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EgPn-440: A Late Prehistoric Bison Pound on the Northwestern Plains

by

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ABSTRACT

EgPn-440 is a Late Prehistoric bison pound located near Calgary, Alberta. This thesis provides a detailed analysis of the faunal remains recovered. Faunal elements are described in detail in terms of portions present and butchering evidence. An aging and sexing analysis, using several techniques, is undertaken in order to suggest herd composition and seasonality. The bison remains are also examined in terms of economic utility, using a series of utility indices to suggest motivations for the butchering patterns observed.

The possibility of suggesting multiple uses of the site is explored through an analysis of the spatial distribution of lithics, specific bison age and sex groups, and bison elements at the site. A number of maps are generated that compare the distribution of elements across the site to determine if the observed patterns represent more than one kill event and if other explanations should be considered.

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CHAPTER ONE

INTRODUCTION

Late Prehistoric bison kill sites are a relatively common phenomena on the Northern Plains, yet they have rarely been examined in detail, particularly the faunal remains. Exceptions include sites studied by researchers such as Frison (1970a; 1970b; 1974), Kehoe (1973), Reher (1970), Reher and Frison (1980), Brink and Dawe (1989) and Shortt (1993). Archaeologists are becoming increasingly aware of the value of examining faunal remains and their distribution at kill sites with the goal of obtaining information such as age and sex composition of herds, seasonality and butchering techniques employed. This information may subsequently provide knowledge about variations in the choices made regarding the selection and butchering of animals, subsistence issues affecting the patterns of movement of hunter/gatherers on the plains, and changes in subsistence and settlement patterns through time.

This thesis consists of a detailed examination of the faunal remains and their spatial distribution at EgPn-440, as well as at some of the lithic materials recovered from the site. EgPn-440 is a Late Prehistoric bison kill site located on the west edge of Calgary, Alberta. The site was discovered in 1996 during a survey conducted by Western Heritage Services Inc. to examine the proposed right of way of a wastewater pipeline between the Town of Cochrane and the City of Calgary. Mitigation of the site was undertaken in 1997.

This thesis is an examination of the butchering patterns, carcass utilization, and spatial distributions of faunal materials remaining at EgPn-440. Quantification of the bison remains, age and sex profiles, butchering patterns and techniques, and possible indications of activity areas are examined in an attempt to provide a detailed analysis of a Late Prehistoric kill site. The focus is on the faunal remains and their spatial distribution in hopes of providing a comparison for other sites and suggesting possible explanations for observed patterns. The possibility of detecting multiple kill events is examined by

using spatial analyses of the lithic and faunal materials. The site is first introduced and placed into context, the faunal remains quantified in order to facilitate more complex analyses, and analyses such as aging and sexing, economic utility and spatial analysis follow.

Chapter two discusses the background of the site in terms of its history and natural setting. Other sites in the area are briefly discussed in order to set the cultural background necessary to examine this site. Chapter three looks at the archaeology of the site. Field methods undertaken during the mitigation of the site are examined here. Site stratigraphy and the horizontal extent are presented, as well as the radiocarbon dates.

Chapter four presents the lithic data examined for this thesis. Lithic material from this site still remains to be examined by other researchers, but some materials were studied for this thesis in order to put the site in a cultural context. Artifacts examined here include the projectile points and small tools. These artifacts are examined in terms of material types and the spatial distribution of those material types throughout the site. A detailed evaluation of discrete and continuous traits as presented by Peck (1996) is undertaken in an attempt to place the lithic assemblage in context with other assemblages from Alberta and Saskatchewan. In addition, a further spatial analysis of aspects of the morphology of the points is undertaken in order to determine if the lithic remains provide evidence for more than one kill event taking place at this locality.

Chapter five presents a detailed description of the faunal remains recovered in 71 square metres of excavation undertaken at EgPn-440. Bone density as it relates to preservation issues is briefly discussed, and non-bison faunal remains are described. The bulk of the faunal material recovered was identified as bison remains, largely from one bone bed, Component One. This material is quantified to allow comparison with other kill sites excavated in both the past and in the future. Detailed descriptions of each element are provided in terms of quantification, butchering evidence, and portions recovered, and these are compared to patterns observed at other bison kills on the plains.

Explanations for the observed frequencies of elements are suggested with reference to possible butchering procedures.

Chapter six attempts to discuss the bison remains recovered in terms of age and sex profiles. Aging of the individual animals in the assemblage is attempted by looking at tooth wear and eruption stages as presented by Reher (1970), Reher and Frison (1980) and Brumley (1990). Sexing of the materials is undertaken using two methods. The first method follows Morlan (1991) in which measurements of carpals and tarsals are presented in bivariate plots. Morlan suggests that clusters in the distribution of points in these plots represent groups of adult males and groups of females and calves. The second method for sexing individuals follows Walde (1985; n.d.). In his Masters thesis and a subsequent paper, Walde presents sets of discriminant functions based on measurements presented by Speth (1983) which potentially distinguish adult males from adult females.

Chapter seven examines the economic utility of the bison faunal remains based on utility indices presented by Emerson (1990). The remains recovered from the site are compared with various utility indices based on general products as well as protein, marrow, bone grease and total fats present in bison. Graphs resulting from these comparisons are then discussed in terms of expected and unexpected patterns of faunal remains left at the site to determine possible butchering patterns and goals of the hunters.

Chapter eight is an examination of the spatial distribution of bison remains in the bone bed at EgPn-440. Using MapInfo, the distributions of both individual elements and groups of elements are examined in an attempt to discern butchering patterns. Distributions are examined in terms of possible activity areas. For example, an attempt is made to distinguish between the kill site and peripheral processing areas. In addition, the possibility of distinguishing separate kill events is discussed relative to differential distribution of elements. Possible variations in butchering based on individual or group differences, or on seasonality, are presented in relation to the spatial distribution of elements.

Chapter nine presents conclusions based on information presented in the previous chapters, and attempts to sum up the overall patterns observed at EgPn-440. Future considerations for the remainder of the site are discussed. Implications for other Late Prehistoric bison kills are suggested, and strategies directed towards future studies of bison kills are proposed.

CHAPTER TWO

BACKGROUND

In the fall of 1996, a Heritages Resource Impact Assessment (HRIA) was undertaken by Western Heritage Services Inc. to examine the proposed right of way of a wastewater pipeline between the Town of Cochrane and the City of Calgary. During the HRIA, a bison kill site, EgPn-440, was encountered. This site could not be avoided in construction of the pipeline. Based on recommendations resulting from the Cochrane-Calgary wastewater pipeline HRIA, mitigation of the archaeological site EgPn-440 was undertaken in the summer and fall of 1997 (Walde 1997c). Pipeline construction was conducted by Stanley Associate Engineering Ltd in late 1997 (D. Walde, personal communication).

EgPn-440 is located at the northeast corner of Section 36, Township 24, Range 3, West of the 5th Meridian. The site consists of a Late Prehistoric bison pound site located in a flat-bottom coulee south of the Bow River and north of the Trans-Canada Highway in the southwest of the City of Calgary, Alberta. Figure 2.1 illustrates the location of the site.

Cultural Setting

Prior to the HRIA, a number of sites were already known from this region. The potential for the presence of cultural resources was considered high in the proposed area, particularly due to the proximity of the Bow River (Walde 1996:3). Bison kill sites are relatively common on the Northwestern Plains. Well known Alberta sites that include Late Prehistoric components include Head-Smashed-In Buffalo Jump near Fort MacLeod (Reeves 1978; Brink and Dawe 1989), Old Women's Buffalo Jump near Cayley (Forbis 1960), and the Ramillies kill and campsite on the Suffield Military Reserve (Brumley 1976)). Recently excavated Late Prehistoric sites in the immediate vicinity of EgPn-440

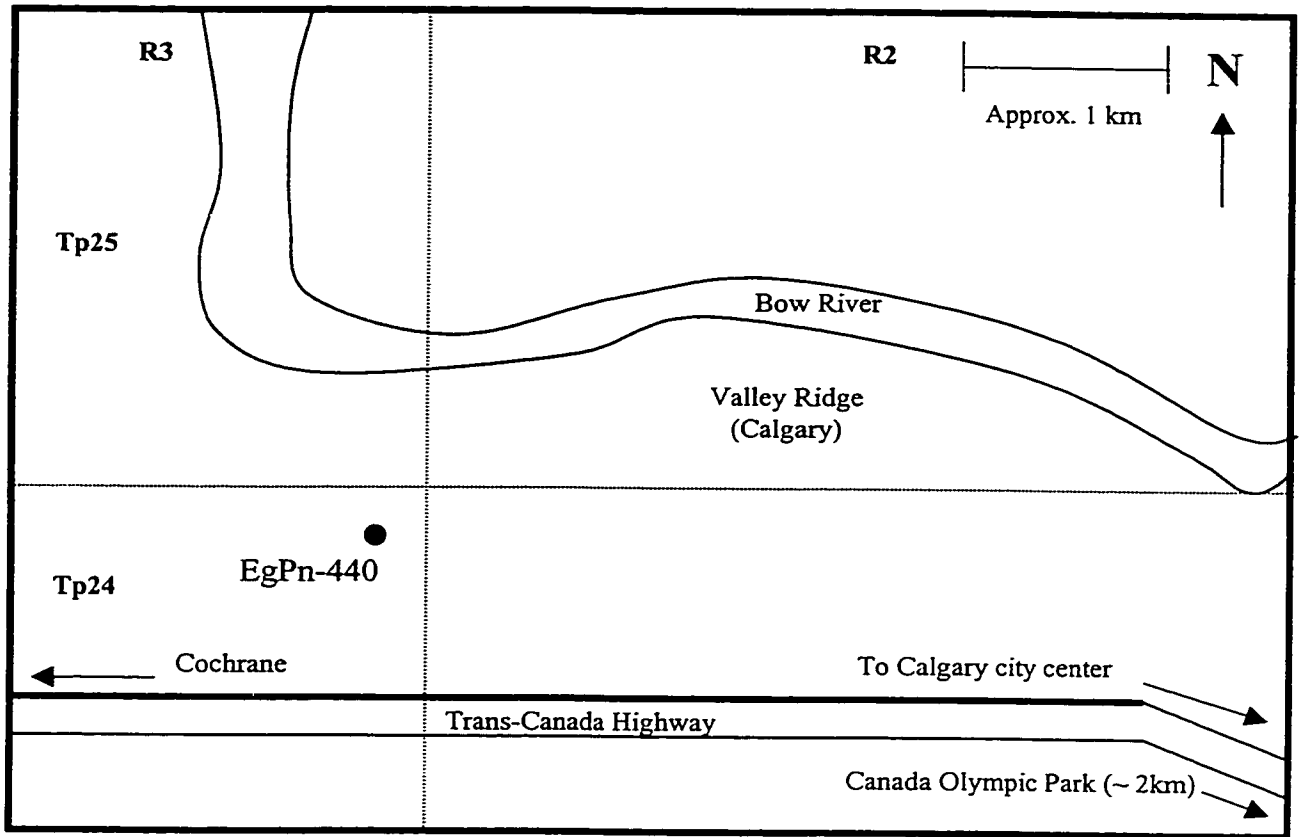


Figure 2.1. Project area showing location of EgPn-440 on the western edge of Calgary.

(the western Paskapoo Slopes) include EgPn-230, a multicomponent site which includes a Late Prehistoric bison processing site as its third component (Vivian et al. 1998). The Happy Valley Site (EgPn-290), a single component bison kill site dating to 2000 years BP (Besant phase) is also very near to EgPn-440 (Shortt 1993). Although the Happy Valley Site dates to the end of the Middle Prehistoric, this kill site has been analyzed in detail and will be compared with EgPn-440 in sections of this thesis. Numerous other sites are located in the area, including a series of sites on coulee heads to the east of the EgPn-440 kill site; these may represent processing sites for the EgPn-440 kill (Walde 1997a). In a 1998 survey of the east Paskapoo slopes (south and east of the west slopes), Reeves (1998) noted the presence of a minimum of 49 sites, with more sites likely to be found in the heavily wooded areas of the slopes.

EgPn-440 was originally thought to be a multi-component site (Walde 1997b), but several of these recognized “components” were visible only in very small sections of the site. This will be discussed in more detail in chapter three, but suffice to say here that the site has one main component, which dates to the Late Prehistoric time period; two other ephemeral prehistoric components exist above this main component in the north part of the site.

The Late Prehistoric period in the Northwestern Plains is usually defined as lasting from approximately 1800 BP to 200 BP (see Dyck 1983:110; Vickers 1986:88; Reeves 1983:16). Wormington and Forbis (1965) used the term “NeoIndian” for this period, but “Late Prehistoric” (based on Mulloy 1958) is more commonly used at present. A number of different designations have been assigned to divide this time period in the last 40 years. For example, Reeves proposed the Tunaxa and Napikwan Cultural Traditions which he suggested span the Middle and Late Prehistoric Period (Reeves 1969). The most common way of dividing the Late Prehistoric in Alberta is to refer to Avonlea as the early phase, from approximately 1800 years BP to 1200 years BP, and the Old Women’s Phase as the later phase. This latter phase is typically broken into the “Prairie Side Notched” (1200 to 700 years BP) and “Plains Side Notched” (700 – 200

years BP) (Kehoe 1966). New methods of dividing the Old Women's Phase have recently been proposed and will be discussed in chapter four.

The Late Prehistoric period is marked by the introduction of the bow and arrow and ceramics to some areas of the Northern Plains, and by "...peoples who were skilled in communal bison hunting" (Meyer and Epp 1990:333). According to Reeves:

(Old Women's) Phase is characterized by ceramics, emphasizes local Plains or Montana lithics to large measure, and has a technology characterized by the extensive use of split pebble techniques to produce blanks for end scrapers, points, pieces esquillees, and burin-like spalls. There is also extensive use made of petrified wood. Projectile point styles are micro-stylistically discrete, particularly those representative of the close of Prehistoric times (Washita) (Reeves 1980, taken from Reeves 1983:19; Reeves 1978).

Reeves (1983:20) considers the archaeological Old Women's phase to be directly ancestral to the Blackfoot people of southern Alberta and surrounding regions.

Site Setting

EgPn-440 is located on the south side of the Bow River on the western edge of the City of Calgary. The Bow River flows out of the Rocky Mountains to the west, originating northwest of Banff. In Calgary, the Bow River "...occupies a deep, flat-bottomed valley, up to 4 km wide" (Wilson 1983:32).

The climate in Southern Alberta is marked by cold winters lasting from November through March, and warm summers. Chinooks, a warm wind that flows from the west, can often dramatically increase the temperature in the winter; the result in some years is a lack of snow cover throughout much of the winter (Wormington and Forbis 1965:6). According to Wilson:

Low snow cover favoured grazing ungulates such as bison, which foraged with ease even at the height of winter. This factor probably led to considerable prehistoric concentrations of bison (and, hence, people) in the strong Chinook zone along the Bow... (Wilson 1983:48).

Flora and Fauna

Although the plains are thought to have extended further to the north in the past (Malainey and Sherriff 1996:336), Calgary's geographic position currently places it on the border between the plains and the parkland regions. In addition, Walde et al. (1995:14) note that "Valley Complexes" (originally defined in Coupland and Rowe 1969) in drainage channels and their tributaries on the plains have such favourable moisture conditions that animal and plant diversity resembles the parklands. For these reasons, plant and animal species inhabiting the Bow River Valley are relatively diverse.

Wilson (1983, following North 1976) considers Calgary to be in the grasslands consisting of *Stipa/Agropyron* (Needle and Wheat grass) (from Archibald et al. 1996). Stands of trees such as Balsam poplar (*Populus balsamifera*), willow (*Salix* spp.) and aspen poplar (*Populus tremuloides*) are also found. The north facing slopes of the Bow Valley demonstrate a different pattern of vegetation dominated by coniferous species, particularly White Spruce (*Picea glauca*) and Douglas Fir (*Pseudotsuga menziesii*) (Wilson 1983:53).

Bird species are abundant in the Bow River Valley, and Wilson (1983:54) lists grouse (Family Tetraonidae), swans, ducks and geese (all Family Anatidae) as those which would have been particularly important to prehistoric populations (see Godfrey 1966). Bison (*Bison bison bison*) are obviously among the mammals that would have been important to prehistoric groups in this area, but other artiodactyls such as the elk or wapiti (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and moose (*Alces alces*) were also present. Other mammals present in the Calgary area included the wolf (*Canis lupus*), coyote (*Canis latrans*), black

bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), snowshoe hare (*Lepus americanus*), white-tailed jackrabbit (*Lepus townsendii*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), porcupine (*Erethizon dorsatum*), long-tailed weasel (*Mustela frenata*), badger (*Taxidea taxus*) and bobcat (*Lynx rufus*) (Wilson 1983:54-55).

