.00	74.5
	SC2	0.26	83.5	16.67	44.5	0.00	74.5
Scapula	SP1	0.5	39.5	25.00	29.5	30.00	14.5
	SP2	0.48	46.5	8.33	57	0.00	74.5
	SP3	0.28	80	0.00	78.5	10.00	42.5
	SP4	0.43	56.5	0.00	78.5	10.00	42.5
	SP5	0.17	90	0.00	78.5	0.00	74.5
Humerus	HU1	0.24	86	0.00	78.5	0.00	74.5
	HU2	0.25	85	25.00	29.5	0.00	74.5
	HU3	0.45	52.5	33.33	16.5	0.00	74.5
	HU4	0.48	46.5	0.00	78.5	20.00	25
	HU5	0.38	66	25.00	29.5	20.00	25
Radius	RA1	0.48	46.5	41.67	7	20.00	25
	RA2	0.56	27.5	41.67	7	10.00	42.5
	RA3	0.62	16	33.33	16.5	0.00	74.5
	RA5	0.35	71.5	16.67	44.5	10.00	42.5
Ulna	UL1	0.34	75	16.67	44.5	10.00	42.5
	UL2	0.69	8.5	50.00	3	0.00	74.5
Radial carpal	Scaphoid	0.42	58.5	33.33	16.5	20.00	25

Internal carpal	Lunar	0.35	71.5	33.33	16.5	40.00	9
Ulnar carpal	Cuneif	0.43	56.5	33.33	16.5	40.00	9
Unciform	Uncif	0.44	54.5	41.67	7	10.00	42.5
2/3 carpal	Trapmag	0.5	39.5	16.67	44.5	10.00	42.5
Metacarpal	MC1	0.59	22.5	33.33	16.5	0.00	74.5
	MC2	0.63	13	25.00	29.5	0.00	74.5
	MC3	0.69	8.5	0.00	78.5	0.00	74.5
	MC4	0.6	20.5	41.67	7	0.00	74.5
	MC6	0.53	31.5	50.00	3	0.00	74.5
5th Metacarpal	5MC	0.62	16	16.67	44.5	0.00	74.5
Ilium	IL1	0.22	87.5	0.00	78.5	0.00	74.5
	IL2	0.52	35	0.00	78.5	10.00	42.5
Ischium	IS1	0.5	39.5	0.00	78.5	0.00	74.5
	IS2	0.19	89	0.00	78.5	0.00	74.5
Pubis	PU1	0.55	29	0.00	78.5	0.00	74.5
	PU2	0.39	63.5	0.00	78.5	0.00	74.5
Acetabulum	AC1	0.53	31.5	25.00	29.5	20.00	25
Femur	FE1	0.31	78.5	0.00	78.5	20.00	25
	FE3	0.34	75	0.00	78.5	0.00	74.5
	FE4	0.45	52.5	8.33	57	0.00	74.5
	FE5	0.36	69.5	8.33	57	0.00	74.5
	FE6	0.26	83.5	0.00	78.5	0.00	74.5
	FE7	0.22	87.5	0.00	78.5	0.00	74.5
Tibia	TI1	0.41	61	16.67	44.5	0.00	74.5
	TI2	0.58	24	33.33	16.5	0.00	74.5
	TI3	0.76	7	8.33	57	0.00	74.5
	TI4	0.44	54.5	8.33	57	0.00	74.5
	TI5	0.41	61	8.33	57	10.00	42.5
Lateral mal.	LATMAL	0.56	27.5	16.67	44.5	30.00	14.5
C+4 tarsal	NC3	0.77	6	33.33	16.5	50.00	4
2/3 tarsal	2&3 CP	0.5	39.5	33.33	16.5	30.00	14.5
Calcaneous	CA1	0.46	50.5	16.67	44.5	10.00	42.5
	CA2	0.8	3	25.00	29.5	10.00	42.5
	CA3	0.49	42.5	33.33	16.5	10.00	42.5
	CA4	0.66	11	33.33	16.5	10.00	42.5
Astragalus	AS2	0.62	16	58.33	1	30.00	14.5
	AS3	0.6	20.5	33.33	16.5	30.00	14.5
Metatarsal	MR1	0.52	35	33.33	16.5	40.00	9
	MR2	0.59	22.5	33.33	16.5	50.00	4
	MR3	0.67	10	16.67	44.5	20.00	25
	MR4	0.51	37	16.67	44.5	20.00	25
	MR6	0.48	46.5	16.67	44.5	10.00	42.5
1st phalanx	P11	0.48	46.5	29.17	24	22.50	18.5
	P13	0.48	46.5	20.83	36	17.50	31
2nd phalanx	P21	0.41	61	27.08	25	7.50	52.5
	P23	0.46	50.5	22.92	34.5	7.50	52.5
3rd phalanx	P31	0.32	77	22.92	34.5	22.50	18.5