Summary

The Bow River valley was clearly used and inhabited with great regularity in prehistoric times, as evidenced by relatively abundant kill sites, processing sites and campsites along the valley. In the immediate vicinity of EgPn-440 there are numerous sites dating back thousands of years which show evidence of a variety of uses. The Late Prehistoric time period is considered to represent the most frequent and skilled use of communal bison kills. EgPn-440 represents an extremely well preserved kill site which should provide insights into past lifeways in the Bow Valley.

CHAPTER THREE

ARCHAEOLOGY OF EgPn-440

Field Methodology

During the initial HRIA study in 1996, seven shovel tests (Test Units 41 to 47) were conducted at EgPn-440. Stage one mitigation excavations took place in the spring of 1997 and consisted of two 2 by 2 metre units near two productive shovel tests and eight 1 by 0.5 metre units (Walde 1997a). Figure 3.1 illustrates the 2 by 2 metre units and five of the 1 by 0.5 units as grey-shaded assessment units. The remaining three assessment units are not shown on this map, as they would be located beyond the boundaries of the page. Stage two mitigation, conducted in fall 1997, consisted of the excavation of an additional 60 square metres.

Excavation of EgPn-440 was conducted by Western Heritage Services under the supervision of Dale Walde. Excavation of the uppermost component, Component 5, was conducted in 2 by 2 metre units to depths ranging from 0 to 30 cm below surface to 0 to 50 cm below surface. Below this component, excavation took place in five centimetre arbitrary levels and in 50 by 50 cm units. Exceptions to this occurred during the excavation of Component 1, the lowermost cultural component which consisted of a bone bed. This component was excavated as a cultural level, not an arbitrary one. Matrix was screened through 6 mm screen, and cultural materials recovered were bagged by 50 by 50 cm provenience unit. Figure 3.1 illustrates a map of the excavation grid from EgPn-440.

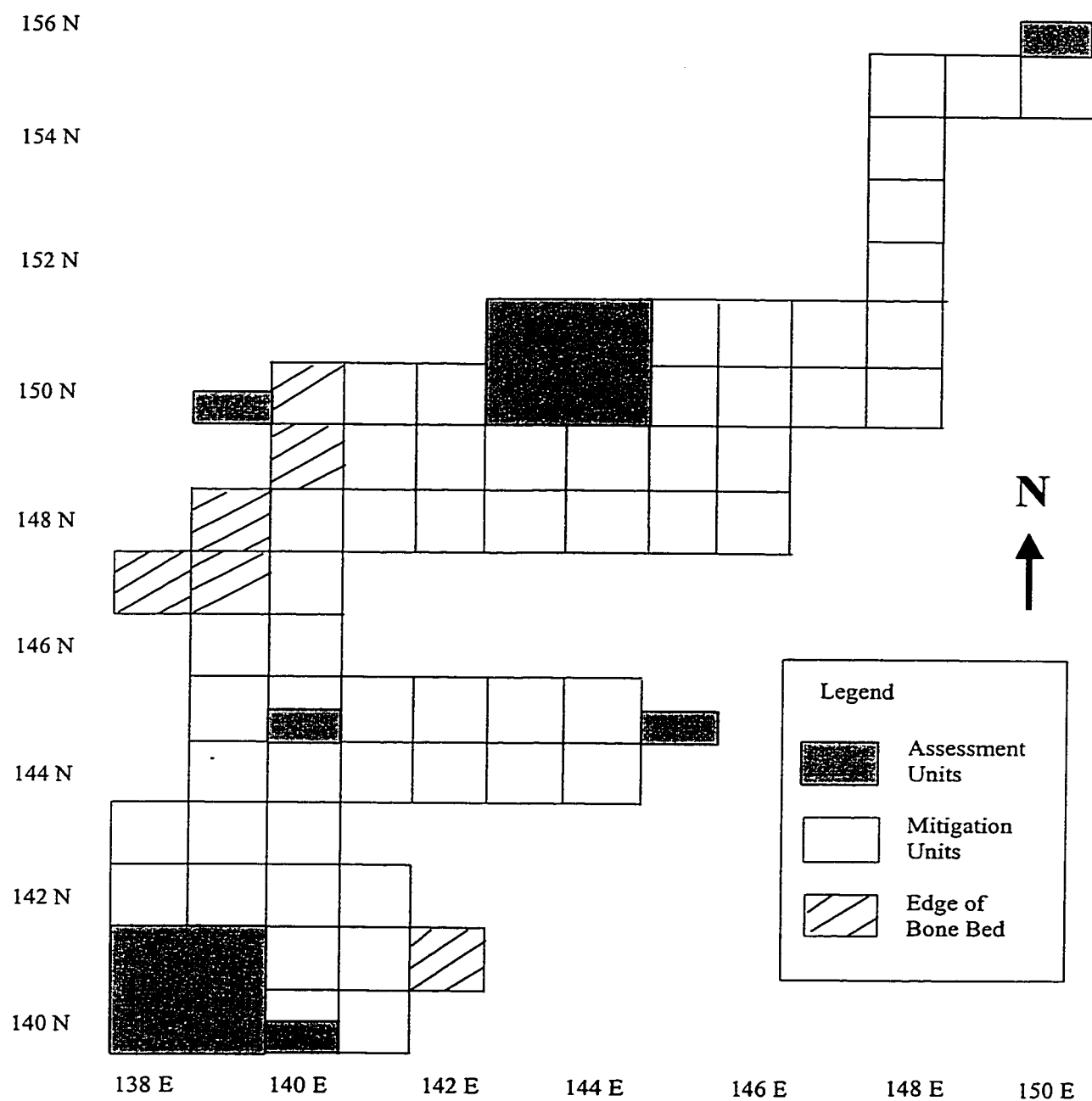


Figure 3.1. Excavation grid at EgPn-440.

Natural stratigraphy

The following description of the natural stratigraphy at EgPn-440 is taken from the final report of excavations (Walde 1997c).

The base of the excavations is defined by the surface of a layer of yellow clay matrix with glacially transported pebbles and cobbles. This yellow clay matrix is similar to that described for the nearby sites of Happy Valley (Shortt 1993) and EgPn-230 (Vivian et al. 1998). This layer of glacially deposited material marks the retreat of the glaciers at the end of the Wisconsin and the subsequent glacial Lake Calgary (see Wilson 1983:73). These glacial deposits range in depth at the site from 20 cm below surface at the sides of the coulee to 185 cm below surface at the centre of the coulee. This transition is not a gradual one, however. Rather, the depth of the glacial deposits drops abruptly just east of the west wall. As expected, no cultural materials are found in this layer.

The layer resting on the glacial matrix is an olive green clayey loam with some rounded pebbles. The layer is thin at the walls of the coulee but is as thick as 185 centimetres at the centre of the coulee. "This layer appears to be the result of incremental redeposition of glacial materials from the coulee walls through mass wasting combined with ongoing soil development" (Walde 1997c). Within this layer, two intermittently visible paleosols were evident at 70 to 75 cm and 90 cm below surface.

Resting on the olive matrix is a layer of dark brown to black clayey loam with occasional rounded pebbles. This layer ranges in thickness from 10 to 35 cm. Similar factors to those described for the olive matrix are probably affecting the development of this layer.

Overlying the black matrix is the sod layer that defines the present surface of the coulee. The thickness of this layer ranges from 8 to 15 cm. Figure 3.2 illustrates an example of the stratigraphy at EgPn-440.

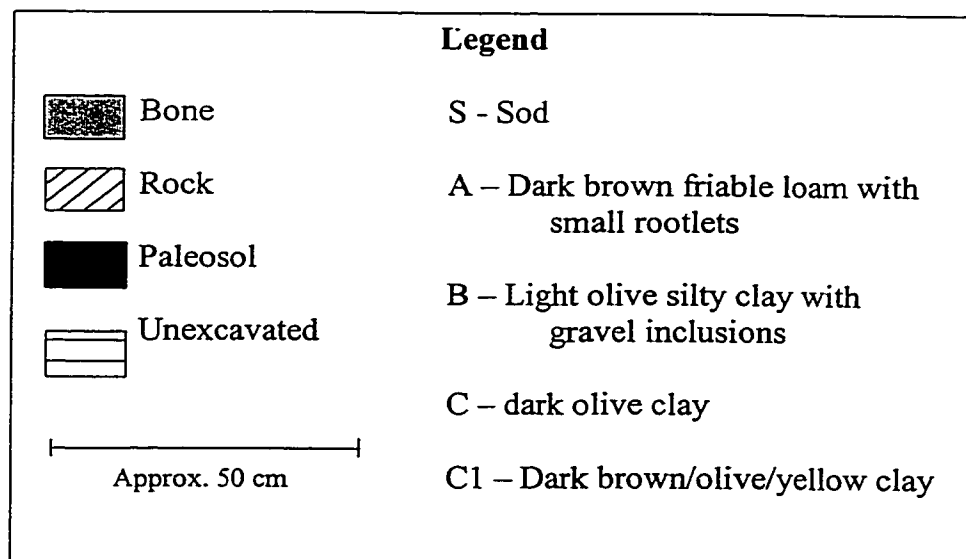
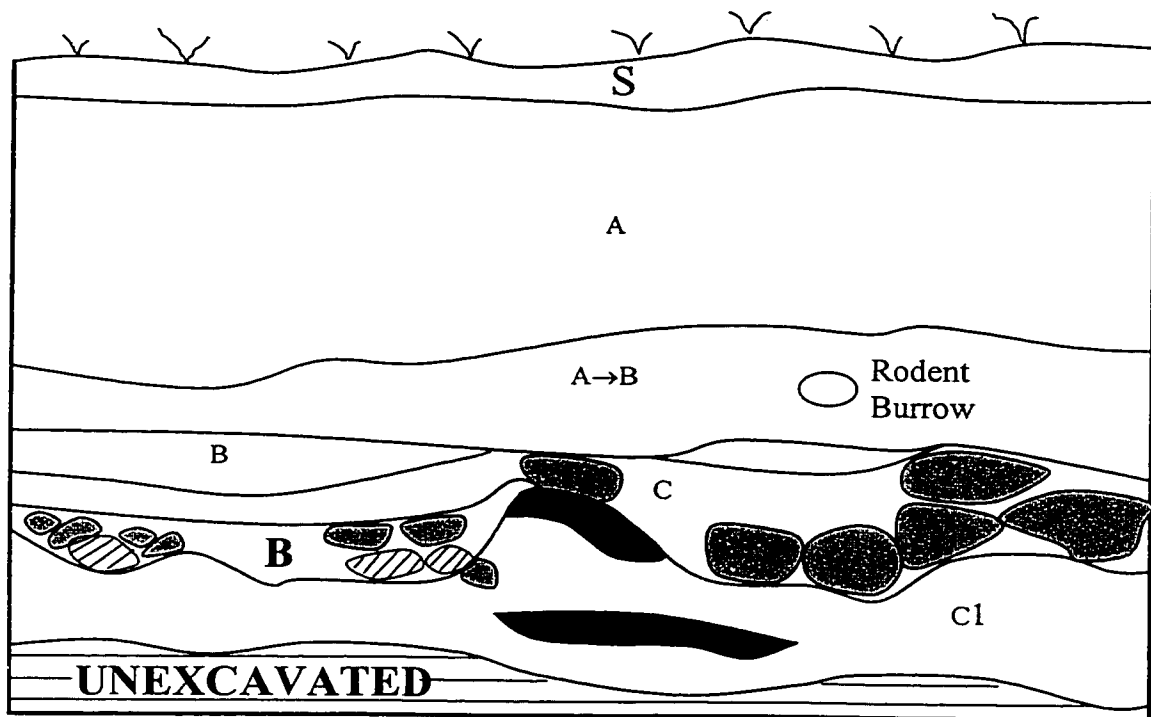


Figure 3.2. Stratigraphy of north wall of units 151N 145E and 151N 146E (not drawn to scale).

Cultural Stratigraphy

Five components are described by Walde (1997c). Two (Components Two and Three) are visible in a four square metre excavation block in the north of the site only. Components One (the bone bed) and Component Five (the surface level) produced the most archaeological material. Component Four materials were only found in the north part of the site.

Component One

Component One is situated on the top of the yellow glacial matrix which defines the base of the excavations. This component occurs at depths ranging from 50 to 100 cm below surface. Typically, this component occurs from 70 to 85 cm below surface and is around 15 cm in depth through most of the site. Component One consists of a layer of complete and butchered bison bone as well as lithic materials such as cobble choppers, biface fragments, several small tools, flakes, and a number of projectile points. This component extends beyond the boundaries of the excavation area, particularly at the east of the site where very large concentrations of materials remain.

Component One represents the remains of a bison kill event or events involving the use of a bison pound. The presence of a bison pound in the base of a coulee represents a common method of bison procurement, where natural features are used to aid in the hunt (Frison 1991; Albanese 1978). This site is a kill site, but some evidence of primary butchering in the form of cut marks and long spiral fractures is present. The faunal remains are overall in very good condition.

A possible hearth feature is evident in the southeast quadrant of unit 155N 150E on the northern periphery of the excavation. Small amounts of burned and calcined bone, as well as charcoal, were recovered from this unit, although unburned identifiable bison elements were also recovered. The peripheral location of this possible hearth may suggest that some processing of the bone from the kill site took place.

Post hole features were identified in units 148N 140E (1), 150N 147E (2), and 154N 148E (3). Post hole 1 is located on the western edge of the kill area and consists of a darkened area in the northwest quadrant associated with footing stones at the base and rocks and bone uprights probably used to wedge the pole into place (as described in Frison 1971:80). Post hole 3 is located at the northern periphery of the bone bed and is similar in appearance to post hole 1. A humerus was associated with the base of this pole hole. Post hole 2 is located at the eastern periphery of the excavation grid, but is located well within the bone bed. It is suggested that this post may be "...associated with ceremonial activities conducted by a poundmaster at the initiation of the hunt" (Walde 1997c). This post hole was similar in structure to the other two with the exception of the absence of the footing stones. Vertebral elements and possibly the foot of a bison are associated with this post hole.

Walde (1997c) suggests that these post holes are likely associated with Component One since their bases are located below the base of this occupation level. To confirm this hypothesis, radiocarbon dating of bone from these features is planned but has not yet been undertaken.

The western boundary of the bone bed was encountered in units 150N 141E, 149N 140E, 148N 140E, 147N 139E, and 146N 139E. The north-eastern boundary of the bone bed may have been encountered in unit 154N 150E, but a large portion of the eastern part of the bone bed remains unexcavated. The extreme concentration of bone at the eastern edge of the excavation area and the locations of the post holes indicates that a large portion of the main pound lies outside of the excavation area. This area should be considered to be of significance if further development is proposed in the future.

Component Two

During excavation, Component Two was only recognized in excavation units 150N 143E, 150N 144E, 151N 143E and 151N 144E, which were excavated in Stage One assessment as a 2 by 2 m block. According to Walde (1997c), the occupation "...consists of isolated bone smashing stations composed of large stone 'anvils' with associated cobble hammers and large bone fragments...(t)his occupation most probably represents activities associated with a kill site located outside the project area." No diagnostic artifacts were recovered from this component. A large number of bone fragments were recovered from this level, which is about 65 to 70 cm below surface (just above Component One). Little identifiable faunal material was recovered, however.

Component Three

As with Component Two, this component has only been recognized in the 2 by 2 m assessment block 150N 143E, at approximately 60 to 65 cm below surface. Walde suggested a similar explanation for this component to that for Component Two. The faunal remains are, however, extremely sparse in this level and the small amount of bone entered into the database provides no evidence for the existence of this component.

Component Four

My investigations indicate that Component Four has been identified in the north portion of the site only, usually at approximately 55 cm below surface. The presence of this component in unit 139N 134E in the far south of the site was noted in the mitigation report (Walde 1997c), but the faunal analysis of this unit revealed only very small amounts of bone. Walde (1997c) suggested that this component represents a primary butchering/processing station. Sparsely distributed identifiable bison elements are present. No butchering was identified, but spiral fractures were evident on a metatarsal and humerus recovered from this component.

Several Late Prehistoric projectile points were recovered from Component Four and several others (probably originally associated with Component Four) were recovered from Component Five, a mixture of historic and prehistoric materials. These points are not distinguishable from points recovered from Component One.

Component Five

Component Five consists of a mixture of very recent materials with occasional prehistoric materials interspersed. This component is evident throughout the area up to depths of around 40 cm below surface. Mixing of recent and precontact materials is suggested to be the result of extensive rodent burrowing. Materials recovered from this component include metal scraps, screws and wire nails, glass, contemporary ceramics, large bovid, pig and sheep/goat bone (often sawn), fish bone, calcined and burned bone fragments, and projectile points. “The contemporary materials recovered are most probably associated with garbage disposal activities conducted by the occupants of the now abandoned farmstead on the upland immediately to the west of the coulee in which the site is located” (Walde 1997c).

Radiocarbon Dating

Three radiocarbon dates were obtained: two from Component One (the bone bed) and one from Component Four. Bone was sent for radiocarbon dating to Beta Analytic Inc. in Miami. Dates were obtained using collagen extraction. Elements used for the Component One radiocarbon dating were thoracic vertebrae, one from unit 148N 143E (#65356) and one from unit 145N 143E (#17913). The element used for the Component Four radiocarbon dating was an atlas from unit 151N 145E (#31347).

Table 3.1 provides the radiocarbon dates received from Beta Analytic. The standard “Conventional Radiocarbon Age” is provided (one sigma), and the two sigma date range is also provided. Dates received of 1280 +/- 50 BP (Beta-141209) and 1240

+/- 50 BP (Beta-141211) for Component One and 1130 +/- 60 BP (Beta-141210) are older than originally anticipated. Based on initial impressions of the projectile points, an age of approximately 800 years BP was expected. However, the Component One dates approximate each other very closely, and the Component Four date is younger, as expected. The samples were large enough and contained ample carbon for reliable measurements. There is thus no reason not to accept the radiocarbon dates.

The Component One radiocarbon dates thus place the site very early in the “Prairie Side-Notched” of the Old Women’s Phase rather than at the “Prairie Side-Notched”/“Plains Side-Notched” transition as expected. In fact, the dates suggest that the site was used at approximately the same time as the transition from the Avonlea phase to the Old Women’s phase, although Avonlea points were not recovered at the site. Projectile point morphology will be discussed in detail in chapter four, but suffice to say here that the time period suggested by the point morphology and the radiocarbon dates received do not correlate exactly.

Table 3.1. Radiocarbon dating results from EgPn-440.

Lab. Number	Component	Catalogue Number	Radiocarbon Age (one sigma)	Radiocarbon Age (two sigma)
Beta-141209	1	EgPn-440-0017913	1280 +/- 50 BP	1290 – 1070 BP
Beta-141211	1	EgPn-440-0065356	1240 +/- 50 BP	1280 – 1055 BP
Beta-141210	4	EgPn-440-0031347	1130 +/- 60 BP	1180 – 935 BP

CHAPTER FOUR

LITHIC REMAINS

This chapter briefly discusses lithic artifacts recovered from excavations at EgPn-440, and includes a discussion of discrete and continuous attributes that Peck (1996) outlines. For the purposes of this study, only projectile points, point fragments, and small tools (such as endscrapers) were examined. A total of 84 pieces were catalogued and studied. A number of flakes, large tools and debitage remain to be examined. Plates 1 and 2 show a selection of the more complete projectile point specimens.

Material Types and Spatial Distribution

Table 4.1 illustrates the frequency distribution of material types found at EgPn-440 for the collection of projectile points and small tools. From a brief look at the other tools, it is clear that the majority of flakes and large tools are made from local quartzites. The examination of material types in this thesis applies only to points and small tools.

Material types include both local and exotic materials. Montana chert is the most common material type, representing 38.1% of points/small tools. The second most common material type is black chert of unidentified sources, at 16.7%. The third most common material type at 15.5% is petrified wood, a poor quality material for manufacturing tools. A possible source of this petrified wood is Dinosaur Provincial Park in southeastern Alberta although it can be found in a number of locations in Alberta. The frequencies of other material types are very low, but include such materials as Knife River Flint (from North Dakota) at 3.6%, obsidian (probably from Wyoming) at 1.2%, Top of the World Chert (from southeastern British Columbia) at 2.4%, Swan River Chert (from Manitoba, but found in gravels in southeastern Alberta) at 3.6%, basalt (from British Columbia) at 2.4%, ironstone (source unknown) at 1.2%, as well as unsourced chalcedony, cherts, quartzites and one point of unknown material.

Table 4.1. Frequencies of material types used for projectile points and small tools.

Material Type	Frequency	Proportion of Total (%)
Knife River Flint	3	3.6
Chalcedony	4	4.8
Obsidian	1	1.2
Montana Chert	32	38.1
Top of the World Chert	2	2.4
Swan River Chert	3	3.6
Black Chert	14	16.7
Grey Chert	1	1.2
Brown Chert	2	2.4
Basalt	2	2.4
White Quartzite	2	2.4
Black Fine-Grained Quartzite	2	2.4
Brown Silicified Siltstone	1	1.2
Ironstone	1	1.2
Petrified Wood	13	15.5
Unknown	1	1.2
TOTAL	84	100.3

The high frequency of artifacts made from Montana Chert indicates that the group or groups using this pound had access to material from various quarries in southwestern Montana. Whether this can be attributed to trade or to travel to the source is unknown. However, the high frequency of points made from petrified wood also suggests that high quality materials may have been somewhat scarce. Petrified wood is an extremely poor quality material in terms of flaking because the grain of the wood creates unpredictable fracture patterns. The use of this material suggests that quality flaking material may have been difficult to find. Andrefsky (1994) notes that when poor quality materials are more readily available than higher quality materials, the poor quality material is still used, but more “informal” tools are manufactured. Projectile points are manufactured out of both Montana chert (a relatively high quality material) and petrified wood at EgPn-440. The petrified wood points do appear to have been worked less than the Montana chert points (fewer flakes removed), and may have been considered to be more expedient tools.

However, both material types are relatively abundant at this site compared to points manufactured from other material types of intermediate quality.

The general material types are relatively consistent with those found at other Late Prehistoric sites on the Northern Plains. From the Gull Lake Site in south Saskatchewan, Kehoe (1966:832) states that Plains Side Notched points were most commonly made of chert (36%), Knife River Flint (8%), other chalcedonies (16%), “flints” (14%), petrified wood (12%) and others making up the remaining 14%. These frequencies are not unlike those observed at EgPn-440. Similar patterns are also present at EgPn-230, a multi-component site located approximately 1.5 km to the east of EgPn-440 (Vivian et al. 1998). Looking only at the small tools, including points, scrapers, bifaces and retouched/utilized flakes, the material types used are cherts (55.7%), petrified wood (18.6%), siltstone (11.4%), chalcedony (7.1%), with quartzite, porcellanite and basalt making up the remaining 7.2%. Again, cherts dominate, but petrified wood is fairly common, with other materials being used in smaller but consistent frequencies.

Figures 4.1 and 4.2 illustrate the spatial distribution of projectile points and small tools based on material types. Figure 4.1 illustrates the distribution of the two most common identifiable material types, Montana chert and petrified wood. This map demonstrates no obvious spatial patterning in terms of the distribution of these material types. Tools made from these materials are evenly distributed across the site. Similarly, figure 4.2 illustrates the distribution of the other identifiable material types: basalt, Knife River Flint, obsidian, Swan River Chert, and Top of the World Chert. These materials are represented by far fewer specimens. Knife River Flint and Swan River Chert are found only in the north and central parts of the site, whereas basalt and Top of the World chert are found only in the south and central parts of the site. This vague differentiation of material types between the north and south of the site may suggest that these two localities (north and south) were used by different groups. However, the extremely small

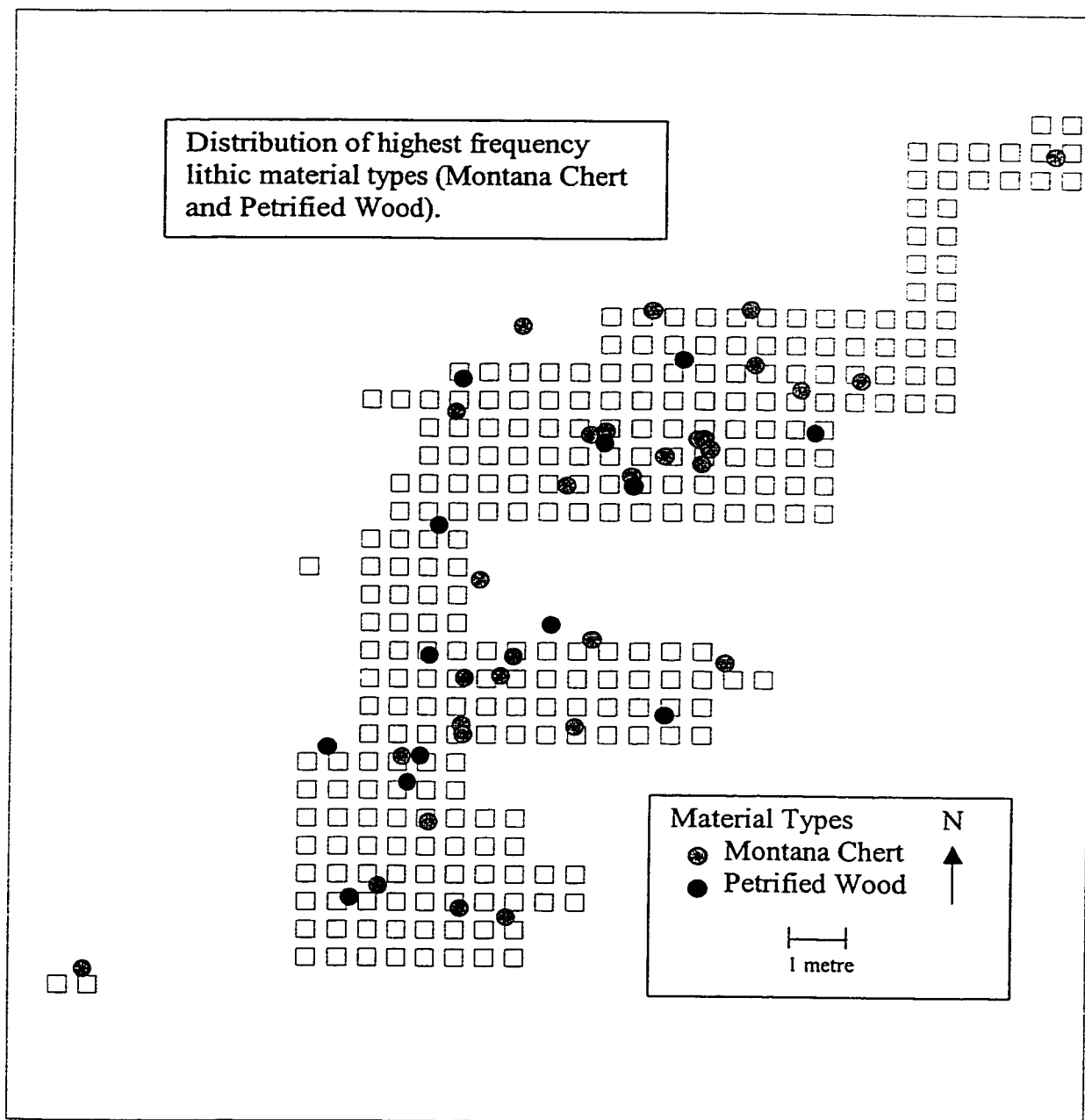


Figure 4.1. Distribution of highest frequency lithic material types (Montana Chert and Petrified Wood). Both materials are found throughout the site.

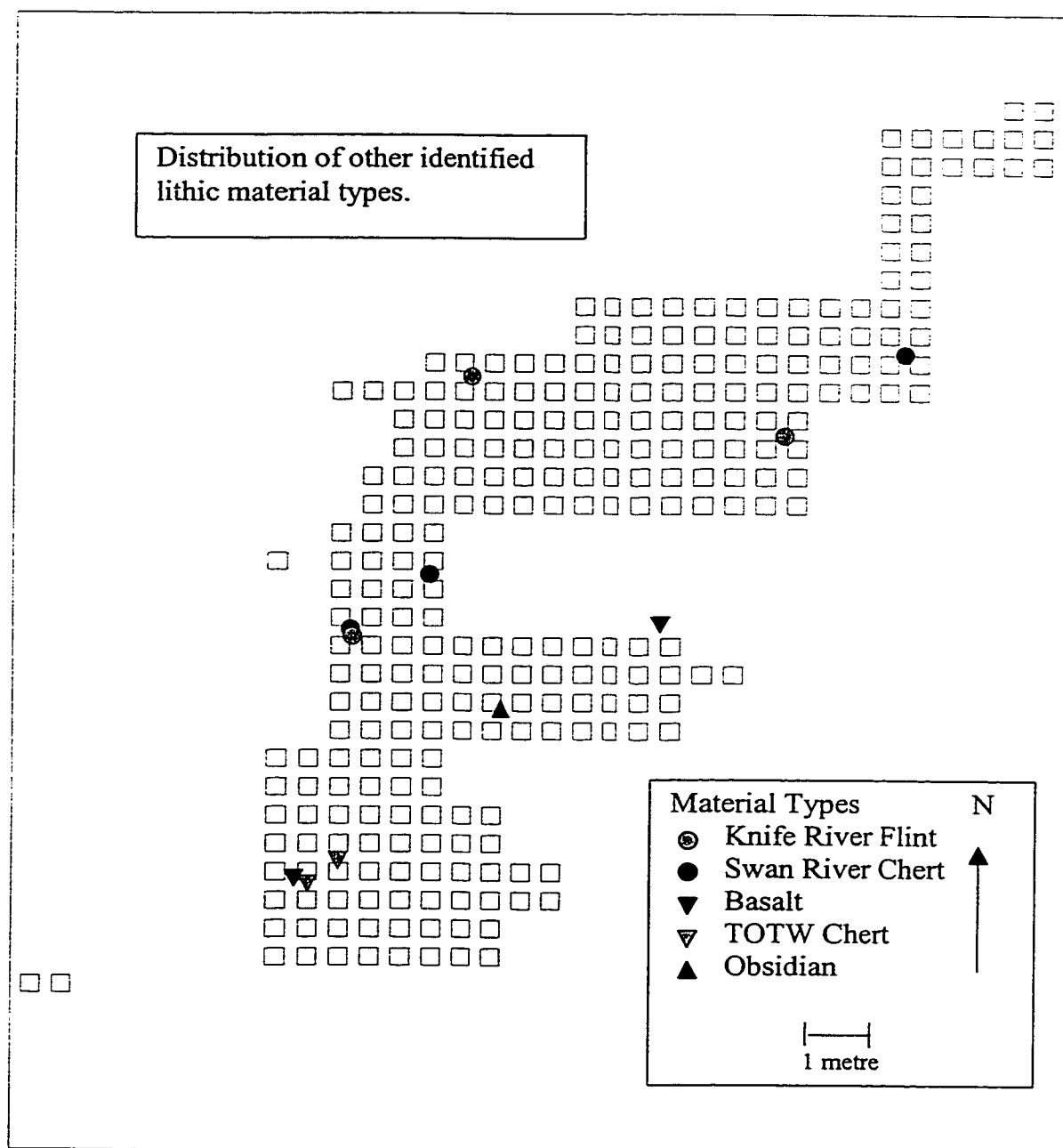


Figure 4.2. Distribution of other identified lithic material types. Knife River Flint and Swan River Chert are found only in the north and central parts of the site, whereas Basalt and Top of the World Chert are found only in the south and central parts of the site.

sample size precludes any real conclusions from being suggested. The remaining “materials types” could only be identified to a generic level, such as “black chert” or “quartzite”. The distribution of these is not illustrated here.

Late Side-Notched Projectile Point Attributes

Table 4.2 illustrates the tool/point types studied. Of the 84 lithic artifacts examined, 56 were identified as Late Side Notched points and 21 were identified as point tips. In addition, one drill, one end scraper, one knife, one retouched/utilized flake and 3 biface fragments were identified.

Table 4.2. Frequencies of lithic artifact types.

Artifact Type	Frequency	Proportion of Total (%)
Late Side Notched Point	56	66.7
Point tip	21	25.0
Drill	1	1.2
Knife	1	1.2
End Scraper	1	1.2
Biface Fragment	3	3.6
Retouched/Utilized Flake	1	1.2
TOTAL	84	100.1

Because the points found at EgPn-440 were all identified as Late Side-notched, various attributes were examined and measured based on the attributes presented in Peck (1996). In his thesis, Peck establishes a classificatory system for Late Side-notched points which attempts to overcome issues arising from the conventional classification of such points as either Prairie Side Notched (typically assigned a time period of approximately 1300 to 700 BP) or Plains Side Notched (typically assigned the subsequent time period of roughly 700 BP to the historic period) (Kehoe 1966:830-833; Forbis 1960). The new system presented by Peck is based on a set of both discrete and

continuous attributes, some of which have been used before in classifying Late Side-notched points (Forbis 1960), and some of which were developed by Peck (1996).

Peck uses a system of attributes to classify Late Side-notched points as either Cayley series points or Mortlach Group points. Early Cayley series points are found throughout Alberta and Saskatchewan from ca. 1250 BP to ca. 650 BP. Late Cayley series points are found in the western portion of that area after ca. 650 BP. In Saskatchewan, the Mortlach Group points, which differ significantly from the Cayley series, appear after this date (Peck 1996:115). This classificatory system has since been used by Peck and Ives (n.d.), where they identify attributes deemed particularly significant, and by Peck and Sinkey (n.d.) in a comparison of projectile points from Cold'Arse Cave in Southern Alberta.

Fifty-six complete or partial points from EgPn-440 were examined and measured using Peck's attributes. Attributes evaluated will be used in two ways in this thesis. First, attributes will be evaluated for the entire point assemblage in an attempt to ascertain an affinity with either Early Cayley, Late Cayley or Mortlach. This is based on an assumption that the points represent a single kill event. The second method will involve the use of a spatial distribution of several attributes which are distinctive of one of the series (Early Cayley, Late Cayley or Mortlach). If a group of points with a distinctive attribute is found in a specific part of the site but is absent elsewhere, this may indicate that two separate kill events are discernible based on the projectile points.

Although Peck and Ives (n.d.) determined that the most significant discrete attributes were Basal Edge Shape, Notch Form, and Base Form, all seven of the discrete attributes described by Peck were evaluated in this study. These are presented in tables 4.3 through 4.9 alongside the expected frequencies from the Early and Late Cayley series, and the Mortlach group. Seven discrete attributes were examined: Basal Edge Shape, Notch Type, Notch Form, Flaking Pattern, Cross-Section, Outline Symmetry, and Base Form. These attributes were evaluated by comparing standardized frequencies of the

different forms, as described and illustrated by Peck (1996), with the frequencies expected as determined by Peck's classificatory system.

Twelve continuous attributes were measured: Base Height, Shoulder Height, Notch Height, Notch Depth, Base Width, Neck Width, Blade Width, Length, Thickness, Proximal Base Angle, Distal Base Angle, and Shoulder Angle. The mean value for each attribute was again compared with the expected mean as determined by Peck's system. These results are presented in Table 4.10. Note that the values provided by Peck for the Early Cayley and Late Cayley series are identical (1996:81-83).

An interpretation of each of the attribute frequencies (for both discrete attributes and continuous attributes) will be provided in the following sections.

Evaluation of Discrete Attributes

Table 4.3 summarizes the frequencies of basal edge shapes as compared with the expected frequencies from the Cayley series and Mortlach group. Basal Edge Shape indicates whether the basal edge of the point is straight, concave, convex, and so on. Examining Table 4.3, the points from EgPn-440 clearly show affinity with the Cayley series points, both early and late, and not with the Mortlach group.

Table 4.4 presents the notch type frequencies. Notch type refers to the location of the notches, such as side-notched or corner-notched. Only one of the EgPn-440 points demonstrated corner notching, and the side-notched variety was clearly the most common. No other notch types were observed. This differs from both the Cayley series and the Mortlach group points in that less variety is observed. The high proportion of side-notched points most resembles the Mortlach pattern.

Table 4.3. Comparison of standardized basal edge shape frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Straight	41.3	49.5	48.6	73.5
Concave	30.4	28.9	35.4	19.0
Convex	10.9	17.8	9.2	4.0
Notched	0	0.6	0.6	0.2
Oblique	0	0.3	0.8	0.2
Spurred	0	0	0.6	0.2
Irregular	17.4	2.9	4.7	2.8
TOTAL	100	100	100	100

Table 4.4. Comparison of standardized notch type frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Side-Notched	98.0	85.9	86.0	98.1
Corner-Notched	2.0	4.3	2.9	0.8
Side-Corner	0.0	9.2	7.5	0.6
Other	0.0	0.6	3.6	0.4
TOTAL	100	100	100	99.9

Table 4.5. Comparison of standardized notch form frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach Group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Broad	100.0	97.5	86.2	37.5
Narrow	0	2.5	13.8	62.5
TOTAL	100	100	100	100

Table 4.6. Comparison of standardized flaking pattern frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Irregular	100.0	79.1	76.9	80.6
Edge-Modified	0	11.4	12.8	12.5
Parallel	0	5.6	4.2	2.9
Double Diagonal	0	3.2	5.6	2.9
Diagonal Oblique	0	0.8	0.6	0.9
TOTAL	100	100.1	100.1	99.8

Table 4.7. Comparison of standardized cross-section frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Plano-convex	27.8	26.2	37.2	11.5
Convex-asymm.	70.4	60.4	40.3	63.8
Convex-symm.	1.9	5.2	13.4	14.5
Biplano	0	6.7	3.7	0
Plano-triangular	0	1.6	4.9	9.8
Convex-triang.	0	0	0.5	0.4
TOTAL	100.1	100.1	100	100

Table 4.8. Comparison of standardized outline symmetry frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
Asymmetrical	97.3	94.6	91.0	93.1
Symmetrical	2.7	4.8	7.2	6.6
Intentional Asymm.	0	0.7	1.8	0.2
TOTAL	100	100.1	100	99.9

Table 4.9. Comparison of standardized base form frequencies from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach group.

	EgPn-440 (%)	Early Cayley Series (%)	Late Cayley Series (%)	Mortlach Group (%)
#2 Fish-tailed	23.4	20.6	21.8	9.6
#3 Oblong	2.1	7.2	5.6	1.8
#4 Barn	27.7	6.2	4.6	3.3
#5 Pie-pan	6.4	21.3	21.5	5.1
#6 Rectangular	4.3	2.1	5.3	53.8
#13 Lens	6.4	11.7	4.2	0
Other	29.8	30.9	37.0	26.1
TOTAL	100.1	100	100	100

Table 4.10. Comparison of average values (in mm) for projectile point attributes from EgPn-440, Early Cayley series, Late Cayley series, and the Mortlach Group.

	EgPn-440	Early Cayley Series	Late Cayley Series	Mortlach Group
Base Height	2.9	2.0	4.0	4.1
Shoulder Height	6.5	6.5	6.5	6.8
Notch Height	3.8	3.2	3.2	2.5
Notch Depth	2.0	1.8	1.8	2.3
Base Width	13.4	12.6	12.6	14.6
Neck Width	9.5	8.7	8.7	9.6
Blade Width	14.2	12.8	12.8	13.8
Length	23.7	20.6	20.6	21.3
Thickness	3.6	3.4	3.4	3.6
Prox. Base Angle	105	105	105	95
Dist. Base Angle	114	112	112	99
Shoulder Angle	110	107	107	92

Table 4.5 presents the notch form frequencies. The projectile points from EgPn-440 demonstrate 100% broad notches, which are defined as being wider than they are deep. This pattern most closely resembles the Early Cayley series projectile points, and is least similar to the Mortlach series projectile points.

Flaking pattern frequencies are presented in Table 4.6. Flaking pattern refers to the pattern of flake scars observed on the point. One hundred percent of the EgPn-440 points exhibit an irregular flaking pattern, a much higher proportion than observed in any of the comparative groups. The Mortlach group exhibits the highest proportion of irregular flaking patterns at 80.6%, but the difference between this figure and those figures for the Cayley series are not significant compared to the difference between the Mortlach group and EgPn-440. Comparing the mean for the EgPn-440 points with the Cayley series or Mortlach group appears to provide little information with which to classify the EgPn-440 points.

Cross-section frequencies are presented in Table 4.7. Cross-section refers to the apparent cross-section of the point as observed when looking down the longitudinal axis and is an indication of the degree of flaking (Peck and Sinkey, n.d.). The pattern exhibited by the EgPn-440 projectile points most closely resembles the pattern observed for the Early Cayley series points, with similar proportions of Plano-convex, Convex-asymmetrical, and Convex-symmetrical cross-sections. The pattern is most unlike the Mortlach group points.

Table 4.8 presents the frequencies of outline symmetry, which refers to the symmetry of the margins, notches and base of the point. The projectile points from EgPn-440 demonstrate a large proportion of asymmetrical points which most closely resembles the Early Cayley series points, and is least like the Late Cayley series.

Table 4.9 presents the standardized frequencies for the base form of the projectile points. Base form is the shape of the base of the point as illustrated by Peck (1996:262).

The frequencies of base forms for the EgPn-440 points again appear to resemble the Cayley series points most closely, particularly in the relatively high frequency of the “fish-tailed” base, and in the low frequency of “rectangular” bases. The unexpectedly low frequency of “pie-pan” shaped bases, however, appear to contradict this pattern. A possible explanation for this anomaly may lie in the small number of points (47) for which base form could be identified. Looking at the overall pattern, however, it seems clear that, from an evaluation of the discrete attributes, EgPn-440 points are most similar to the Early Cayley series points.

Evaluation of Continuous Attributes

All twelve continuous attributes described by Peck were measured for the EgPn-440 assemblage. The mean measurement for each attribute from EgPn-440 is presented in Table 4.10, along with the mean measurements for the Early and Late Cayley series and the Mortlach group. Base Height and Notch Height are the linear measurements which are considered by Peck to be the most significant, and the three angular measurements (proximal base angle, distal base angle and shoulder angle) are also considered to be significant. Peck provides boxplots for many of the characters, which display the statistics for the distribution of attributes from various sites. By comparing the EgPn-440 values to those presented in the boxplots for each character, it is possible to compare the assemblages. The EgPn-440 assemblage will be compared to the Old Women’s Buffalo Jump and Head-Smashed-In distributions, as these sites provide the most information on variation of point attributes through time. A probably time period for the use of EgPn-440 as determined by the point attributes will be suggested and compared with the radiocarbon dates presented in chapter three.

Base height is considered by Peck (1996) to be one of the linear measurements most significant in distinguishing between Early and Late Cayley series points. The mean base height for the EgPn-440 projectile points is 2.9 mm. This figure is between

the means measured for the Early Cayley points at 2.0 mm, and the Late Cayley points at 4.0. The Mortlach points have a mean measurement of 4.1 mm, very similar to that of the Late Cayley points. According to Peck (1996:81), base heights for the Cayley series tend to increase over time. When the mean value for the EgPn-440 points is compared to points from the Old Women's Buffalo Jump, the base heights most closely resemble points from between 700 and 900 BP (Level 8, median value approximately 2.75mm). When the Head-Smashed-In data is used as a comparison, the result is a date of 700 years BP (Level 5, approximately 3.0mm). These dates suggest an affiliation with Early Cayley.

Shoulder height values appear to vary little among the groups presented in the table. The mean shoulder height for the EgPn-440 is the same as the shoulder heights for the Early and Late Cayley series, and is slightly less than the mean value for the Mortlach group. This attribute does not change over time within the Cayley series. When the mean value of 6.5 for the EgPn-440 points is compared with those at the Old Women's Buffalo Jump, a time period of 700 to 900 years BP is again the estimate (Levels 7 to 9, approximately 6.5mm). This suggests an Early Cayley affiliation. However, a date of approximately 450 years BP comes from the comparison to the Head-Smashed-In data (Level 3, approximately 6.5mm), which would suggest a Late Cayley affiliation. This date is not typical of most other results, however.

Notch height is the second of two linear measurements considered by Peck to be significant in distinguishing Late Side-notched projectile points. Notch height values for the EgPn-440 points (mean of 3.8) are higher than any of the values presented by Peck. However, this value more closely resembles the value for the Cayley series than for the Mortlach series. Comparing the mean notch height of the EgPn-440 points to the Old Women's Buffalo Jump material, a time period of 1050 to 850 BP is determined (Levels 9 to 10, approximately 3.8mm). When comparing this value to the Head-Smashed-In points, the result is a date of approximately 750 BP (Level 6, approximately 3.25mm). Both of these dates suggest an Early Cayley affiliation.

Notch depth for the EgPn-440 points was 2.0 mm, higher than the Cayley series at 1.8 mm, and lower than the Mortlach group at 2.3. Given this value, it appears that this attribute when measured on the EgPn-440 points provides us with little information in terms of classifying these points. At both the Old Women's Buffalo Jump and at Head-Smashed-In, the mean values change so little over time, that an approximation of the time period for the EgPn-440 points cannot be made.

Base width values show a similar pattern to notch depth, in that the EgPn-440 values appear to fall between the values for the Cayley series (which do not change over time) and the Mortlach group. Comparing the value of 13.4 from the EgPn-440 points with the Old Women's Buffalo Jump, a time period of around 650 BP is arrived at (Level 6, approximately 13.75mm). This date lies at the transition from Early Cayley to Late Cayley. Comparing this value to the Head-Smashed-In data results in an estimation of around 450 BP (Levels 1 to 2, approximately 14.0mm), indicating a Late Cayley affiliation.

Mean neck width of the EgPn-440 points most closely resembles the Mortlach group points, at 9.5 and 9.6 respectively, compared with 8.7 for the Cayley series points. Peck does not provide boxplots for neck width for comparison purposes.

Mean blade width for the EgPn-440 points is a higher value than that for either the Cayley series or the Mortlach group. This appears to continue a trend for many of the linear values of being higher than expected. This pattern is also evident in the mean length measurement for the points, which is 14.2 mm, higher than both the Cayley series points at 12.8 mm, or the Mortlach group points at 13.8 mm. It appears that the EgPn-440 points are larger than average Late Side-notched points. This may indicate that lithic materials were relatively abundant, both higher quality materials such as Montana cherts and poorer quality materials such as petrified wood. The value of 14.2 for the blade width of the EgPn-440 points is significantly higher than the mean values for any time period for either the Old Women's Buffalo Jump or for Head-Smashed-In; comparisons

with these collections was not possible. Information on length from these sites was not presented by Peck in boxplots for comparison.

Mean thickness measurements are relatively consistent for all the groups presented in Table 4.10. The mean thickness for EgPn-440 is 3.6 mm, the same as the mean for the Mortlach group. The Cayley series points tend to be slightly thinner, with a mean thickness of 3.4 mm. This minor variation in thickness may be explained by the larger overall dimensions of the EgPn-440 and Mortlach group points. Information on the thickness of points from the Old Women's or Head-Smashed-In Buffalo jumps was not provided in boxplots for comparison.

The three angular measurements are all considered by Peck to be significant in classifying Late Side-notched points. Proximal base angle, the angle of the corner at the basal edge, remains constant through time for the Cayley series points, and the EgPn-440 mean value is the same as this value, at 105°. The Mortlach group proximal base angle is much more acute on average, at 95°. Comparing the EgPn-440 value with that of the Old Women's Buffalo Jump results in a date of roughly 750 – 800 BP (Level 8, approximately 105°), placing it in the Early Cayley series. From the Head-Smashed-In information, a date of 450 – 700 BP results (Levels 3 to 5, approximately 105°). This date spans the transition from Early to Late Cayley.

The distal base angle, the angle of the corner at the top of the base, is also much more acute for the Mortlach group points, at 99°, than for either the EgPn-440 points, with an angle of 114°, or the Cayley series, with an angle of 112°. The shoulder angle exhibits the same pattern. The EgPn-440 points have an angle of 110°, which is more similar to the Cayley series at 107° than to the Mortlach group at 92°. For the angular measurements, it seems clear that the EgPn-440 points are much more similar to the Cayley series than to the Mortlach series. Comparing the distal base angle to those from Old Women's and Head-Smashed-In results in dates of 850 – 1050 BP (Levels 9 to 10, approximately 115°) and 1100 BP (Level 7A, approximately 115°) respectively. For the

shoulder angle, the results are dates of 750 – 1050 BP (Levels 8 to 12, approximately 110°) and 750 BP (Level 6, approximately 110°) respectively. All of these dates indicate an Early Cayley affiliation.

Summary of Attributes

Although the EgPn-440 points overall appear to be larger than expected, the key discrete attributes outlined by Peck clearly place these points with the Early Cayley series points.

Key Attributes:	Basal edge shape	Cayley
	Notch form	Early Cayley
	Base form	Cayley
Other Attributes:	Notch type	Mortlach
	Flaking pattern	Indeterminate
	Cross-section	Early Cayley
	Outline symmetry	Early Cayley

The continuous attributes exhibit a similar pattern. Although there is variation in the dates as determined by comparisons with the Old Women's and Head-Smashed-In Jumps, the dates seem to cluster around 750 BP, which would place this kill late in the Early Cayley series. There are, however, also some earlier and later suggested dates. More of the variation in dates tends to be earlier, many suggested dates ranging from 700 to as high as 1050 years BP. This earlier classification of the point assemblage would agree more closely with the radiocarbon dates (approximately 1250 BP) from the site.

Key Attributes:	Base height	OWBJ: 700 – 900 BP HSI: 700 BP
	Notch height	OWBJ: 850 – 1050 BP HSI: 750 BP
	Proximal base angle	OWBJ: 750 – 800 BP HSI: 450 – 700 BP
	Distal base angle	OWBJ: 850 – 1050 BP HSI: 1100 BP
	Shoulder angle	OWBJ: 750 – 1050 BP HSI: 750 BP
Other Attributes:	Shoulder height	OWBJ: 700 – 900 BP HSI: 450 BP
	Notch depth	OWBJ: indeterminate HSI: indeterminate
	Base width	OWBJ: later than 650 BP HSI: later than 450 BP

Overall then, the morphological attributes of the projectile points at EgPn-440 indicate an affiliation of this group with the Early Cayley series.

Spatial Distribution of Attributes

The question of whether EgPn-440 represents a single kill event or two kill events that are spatially distinct was proposed in the introduction. It is suggested that if two kill events took place here, these kill events could be separated on the basis of point morphology. This assumes that the two proposed events took place far enough apart temporally for point styles to have changed somewhat. In the remainder of this chapter, the spatial distributions of some of the discrete attributes will be examined in order to determine if separate kill events can be distinguished based on morphological differences.

Three discrete attributes are determined to be useful in classifying the EgPn-440 assemblage in terms Peck's Cayley series and Mortlach group. These are basal edge shape, cross section, and base form (see Tables 4.3, 4.7 and 4.9). In each of these tables at least one of Early Cayley, Late Cayley and Mortlach can be readily distinguished, and the EgPn-440 assemblage overall exhibits frequencies that are distinctive. For example, in the basal edge shape table (Table 4.3), the "Straight", "Concave" and "Convex" frequencies are all reasonably high for the EgPn-440 assemblage (representing more than just one or two specimens), and the variations in frequencies between Early Cayley, Late Cayley and Mortlach are distinctive. Thus, plotting the spatial distribution of these characteristics for the EgPn-440 points should indicate if the site was used only once (if distributions are consistent throughout the site) or if it was used on more than one occasion (if distributions of morphological attributes vary in different areas of the site).

Figures 4.3, 4.4 and 4.5 illustrate the spatial distribution of the characteristics for basal edge shape, cross section and base form for the EgPn-440 assemblage.

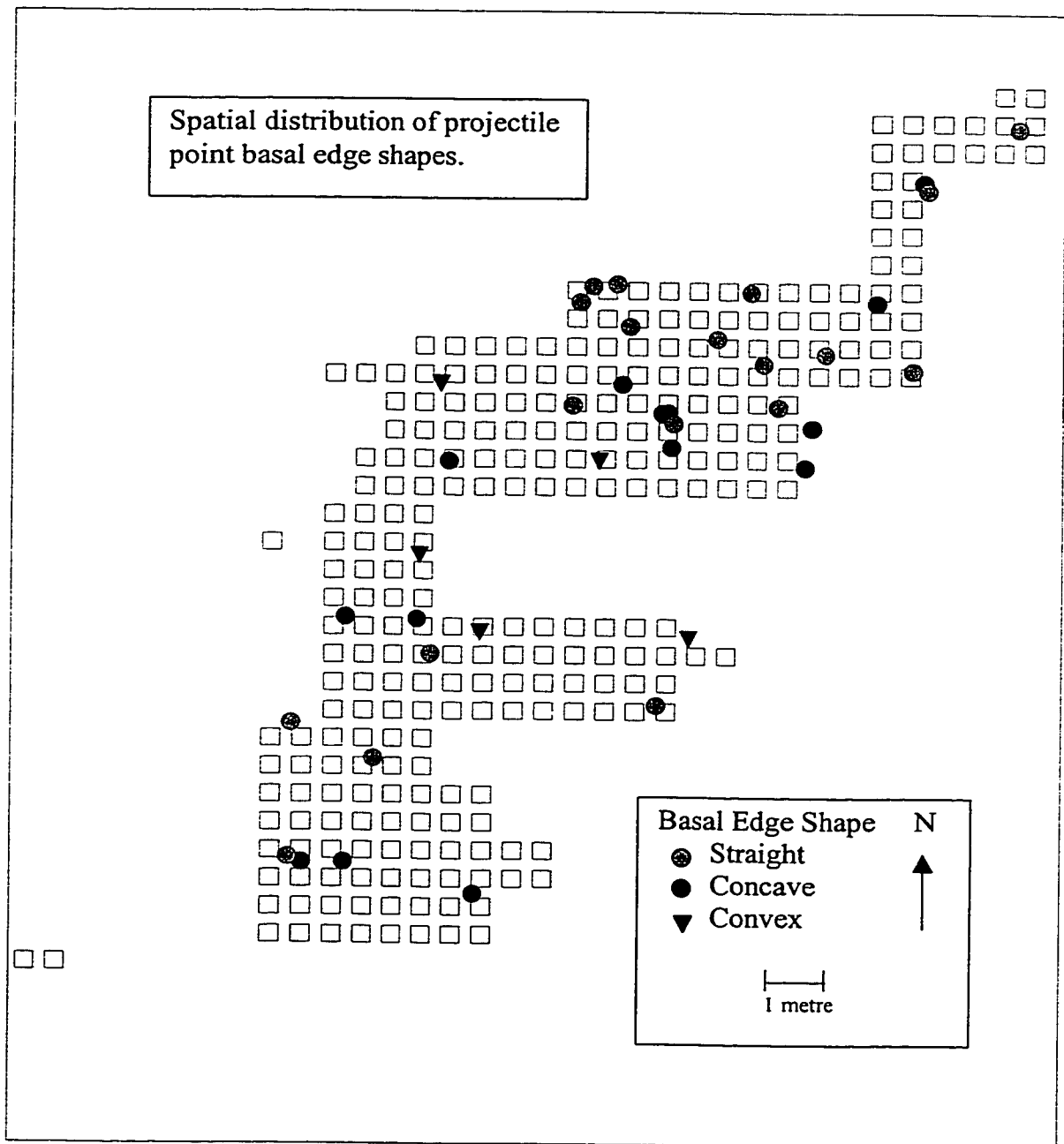


Figure 4.3. Spatial distribution of projectile point basal edge shapes at EgPn-440. This figure indicates a relatively scattered distribution of these basal edge shapes, although there is larger proportion of straight bases in the north part of the site and the convex bases are all centrally located.

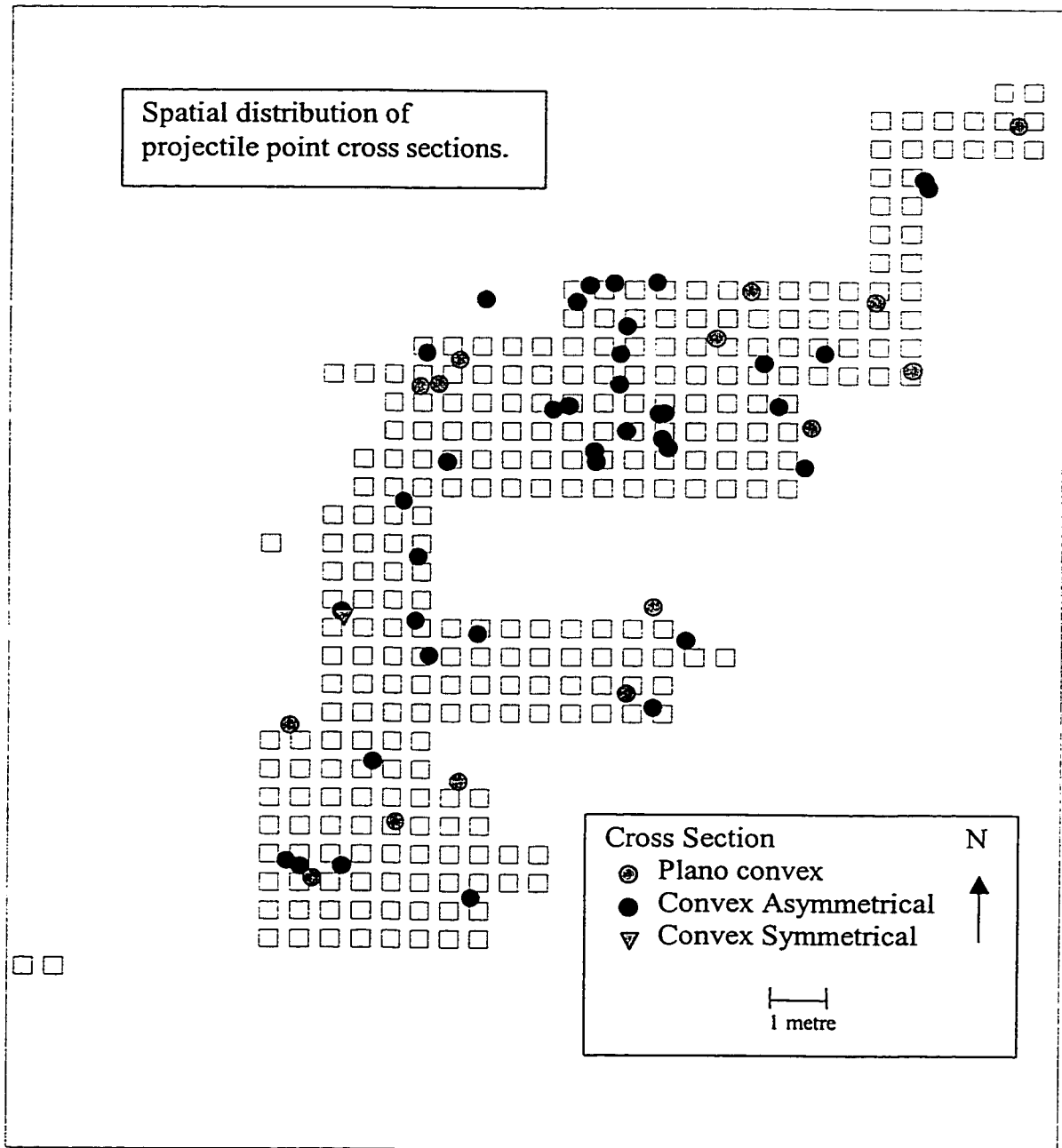


Figure 4.4. Spatial distribution of projectile point cross sections at EgPn-440. Distributions are relatively scattered, although the high proportion of convex-asymmetrical points in the north portion of the site may indicate that this part of the site represents a different kill event from that in the south.

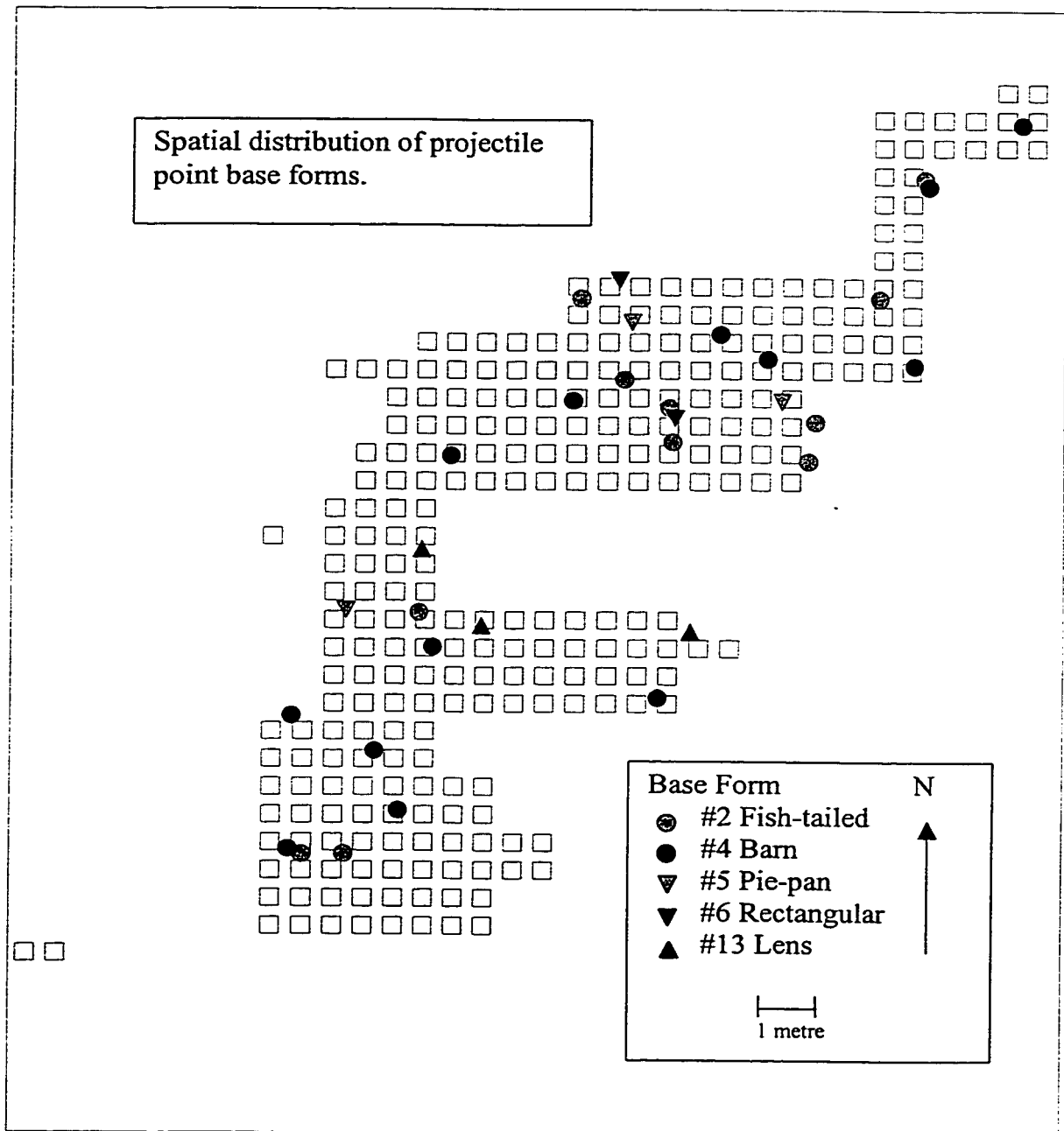


Figure 4.5. Spatial distribution of projectile point base forms at EgPn-440. Fish-tailed forms are more concentrated in the north than in the south, which suggests a tie of the north with the Cayley series, and not the Mortlach group. Other base forms are found scattered through the site, with the exception of lens shaped bases, which are found in the central portion only.

Figure 4.3 demonstrates a relatively scattered distribution of the basal edge shape characteristics. Straight basal edges are the most common edge shape found at EgPn-440. These specimens are found throughout the site, although there is a definite concentration in the north as compared with the south. A high frequency of straight basal edges is most closely associated with Peck's (1996) Mortlach group, and may suggest some sort of affinity with this group in the northern part of the site. Both the Early Cayley and the Late Cayley points also show relatively high frequencies of straight bases, however, and the proportion of straight bases appears to most closely resemble the Early Cayley series. The geographic location of the site (in Alberta, not in Saskatchewan) would suggest that an Early Cayley classification is most appropriate. In addition, the radiocarbon dates of 1280 \pm 50 year BP and 1240 \pm 50 years BP may support the north part of the site being used by Early Cayley series groups. The south part of the site does not exhibit this same concentration of straight bases, which may suggest that a different group used the south of the site at a different time than the north. Note, however, that such minor differences may not necessarily require that a great deal of time has passed between the uses of the site, particularly if two different groups are using the site. The other two characteristics show little evidence of any spatial patterning. Concave bases are relatively common and are found throughout the site. Convex bases are less common at EgPn-440, but are found throughout the site, although they are somewhat concentrated in the central part of the excavation area.

Figure 4.4 illustrates the distribution of cross section frequencies at EgPn-440. Plano-convex cross sections are distributed relatively evenly across the site, although they seem to be lacking in the central part of the northern block. The convex-asymmetrical cross sections exhibit an opposite pattern in the north of the site, demonstrating a clear concentration in the centre of the north block of the excavation grid. As with the straight basal edges above, a high frequency of convex-asymmetrical cross sections shows similarity to Peck's (1996) Mortlach group, although the Early Cayley series also shows a similar pattern. This high proportion of convex-asymmetrical

points in the north portion of the site may indicate that this part of the site was used at a different time than the south part of the site. The radiocarbon dates (taken from the north part of the site) are sufficiently old to suggest that perhaps an Early Cayley series group used this part of the site. Only one convex symmetrical specimen was recovered from EgPn-440. It is included in this spatial analysis simply because it is the only specimen that is not one of the two types described above. It was located in a relatively central location on the excavation grid, although this location probably represents a peripheral region to the site itself.

Figure 4.5 illustrates the spatial distribution of base form frequencies for EgPn-440. The northern portion of the site shows a concentration of Fish-Tailed base forms as compared with the south part. This suggests a closer tie with the Cayley series points. Fish-tailed points are uncommon for the Mortlach group. Barn shaped points were common throughout the site at high frequencies. Unfortunately, this base form was found by Peck to be uncommon for either the Cayley series or the Mortlach group. Pie-pan shaped bases are uncommon at EgPn-440, and any distributional patterns are thus difficult to determine. If the north part of the site were Early Cayley series, as was suggested for the spatial distribution of cross sections, we would expect to find a higher concentration of pie-pan bases. This pattern does not occur. Only two rectangular based points were recovered, both in the north of the site. Three lens shaped bases were recovered. These are most common in the Early Cayley series, so we might expect (if the north represents an Early Cayley series kill) that these lens shaped bases would be found in the north. However, they are found in the central portion of the site only.

To summarize, there are clearly some concentrations occurring in terms of the discrete attributes described by Peck. The basal edge shape frequencies show a definite concentration of straight edges in the north part of the site. This concentration does not distinguish between either of the Cayley series points or the Mortlach points, but the radiocarbon dates and the location of the site in Alberta support an Early Cayley affiliation. The clearest concentration occurs in the frequency of convex asymmetrical

cross sections which are present in the north. This resembles both the Early Cayley series and the Mortlach series, but not the Late Cayley series. The south portion of the site does not exhibit this same pattern. Again, radiocarbon dates would support the use of the north of the site by Early Cayley groups. Unfortunately, no radiocarbon dates were obtained from the south part of the site. Such information would help to support the suggestion that the north and south parts of the site were used at different times. The base form distributions show no obvious concentrations that would indicate separate uses.

Conclusions

Based on Peck's (1996) attributes for Late Side-Notched points, the points from EgPn-440 are most like the Early Cayley series when treated as a single kill event. Their continuous attributes suggest a probable date of approximately 750 years BP. Unfortunately, this does not correspond well with the radiocarbon dates returned from Component One, the bone bed, of 1280 +/- 50 years BP and 1240 +/- 50 years BP. This may suggest that looking at the points as belonging to a single kill may be biasing the results. A spatial distribution of several of Peck's (1996) discrete attributes was examined to determine if two separate kill events might be distinguished at the site. A weak affiliation with the Early Cayley series might be suggested for the north part of the site, based on the concentration of straight edge bases and convex-asymmetrical cross sections here, along with the radiocarbon dates. However, even if specific groups cannot be suggested for different parts of the site, it does appear from the basal edge shape and the cross section attributes that some distinction exists between the north and south of the site. This may suggest that the site was used on more than one occasion in the past. This possibility will be examined again in chapter eight.

Projectile points make up 66.7% of the small tools examined here, and a further 25% are point tips. This is consistent with a bison pound, in which one would expect to find a very high frequency of points compared with other tool types. However, the

presence of several other types of tools (an end scraper, a knife, a drill and other biface fragments) suggests that some degree of processing took place at this site. No spatial patterns were evident for these tools to indicate a processing activity area. Rather, they were found in all portions of the site. Further examination of other lithic artifacts from EgPn-440 will undoubtedly provide increased information on the processing that occurred.

Material types are dominated by Montana cherts and various other types of cherts, as well as petrified wood. Chalcedony, Knife River Flint, quartzites, basalt, silicified siltstone, ironstone and obsidian are present in lesser amounts. Material types are relatively consistent with those found at other Late Prehistoric sites on the Northern Plains.

CHAPTER FIVE

FAUNAL ASSEMBLAGE

The following section first outlines briefly the procedures undertaken in cataloguing and analyzing the faunal remains, and discusses the non-bison faunal remains. The remainder of the chapter is focused on the bison remains from the site. The quantification of the remains is presented, followed by a detailed discussion of each of the elements recovered, focusing particularly on butchering patterns. The final section of this chapter looks at the bone tools recovered and the pathologies present in the bison remains.

Laboratory Methods

The faunal remains from EgPn-440 were washed by workers in the Western Heritage laboratory in Saskatoon and were placed into bags and boxes labelled with the provenience. In the laboratory at the University of Calgary, each element was catalogued and analyzed in a single step and like elements were then placed together. In the analysis, File Maker Pro version 2.0 (Claris 1993) was the database used.

Identifiable specimens were catalogued by recording the catalogue number; provenience information (northing, easting, quadrant, level, depth of level, and exact depth (where applicable)), material class, species, body portion, element, side, weight, and size class. In addition, the stage of fusion, butchering, burning, gnawing, root marks, human modification, weathering stage, and fracture type were also identified. A bone unit (based on Brumley 1991) was assigned to each specimen and the landmarks present (based on Kooyman, n.d.) were also recorded. Specimens which were unidentifiable were catalogued by recording catalogue number, northing, easting, quadrant, level, depth of level, material class, weight and burning. Unidentifiable fragments were classified as Unidentified Skull, Unidentified Tooth, Long bone fragments, or simply Unidentified. Table 5.1 presents the frequencies of classes of unidentified bone fragments.

Sources used to aid in the identification of faunal remains include: Olsen (1964); Schmid (1972); Brown and Gustafson (1979); Hesse and Wapnish (1985); Gilbert (1990); Balkwill and Cumbaa (1992); and Hillson (1996).

Table 5.1. Frequency of unidentified faunal materials.

Class of Unidentified Fragments	Frequency
Unidentified skull fragments	1203
Unidentified long bone fragments	428
Unidentified tooth fragments	2070
Unidentified	52458
TOTAL	56159

A total of 68,478 pieces of faunal material were catalogued from 71 square metres of excavation at EgPn-440. Bison (*Bison bison bison*) dominates the assemblage, representing 91.74% of the total assemblage by count, or Number of Identified Specimens (NISP). Table 5.2 presents the frequencies of species recorded.

A total of 765 burned and 3019 calcined bone or tooth fragments were catalogued. However, when the historic component (Component One) is removed from the sample, the numbers are reduced to 140 burned and 89 calcined fragments. Of these, only two fragments were identifiable. Below the historic material, no evidence of a burned layer is present; burned and calcined bone appears to be present in small amounts in most levels.

Root marks were noted for each identifiable bone. Root marks were identified as either absent (showing root marks on less than 5% of the bone surface), minor (showing root marks on between 5% and 30% of the bone surface), or major (showing root marks on greater than 30% of the bone surface). 19.9 % of bones were classified as absent for root marks; 60.2% of bones were classified as having minor root marks, and 19.9% of bones had major root marks. Root marks did not appear to be a major factor affecting the integrity of the bone.

Table 5.2. NISP of taxa identified at EgPn-440, and their percentage of the total identified assemblage.

Taxon	Common name	NISP	Percent of Total Identified
<i>Bison bison</i>	Bison	11302	91.74
<i>Bos taurus</i>	Domestic cattle	758	6.15
<i>Ovis/Capra</i>	Domestic sheep/goat	5	0.04
<i>Sus scrofa</i>	Domestic pig	11	0.09
Large canids	Wolf	88	0.71
Small canids	Foxes	2	0.02
<i>Cervus elaphus</i>	Elk (Wapiti)	4	0.03
<i>Odocoileus hemionus</i>	Mule deer	6	0.05
Artiodactyla	Artiodactyls	7	0.06
<i>Lepus americanus</i>	Snowshoe hare	20	0.16
<i>Spermophilus richardsonii</i>	Richardson's ground squirrel	9	0.07
<i>Spermophilus columbianus</i>	Columbian ground squirrel	39	0.32
<i>Thomomys talpoides</i>	Northern pocket gopher	12	0.10
Rodentia	Rodents	6	0.05
<i>Branta canadensis</i>	Canada goose	1	0.01
<i>Buteo jamaicensis</i>	Red-tailed hawk	1	0.01
Fish	Fish	48	0.39
TOTAL IDENTIFIED		12319	100
Unidentified	Unidentified	56159	
TOTAL		68478	

Weathering patterns were also observed for the identifiable bone. Degree of weathering was classified into stages based on Behrensmeyer (1978). All bone from EgPn-440 was classified as belonging to either Stage 1, in which small cracks appear on the surface of the bone, or Stage 2, in which cracks and flaking of the cortical surface are present. Only 0.7% of the EgPn-440 identified bone was classified as belonging to Stage 2. The remaining 99.3% were classified as weathering Stage 1. Weathering usually occurs on bone exposed to the elements, particularly temperature extremes and changes in moisture (Behrensmeyer 1978:154). The low degree of weathering on the bones from

EgPn-440 indicates that bison remains at the site were probably buried rapidly after deposition and were thus not subject to the stresses of temperature extremes and moisture fluctuations. In addition, gnawing by carnivores and rodents is relatively rare at EgPn-440. Carnivore gnawing was observed on 131 specimens and fourteen specimens exhibited rodent gnawing. This small proportion of gnawn bones indicates that carnivores and rodents had little impact on the majority of faunal remains at the site. Overall, preservation is good.

Non-Bison Faunal Remains

As demonstrated in Table 5.2, a number of other species and taxonomic groups were found in the faunal assemblage at EgPn-440, although in very small frequencies compared to the frequency of bison remains. The non-bison faunal assemblage will be discussed briefly here.

As mentioned, Component 1 consists of largely historic materials, including metal and glass, and is characterized by the presence of domestic animal remains. These include domestic cattle, domestic sheep/goat, and domestic pig. Domestic cattle (*Bos taurus*) are difficult to distinguish from bison (*Bison bison*). Balkwill and Cumbaa (1992) have prepared a guide aimed toward distinguishing between the two species, using a combination of a number of characteristic on each element. However, this process is time consuming and the results of such a comparison would be tentative at best. Thus, for the purposes of this study, *Bos* was identified as any bovid bone found in the upper levels of the excavation, which ended somewhere between 40 and 50 cm below surface, depending on the unit. 16% of the bovid bone catalogued had evidence of being sawn or cut using modern metal tools, and sawn bovid bone was present up to a depth of 50 cm below surface. Bone classified as domestic *Ovis/Capra* may be either domestic sheep or domestic goat, as these species are difficult to differentiate from the post-cranial skeleton.

Eleven pieces of domestic pig bone were also identified, three of which showed evidence of sawing or cutting.

Eighty-eight specimens identified as Large Canid bones were recovered from the assemblage. Eighty-one of these were from the prehistoric levels and the remaining seven specimens were from the upper historic levels. All of these specimens are as large or larger than the wolf comparative sample in the faunal laboratory in the Department of Archaeology at the University of Calgary. This strongly suggests that these canid remains are likely *Canis lupus* (wolf), rather than the smaller *Canis latrans* (coyote) or *Canis familiaris* (domestic dog). Canid remains in archaeological contexts are relatively difficult to distinguish based on morphology; size may be used to distinguish between the larger wolf and the smaller, slither coyote. According to Driver (1976:10), prehistoric domestic dogs are usually considered to fall somewhere between the two species in terms of size. The large size of the canid specimens found at EgPn-440 suggests that they are probably *Canis lupus*.

A number of these large canid specimens were recovered from a single unit and probably represent a single individual. Thirty-seven elements or pieces of elements were present, including skull, some fragments with teeth, both the left and right mandible, and twelve complete or fragmentary vertebrae, including the atlas and axis. Elsewhere at the site, another fragmented skull was recovered, two mandible halves, several isolated elements, and a number of isolated teeth. The MNI is three based on left mandibles. When compared to the frequencies of other non-bison remains found in the prehistoric levels, large canid is relatively abundant. This is a common pattern in bison kill sites; Krozser (1991) details several possible explanations for the incorporation of canid remains into bison kills. A common explanation is the scavenging nature of wolves when presented with an abundance of fresh meat. However, it should be noted that the good preservation of the faunal remains at EgPn-440 indicates a rapid burial which suggests that the remains were only available to scavengers for a limited amount of time. The reasons behind the death of wolves at kill sites are not always apparent (Walker 1975).

Killing of the wolves for their hides may be one explanation. One metatarsal was found with cut marks evident on the shaft of the bone. This may suggest butchering of the animal for the hide. Alternatively, bone beads made from canid metatarsals are also found on the Northern Plains. Dogs may have also been occasionally included in the diet, as suggested by White (1955:170) and Schwartz (1997), among others.

Two bones belonging to a much smaller canid were also identified in the faunal assemblage. These bones probably belong to a small fox species, perhaps the Kit Fox (*Vulpes macrotis*) or the Swift Fox (*Vulpes velox*). Both of these species were present on the northern plains in the past, but were extinct in Canada until a major reintroduction of the species approximately ten year ago (Banfield 1974:303).

Two species of Artiodactyls were found in the assemblage. Four Elk (*Cervus elaphus*) bones and six Mule Deer (*Odocoileus hemionus*) bones were identified. Two bones belonging to an unidentified Artiodactyl were also noted, as well as five teeth.

Nine bones belonging to *Spermophilus richardsonii* (Richardson's Ground Squirrel) were identified, as well as 39 *Spermophilus columbianus* (Columbian Ground Squirrel) specimens and 12 *Thomomys talpoides* (Northern Pocket Gopher) specimens. Six bones belonging to an unidentified member of the Order Rodentia were also identified. Rodents are commonly found in faunal assemblages on the plains, and specimens in good condition are likely a relatively recent addition to the assemblage. Rodent burrows were recorded in the field notes. The presence of both *S. richardsonii* and *S. columbianus*, however, is interesting, since the distributions of these species do not generally overlap (Banfield 1974). In Canada, *S. richardsonii* is associated with the plains, whereas *S. columbianus* is associated with the eastern part of the Rockies. The presence of both these species at EgPn-440 is likely indicative of the location of the site on the boundary between the plains to the east and the parklands to the west.

Twenty bones belonging to *Lepus americanus* (Snowshoe Hare) were identified. These bones were all recovered from the same unit, and it is likely that they represent one

individual. The humerus of a Canada Goose (*Branta canadensis*) was recovered, as was a coracoid of a Red-Tailed Hawk (*Buteo jamaicensis*). These were the only bird bones identified at the site. Based on the same number of bird bones at the Ruby Site in Wyoming, Frison has suggested that the presence of bird bones may indicate that some camp activity may have been taking place at the site (Frison 1971:86). These bones may have also been introduced to the site by non-human agents before or after the kill took place, although one would expect to recover more than just a single bone if an animal is introduced to the site by natural causes.

Forty-eight fish bones were recovered, 45 of which were vertebrae. These specimens were all recovered from Component Five, the historic component. Species determination of these fish remains was not performed due to their fragmented nature and their presence in the historic component only. No fish remains were recovered from the prehistoric levels.

Quantification of Bison Remains

The remainder of this chapter will deal with the quantification of the bison remains recovered from EgPn-440. Quantification of faunal remains, like the study of faunal remains itself, is a relatively recent addition to archaeological analysis. In order to make full use of the faunal remains recovered from archaeological sites, it is necessary to do more than just determine which species were present. Detailed quantification and discussion of the taphonomic factors which affect faunal remains are now a major part of nearly all faunal analyses and comparisons between sites require that quantification be performed. Standard methods of quantifying faunal data from archaeological sites are now employed and are discussed in detail by Binford (1978; 1981), Grayson (1984) and Klein and Cruz-Urbe (1984).

Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), Minimum Number of Elements (MNE) and Minimum Animal Units (MAU) are the methods of quantification employed for this analysis. These will each be discussed in more detail in the following section. The quantification for each element recovered from EgPn-440 is presented in Table 5.3. Table 5.4 presents the elements ranked from highest MNI values to lowest to give an indication of the relative abundance of elements at the site.

Number of Identified Specimens

NISP (Number of Identified Specimens) is defined by Klein and Cruz-Urbe as “the number of identified bones (specimens) per species...” (1984:25). This is the simplest method of quantifying faunal remains, and is usually the first step in quantification. Most of the more complex methods are based on NISP. This method of quantification has a number of problems in terms of quantifying fauna, and these have been detailed elsewhere (see Grayson (1984), Klein and Cruz-Urbe (1984)).

Minimum Number of Individuals and the Use of Landmarks and Bone Units

Minimum Number of Individuals (MNI) is “the number of individuals necessary to account for all the identified bones” (Klein and Cruz-Urbe 1984:26). White (1953) is credited with introducing this method of quantification into archaeology.

As described in the methodology section of this chapter, both bone units and landmarks were noted for each identifiable bison specimen. The calculation of MNI is one of the most obvious reasons for undertaking such a task. In the past, MNI has usually been calculated by separating “...the most abundant element of the species found...into right and left components and use the greater number as the unit of calculation.” (White 1953:397). Determining MNI is seldom as simple as this description

Table 5.3. NISP, MNI, MNE and MAU values for the bison assemblage.

Element	NISP	MNI	MNE	MAU
Mandible	831	67	126	63
Skull	395	10	10	10
Incisor	169	-	-	-
Max PM	176	-	-	-
Mand PM	143	-	-	-
Max M1, M2, M3	195	-	-	-
Mand M1, M2	83	-	-	-
Mand M3	33	-	-	-
Hyoid	148	16	23	11.5
Sternum	2	1	1	1
Atlas	75	54	54	54
Axis	63	49	49	49
Cervical vertebra	409	48	237	47.4
Thoracic vertebra	1047	36	457	35.2
Lumbar vertebra	318	19	131	18.7
Sacrum	34	22	22	22
Caudal vertebra	51	-	-	-
Ribs	4087	24	593	22.8
Scapula	623	34	58	29
Humerus	133	16	29	14.5
Radius	109	20	35	17.5
Ulna	87	15	28	14
Scaphoid	25	13	25	12.5
Magnum	38	23	38	19
Lunate	26	13	26	13
Cuneiform	24	15	24	12
Unciform	24	14	24	12
Pisiform	20	11	20	10
Metacarpal	60	19	36	18
Fifth metacarpal	16	8	16	8
Innominate	182	28	53	26.5
Femur	92	12	18	9
Patella	7	4	7	3.5
Tibia	142	21	38	19
Astragalus	30	17	30	15
Calcaneus	43	26	41	20.5
Navicular cuboid	37	23	36	18
Cuneiform pes	33	19	33	16.5
Lateral malleolus	27	14	27	13.5
First tarsal	13	7	13	6.5

Table 5.3 continued. NISP, MNI, MNE and MAU values for the bison assemblage at EgPn-440.

Element	NISP	MNI	MNE	MAU
Metatarsal	60	21	34	17
Second metatarsal	8	4	8	4
Proximal phalanx	145	19	139	17.4
Middle phalanx	111	16	108	13.5
Distal phalanx	116	15	112	14
Proximal sesamoid	69	5	69	4.3
Distal sesamoid	48	6	48	6
Irregular sesamoid	2	1	2	0.5

Table 5.4. Elements ranked by MNI.

Element	MNI	Element	MNI
Mandible	67	Humerus	16
Atlas	54	Middle phalanx	16
Axis	49	Ulna	15
Cervical vertebra	48	Cuneiform	15
Thoracic vertebra	36	Distal phalanx	15
Scapula	34	Unciform	14
Innominate	28	Lateral malleolus	14
Calcaneus	26	Scaphoid	13
Ribs	24	Lunate	13
Magnum	23	Femur	12
Navicular cuboid	23	Pisiform	11
Sacrum	22	Skull	10
Tibia	21	Fifth metacarpal	8
Metatarsal	21	First tarsal	7
Radius	20	Distal sesamoid	6
Lumbar vertebra	19	Proximal sesamoid	5
Metacarpal	19	Patella	4
Cuneiform pes	19	Second metatarsal	4
Proximal phalanx	19	Caudal vertebra	1
Astragalus	17	Irregular sesamoid	1
Hyoid	16		

implies; rarely are elements such as long bones (or even their distal or proximal ends only) found intact at archaeological sites. The use of bone units or landmarks (Kooyman 1985:123), entered into the database at the time of initial analysis, provides a simple method of finding the most abundant portion or locus of a bone and determining the number present simply by searching for those specimens with that landmark present.

In the determination of MNI in this study, the landmarks which had the possibility of being the most common for each element were examined using the “find” function in File Maker Pro (Claris 1993). A number were selected for each element so that it could be certain that the most commonly occurring landmark would be selected. In addition, bone units that included a common portion of the bone (for example, bone units that included the body of the axis) were added together to determine an MNI. Performing a series of checks for frequencies of various landmarks and various bone units resulted in a variety of different MNI values. The highest value for each element was selected as the minimum number of individuals that it would take to result in such an assemblage.

An advantage of this system of determining MNI is the time and effort saved by the need to look at the specimens only once. In addition, the MNI determined by using such a system will likely be more accurate than that determined by visually inspecting each specimen. Particularly with the use of landmarks, the absence or presence of very specific points on each element are recorded. Rather than searching for all specimens in which the medial half of the distal end of the tibia is intact, for example, a number of precise points on this part of the bone and others can be quickly checked and compared.

In comparing the benefit of using landmarks versus bone units, the advantage of one over the other appears to change with the element being examined. Thirteen elements resulted in a higher MNI using landmarks, 10 elements had a higher MNI count using bone units, and 11 (all carpals and tarsals) had an equal MNI count for both landmarks and bone units.

Limb bones appeared to be equally balanced between landmarks and bone units in terms of which produced the highest MNI. Femora, metacarpals, metatarsals, and phalanges resulted in higher MNI counts when landmarks were searched in the database. Humeri, radii, and tibiae resulted in higher counts when bone units were searched. Irregular bones, including the mandible, skull, hyoid, and innominate resulted in consistently higher MNI counts using landmarks, with the exception of the vertebral column elements (atlas, axis, cervical, thoracic, lumbar vertebrae and the sacrum), which had higher MNI counts when using bone units. The reason for these differences lies in the symmetry of the bones. It was found in this study that the bone units for such elements as the mandible, skull and innominate were insufficiently precise in determining MNI. A number of additional bone units were used to accurately identify the portion of these elements present, particularly the mandible. This element is sufficiently complex and asymmetric that the presence or absence of landmarks was far more precise in indicating which portion of the element was present than selecting bone units that included a common portion. In contrast to this, the symmetry of the vertebral elements and the presence of one obvious and central feature, the centrum, made the bone units more practical for these elements. Bone units for the vertebrae were less precise than landmarks, but provided a more accurate count of whether the majority of the centrum was present or not. Crushing and similar types of data often meant that some landmarks of the centrum were absent even though the bulk of the centrum was present. Thus, using bone units provided a more accurate MNI count than searching for specific landmarks on the centrum. Adding the frequencies of all bone units which include the majority of the centrum (so that no single element would be counted twice) resulted very clearly in the highest MNI counts for the vertebral units.

Two further comments should be added to this discussion. First, it is impractical to search all possible combinations of landmarks and bone units. A number of such searches will yield the same results, simply because the same information is being found. For example, if the landmarks of the condyle on the mandible are being found, then searching for bone units which include the condyle will return the same results. Second,

the searches to be done are, to some extent at least, based on patterns noted during analysis. During the basic analysis, it was clear that certain portions of elements were more commonly recovered, due to butchering patterns or taphonomic processes. The searches to be conducted in a study such as this are most efficiently based on trends and patterns defined during analysis, although other alternative searches should also be conducted to ensure that patterns weren't missed during analysis.

It is important to remember that the minimum number of individuals is just that – a minimum value. The actual count may have been much higher than this. Speth (1983:53) notes that, with the material at the Garnsey Site in New Mexico, higher MNI estimates “... would be obtained if: (1) each stratigraphic level were treated as a discrete unit; (2) each bone cluster within a level were treated as a discrete unit; (3) the ages of cranial and postcranial elements were considered; (4) idiosyncratic metric and nonmetric characteristics of postcranial elements were considered.” Similarly, higher MNI values may be obtained from the faunal remains at EgPn-440 if more attention was directed along these avenues.

Minimum Number of Elements and Minimum Animal Units

MNE (Minimum Number of Elements) was a count originated by Binford (1978:69; 1984:50) and is defined by Lyman (1994a:42) as the “minimum number of individual elements necessary to account for the whole and fragmentary specimens observed.” MNE takes into account the minimum number of elements that can account for the sample regardless of side. For example, if there are five left femora and three right femora, the MNE becomes eight. Shortt (1993:75) notes that for assemblages in which preservation is poor, the use of MNE counts may provide more information, since elements which cannot be sided cannot be used in MNI, but can still be accounted for in MNE. As already mentioned, preservation was generally very good at EgPn-440, so MNE values were rarely different from MNI values.

MAU (Minimum Animal Units), a count also developed by Binford (1978:70; 1984:51), was created in response to the suggestion that the use of MNI implied that meat is used by people in whole animal units. "...MAU's are specimen counts normed by the number of times the element involved is represented in the skeleton of the taxon involved." (Grayson 1984:89). MAU is calculated by dividing the MNE for each element by the number of times that element occurs in the skeleton of a particular taxon (Lyman 1994a:42). So, for the example of the femora mentioned above, the MNE of eight is divided by the number of times the femur occurs (two), and the minimum animal unit count is four.

Bone density

Prior to discussing the portions of elements recovered and associated butchering patterns, a brief discussion regarding the preservation of bone at the site is warranted. A variety of factors may influence the presence or absence of bone elements at an archeological site. If different elements are present in different frequencies, human removal of the element from the assemblage may not be the only cause. Preservation of bone at an archaeological site should be examined before any conclusions are made regarding cultural processes. Lyman notes:

Given an interest in explaining skeletal part frequencies by reference to transport or economic utility indices, the zooarchaeologist must be sure that those frequencies are indeed a reflection of economic decisions and not some other factor, such as differential preservation (Lyman 1994:235).

As a means of addressing this issue, two techniques were undertaken with the EgPn-440 assemblage. The first, bone weathering, has been discussed briefly already. Behrensmeyer (1978) presents weathering stages, ranging from zero to five, to indicate the degree to which elements such as moisture and temperature have affected the specimen. The weathering stage of each identifiable bone specimen at EgPn-440 was

noted during the initial analysis. These are presented in Table 5.5. Weathering stages for this assemblage were consistently noted to be in the very early stages, all specimens being classified as either Stage 1 or Stage 2. This overall lack of weathering indicates that this assemblage was likely buried very rapidly, preventing moisture and temperature changes from affecting the integrity of the bone. This lack of weathering has resulted in excellent preservation of the faunal remains at this site.

Table 5.5. Frequencies of weathering stages on identified specimens.

Weathering Stage	Brief Description	Frequency at EgPn-440	Percentage of Assemblage
One	Small cracks appear in the surface of the bone.	11175	99.3%
Two	Cracks and flaking of the cortical surface are present.	83	0.7%

In addition to bone weathering, however, other factors such as leaching of bone minerals can also affect the integrity of the bone. As a second technique of determining bone integrity, volume density scan values for portions of bison elements were examined in terms of the frequency of landmarks noted for the EgPn-440 specimens, following Kooyman (in press).

Kreutzer (1992) presents volume density scan values for various portions of bison bone elements and includes diagrams of the locations of the scans. Three elements were chosen as a sample for the EgPn-440 assemblage: atlas, axis, and calcaneus. These elements demonstrate significantly different volume density values for different parts of the element, allowing the degree of preservation to be ascertained. These elements are all generally low in terms of economic utility, and therefore it is expected that the cultural removal or destruction of these elements due to their economic value will not be a considerable factor.

Table 5.6 lists the scan sites as labelled by Kreutzer (1993) and their associated values. The landmarks which best represent the scan area are listed, and the frequency of which those landmarks are present is noted (MNE and MNI).

Table 5.6. Scan sites and volume density values, and frequency of associated landmarks (indicated by MNE and MNI).

Element	Scan Site	Volume Density	Best Associated Landmarks	MNE	MNI
Atlas	AT1	0.52	7, 18	50	50
	AT2	0.91	20, 21	50	50
	AT3	0.34	3, 6, 11, 15	49	49
Axis	AX1	0.65	1, 2, 3	48	48
	AX2	0.38	23, 26	40	40
	AX3	0.97	21, 22	43	43
Calcaneus	CA1	0.46	8, 11	36	23
	CA2	0.80	7	42	26
	CA3	0.49	4, 5, 6	39	25
	CA4	0.66	1	40	25

Table 5.6 illustrates that for all three elements, the frequency of specimens does not change substantially for those scan sites with high volume density values versus those with low volume density values. I suggest that this is an indication of the integrity of the bone at the site, since both less dense and more dense portions of the elements are almost equally well preserved. This is an indication that poor preservation of bone is not a major factor contributing to the frequencies in which elements are recovered from the site. Other factors, such as cultural ones, must thus be incorporated to explain these frequencies. This issue will be addressed throughout the remainder of this thesis.

Description of Elements Identified at EgPn-440

The following section will describe in more detail the identifiable bison elements from EgPn-440, including frequencies, portions, fracture locations and types, and the butchering patterns inferred. Note (Table 5.1) that there is an abundance of unidentified materials recovered from this site. Since the bulk of the identified material recovered was identified as bison it seems likely that a good portion of the unidentified materials are also bison, but are fragments too small (or lacking distinguishing features) to be identified. The amount of unidentified bone and the presence of 428 pieces of unidentified long bone fragments suggests extensive butchering of bone, particularly in light of the good preservation of the material as shown from weathering stages and bone density/element frequency analysis. Although unidentified materials cannot be incorporated into specific discussions of butchering, the number of unidentifiable fragments should be taken as evidence that significant butchering occurred at this site.

Overall, cut marks and spiral fractures are relatively rare, particularly considering the good preservation of the faunal remains. For comparison, see Brink and Dawe (1989:159) for their discussion of the Head-Smashed-In faunal assemblage. In the 1985 and 1986 HSI seasons, cut marks and spiral fractures were more abundant than for the EgPn-440 assemblage, despite the eroded nature of the HSI faunal assemblage and despite a smaller assemblage size. Lyman states that "...it is clear that the frequency of cut marks is... an important variable that in some manner reflects human behaviours" (Lyman 1994b:303). However, Lyman (1978:4) has also noted that an "...absence of cut marks on archaeological specimens does not eliminate "deboning" of meat from the butchering process." Cut marks are a reflection of the procedures undertaken for removal of meat, but some methods of meat removal, such as cuts made parallel to the bone's surface, may not result in cut marks appearing on the bone. However, despite the relatively small number of cut marks present in the EgPn-440 assemblage, a combination of approaches that includes looking at butchering marks, spiral fractures, and distribution

of elements at the site will provide a great deal of information about the cultural procedures taking place.

Fusion stages of elements are also noted with the descriptions of each element. Approximate age estimations are provided based on Duffield (1973). However, it should be noted that Duffield's correlation of fusion with age is based on studies of European bison (*Bison bonasus*). Todd (1987:172) notes that a number of discrepancies exist between known fusion rates of *Bison bonasus* as compared with *Bison bison*, and the ages suggested here should be taken merely as a very general approximation of age.

Axial Skeleton

Mandible

Specimens identified as mandible numbered 831, including 270 left, 317 right and 244 pieces that were indeterminate as to side. Pieces consisting of both bone and tooth (those including some socketed teeth) numbered 111, whereas the remaining 720 pieces consisted of bone only. The MNI was determined by the presence of 67 rights with landmark #19, the medial half of the condyle. This MNI proved to be the highest MNI of all elements at EgPn-440.

Six specimens were either complete or were missing only the coronoid process or demonstrated crushing of the angle. Twelve specimens consisted of large (greater than half of the element) anterior portions, and 16 specimens consisted of large (greater than half of the element) posterior portions. Ninety-six coronoid processes were found individually, 103 condyle portions were found individually, and 113 pieces were identified with the condyle, coronoid process and small parts of the ascending ramus. Forty-three specimens consisted of part or all of the angle, and 24 were identified as being part of the anterior margin of the ascending ramus. Thirty-three specimens had the complete tooth row only, and 291 specimens consisted of just a portion of the tooth row. Specimens consisting of just the anterior part of the element, anterior to the tooth row,

numbered 168. Thirty-seven specimens consisted of part of the ventral border only. Sixty-eight bone units were used to identify portions of the mandible, and 31 landmarks were used.

Only one mandible exhibited cut marks, found on the lateral surface of the horizontal ramus. One specimen was made into a tool, possibly a scraper of some kind (see the final section of this chapter for descriptions of bone tools). Three specimens exhibited carnivore gnawing, and 17 specimens were identified as having spiral fractures, which may suggest that the jaw was being broken either during removal from the skull, or to extract marrow from the horizontal ramus. Spiral fractures are an indication that the bone was broken when it was fresh, and humans are generally considered to be the cause of such fractures at archaeological sites (but see Haynes 1983 for a discussion of spiral fractures caused by trampling by ungulates). The large number of loose coronoid processes (96), condyles (103) and a combination of the two (113) may suggest that the jaw was being removed, resulting in breakage of these parts of the mandible. From a similar pattern identified at the Happy Valley Site, Shortt (1993:100) suggests that "...a likely method of jaw removal involved several sharp blows with a blunt hammerstone against the point of articulation between the skull and mandible." However, the lack of cut or chopping marks may not support this conclusion at EgPn-440.

Of the 17 specimens identified as having spiral fractures, nine consist of the anterior portion of the mandible, including the incisor sockets, symphyseal end, mental foramen and interalveolar border. Two others consist of a smaller portion of this anterior end. This suggests that the mandible was deliberately broken at the interalveolar border, perhaps to extract the marrow in the horizontal ramus. Two specimens with spiral fractures include an essentially complete tooth row beginning posterior to the interalveolar border. These are again probably specimens broken to obtain marrow. The remaining four specimens consist of large portions of the ascending ramus, two with the condyle present and two without; none of these specimens have the coronoid process. These four specimens may have been fractured to obtain marrow as described for the

previous specimens. The lack of coronoid processes on these specimens may also suggest that the mandible was deliberately removed from the skull by chopping through this process.

Skull

Fragments identified as belonging to the skull, or cranium, of the bison numbered 395. Most of these were fragments of horn cores or those associated with horn cores (115), including five complete horn cores. Other fragments identified include portions of the nasal (45), premaxilla (64), occipital condyles (8), orbit (10), maxillary fragments (32) and portions of the temporal and/or zygomatic process (47). Twenty-four fragments of the petrous portion of the skull (internal auditory meatus) were identified, resulting in an MNI of ten based on right elements. This MNI value is significantly lower than the MNI of sixty-seven for the mandibles. Since the petrous portion of the skull is very dense and is more likely to survive than other parts of the bison skeleton, this discrepancy suggests that the skull and mandible were treated as separate units, as previously inferred by Frison (1971:83). The skulls may have been removed from the site for ceremonial purposes. Mandelbaum (1979:54) describes the presence of a buffalo skull at the entrance to a tipi beside the pound in which a shaman called for spirit help. This suggests that the skull of the buffalo had spiritual importance. Alternatively, the skulls may have been removed from the site for further processing. The brains and nasal cartilage may have been removed at a processing area or campsite, as has been suggested for the Cactus Flower site (Brumley 1978:189). There is also record of the cartilage in the head of the bison being boiled for glue (Mandelbaum 1979:60). No spiral fractures were evident on any of the skull fragments.

Loose Teeth

Loose teeth or fragments of loose teeth numbered 799. The following frequencies were observed: 176 maxillary premolars, 195 maxillary molars, 169 incisors, 143

mandibular premolars, 83 mandibular first or second molars, and 33 mandibular third molars. Of the third mandibular molars, 12 were left, 18 were right, and three were indeterminate as to side.

Hyoid

Specimens identified as hyoids numbered 148. Thirty-one of these were identified as left, 29 as right, and 88 fragments were indeterminate as to side. The MNI that resulted from examination of the hyoids was 16, based on the presence of the caudal (smaller) projection. Fourteen bone units and six landmarks were used to indicate the portion present. Four of the hyoids exhibited cut marks on the shaft. The hyoid supports the tongue, and the removal of the tongue will often result in the hyoid being removed or in cut marks resulting on the bone. Ethnographic accounts indicate that the tongue of the bison was a choice part (Roe 1972; Schaeffer 1978; Mandelbaum 1979; Verbicky-Todd 1984). The presence of cut marks on four of the hyoids from EgPn-440 indicates that the tongue was likely removed. However, Frison (1974:48) notes that at the Casper Site, the removal of the tongue often resulted in cut marks on the medial side of the mandible as the mylohyoideus muscle was removed. These cut marks do not appear on the mandibles at EgPn-440. Nonetheless, the presence of cut marks on four of the hyoids does suggest that the tongue was removed, perhaps by a different process than that which occurred at the Casper Site.

Sternum

Only two specimens were identified as sternebrae. The sternum is a porous bone, and preservation of sternebrae is expected to be rare. This may explain the paucity of sternal remains at this site, although, as already noted, preservation at EgPn-440 is overall very good. However, the sternum is an element associated with large amounts of meat. In Binford's study of meat utility for the caribou, the sternum has the third highest value on the meat utility index, after only the distal femur and the proximal femur (Binford

1978:73). Frison (1974:44) also noted that at the Casper Site, the lack of sternal bones suggests that the brisket was a desired cut of meat, with the distal ends of the first ribs being removed along with the sternum. However, Emerson's (1990) bison utility indices assign the sternum a lower utility index in bison than Binford did for caribou. In Emerson's Total Products index, for example, the ribs, vertebrae and sacrum-pelvis all receive higher values than the sternum, indicating that the utility of this element is significantly different for caribou and bison. The extreme paucity of sternbrae at EgPn-440 is thus more difficult to explain in terms of butchering choices.

Atlas

Seventy-five specimens were identified as atlases. Of these, 54 were complete or complete with crushing along the edges of the wings. Overall then, the preservation of the atlas specimens is excellent, with little breakage appearing to have occurred. Other bone units which were identified include the element broken in half (2), small portions of the dorsal arch (4) and the ventral arch (2), fragments of the anterior articular surface (4) and various other fragments occurring in low frequencies. No cut marks were identified on any atlas specimens. Fourteen bone unit designations and 34 landmarks were used. One specimen was classified as being unfused, and four other fragments were associated with this specimen (although fusion could not actually be determined on these specimens). Fifty-four specimens were identified as being fused without a line, indicating an age of over one year (Duffield 1973:133).

There appear to be two different butchering patterns in terms of the removal of the skull. Kehoe (1973:153) notes that at the Gull Lake Site, the atlas was removed with the skull by cutting between the atlas and axis. This pattern is noted at other sites, such as the Mulbach Site (Shortt 1993:269), the Fitzgerald Site (Hjermstad 1996:178) and the Casper Site (Frison 1974:48). Evidence for this is suggested to be the presence of articulations of vertebrae beginning at the axis rather than the atlas, and the presence of butchering and related damage to the spine and processes of the axis (Hjermstad

1996:178). At EgPn-440, butchering is not evident on either the atlas or the axis (see below).

Axis

Sixty-three axis specimens were identified at EgPn-440. The MNI is based on 49 specimens which had the complete body present, with damage occurring to various other portions of the element. Configurations of the axis specimens include 26 specimens which are essentially complete with various degrees of crushing of the spine, 23 specimens which are characterized by the absence of one or both posterior processes, one piece which is a single detached posterior process, and 12 fragments of the anterior articular surface. No cut marks, carnivore gnawing or rodent gnawing were identified. Specimen #25222, identified as an axis in the database, actually consists of a pathological fusion of the axis and third cervical vertebra. Twenty-two of the axis specimens were identified as unfused (indicating an individual under approximately six years in age), one specimen was fused with the fusion line still visible (indicating an individual in the sixth year), and 26 were fused without a line (indicating an age of over six years) (Duffield 1973:133). Nineteen bone units and 28 landmarks were used to identify portions.

The configurations of the axis described here may be compared to Shortt (1993:84). At the Happy Valley Bison Kill, Shortt notes that the “ubiquitous” removal of the transverse and spinous processes at Happy Valley may be related to the removal of either neck muscles or to the removal of the skull. In the EgPn-440 assemblage, elements showing removal of the transverse and/or spinous processes are common, but not ubiquitous. This may suggest that different butchering patterns occurred at these two sites.

As mentioned, butchering is not evident on either the atlas or the axis elements, although the axis elements are more damaged and incomplete than the atlas. This may indicate that this is the point where the skull was being severed. However, another

pattern of skull removal is noted in Binford's ethnographic study of the Nunamiut of north central Alaska. In their butchering of caribou, the head was always separated from the body by cutting between the occipital condyles of the skull and the atlas (Binford 1978:51-54). This was also noted, in ethnographic research among African groups and the Navajo, as being the ideal method of separating the skull from the neck (Binford 1981:91). This must be considered as a second method of removing the skull that may result in different butchering patterns. If this were the method of removing the skull, one might expect to find evidence of butchering on the base of the skull at the occipital condyles. At EgPn-440, no butchering marks are evident on the occipital condyles to indicate that this is the point of separation of the skull. However, skulls are extremely rare at EgPn-440, suggesting that the separation may have occurred between the skull and atlas, and the skulls subsequently removed from the site.

Cervical Vertebrae

At EgPn-440, 409 specimens were identified as cervical vertebrae C3 through C7. No attempt was made to distinguish between the different cervical vertebrae beyond separating the atlas and axis from the remaining five. By adding together the frequency of specimens in which the bone units include an essentially complete centrum, the minimum number of elements was calculated to be 237. Thus the MNI was calculated at 48 based on five per bison. Other configurations of cervical vertebra included specimens that had part of the centrum (19), arch and anterior/posterior processes (2), parts of the spine (12), ventral or lateral transverse processes detached from the element (60), anterior or posterior processes detached (13), and unfused fragments of cranial, caudal or process epiphyses (66). Fifty bone unit designations and 28 landmarks were used. No cut marks were observed. One specimen exhibited carnivore gnawing. Without taking into account whether fusion involved the cranial or caudal epiphysis, 190 specimens were identified as being unfused, 20 were fused with a visible line and 117 were fused without a line. These fusion stages respectively indicate individuals of ages of under six years, individuals in the sixth year, and individuals seven years or older (Duffield 1973:133).

No direct evidence of butchering was found on the cervical vertebrae. Sixty ventral and/or transverse processes were detached from the body and twelve spinous processes were also detached. Kehoe (1973:153) suggested that the removal of these processes may occur with the removal of the neck meat. However, these portions of the element are relatively fragile and natural fracturing may account for their fragmented nature. The lack of any cut marks also supports this suggestion. Binford (1981:110) noted that the neck does not usually undergo a large degree of butchering in the primary butchering stages. The MNI of 48 for the cervical vertebrae is relatively high, suggesting that the cervical vertebrae were left at the kill site.

Thoracic Vertebrae

Specimens identified as thoracic vertebrae numbered 1047. The minimum number of elements, again determined from the presence of the complete centrum, was 457. MNI was thus 36. Fifty-one specimens consisted of part of the body, 14 specimens were transverse processes only, 18 pieces consisted of part of the arch (sometimes also including the proximal spine), 506 specimens were a fragment of the spinous process or the base of the spinous process, sometimes including parts of the anterior or posterior articular processes, and 100 pieces were fragments of unfused cranial or caudal epiphyses. Forty-five bone unit designations and 28 landmarks were used. Cut marks were identified on eleven specimens. Four of these specimens had short cut marks, three located mid-way up the spine, and the fourth located on the left side of the arch. Two specimens had very fine, longer (3-4 cm) cut marks located on the side of the spine at the level of the posterior facets. One specimen had approximately 10 cut marks on the cranial part of the spine half way up the spine. One specimen had very large, coarse cut marks near the tip of the spine. One specimen had a large cut mark across the cranial epiphysis, and part of the epiphysis had been removed, probably due to a blow. One specimen had chopping marks at the base of the spine below the left posterior facet. Carnivore gnawing was identified on eight thoracic specimens, and rodent gnawing was

absent. Again, without taking into account whether fusion involved the cranial or caudal epiphysis, 354 specimens were classified as unfused (100 of these were unfused epiphyses), 37 were fused with a line, and 262 were fused without a line. Fusion stages indicate similar ages to those cited for the cervical vertebrae above.

The transverse butchering cut marks found on the spine are likely from the removal of hump meat, whereas the cut marks found on the body of the thoracic and at the base of the spine are more likely to have resulted from segmentation of the vertebrae (Binford 1981:110-111). The MNI for the thoracic vertebrae is 36, lower than the MNI for the atlas, axis and other cervical vertebrae, suggesting that the thoracic part of the vertebral column was being segmented, and parts removed from the site for further processing. For those thoracic vertebrae that remained at the site, nearly all of the spines were broken off and are absent. This suggests that the distal spines were removed from the site with the hump meat and taken elsewhere for further processing (Frison 1974:45). Similarly, Kehoe (1973:153) suggests that the spines were cut off or broken to remove the prized back fat. The presence of eight spirally fractured thoracic spines may confirm this. Thus, for EgPn-440, it appears that the spines were broken to remove the meat and fat from the hump of the bison, and that segments including several thoracic vertebrae were removed in their entirety for further processing.

Lumbar Vertebrae

Specimens identified as lumbar vertebrae numbered 318. The minimum number of elements, based on the presence of the complete centrum, was calculated to be 131. In addition, six specimens had part of the centrum, 43 had articular processes only and/or part of the neural arch, 66 had part of the spinous process attached to the arch, and 50 consisted of part or all of one of the transverse processes. Twenty-three specimens were part or all of one of the unfused cranial or caudal epiphyses. Thirty-eight bone unit designations and 28 landmarks were used to indicate the portion present. Cut marks were present on one specimen on the cranial spine, near the base of the spine. One specimen

exhibited carnivore gnawing. Seventy-two specimens were found to be unfused, one was fused with a line, and 92 were fused without a line. Again, fusion stages indicate ages similar to those cited for the cervical and thoracic vertebrae above, although the lumbar epiphyses are generally the last to fuse of the vertebral elements (Duffield 1973:133).

Only one element has both transverse processes present, and a further two have one of the two transverse processes. The remaining elements that make up the MNE count are missing both left and right processes. Fifty fragments of transverse processes are present in the assemblage, ranging in size from a few relatively complete processes to small fragments. This pattern of removal of transverse processes may suggest that the side meat was removed; only 50 fragments of these processes were recovered, which does not approximate the missing processes from 130 specimens (the MNE). This pattern may result from the transverse processes being removed with the side meat and transported elsewhere for processing. Frison suggests that this is a common procedure when the sublumbar muscles are included with the meat removed from the rib sections (Frison 1974:38). However, there is a lack of cut marks evident on the transverse processes, which may suggest that the fragile nature of these processes is another explanation for their removal from the assemblage. This hypothesis is not supported by the lack of transverse processes in the assemblage. There is also a paucity of distal parts of the spinous processes, much like the thoracic vertebrae. Brumley suggests that this:

...may reflect the removal of the loins which lie along either side of the vertebral column. In removing the loins, an occasional spinous process might have been broken off and transported back to camp with the meat, while the rest of the element was usually left behind (Brumley 1978:189).

The MNI of 19 for the lumbar vertebrae is significantly lower than that for the other vertebral elements discussed; this may also suggest that the lumbar portion of the column was segmented and removed from the site for further processing.

Sacrum

Thirty-four specimens were identified as being part of the sacrum. Adding together the frequencies of the bone units which contained the complete first vertebra of the sacrum resulted in a minimum number of elements of 22. The remaining specimens are fragments of the sacrum (8), one set of fused spinous processes, and three unfused epiphyses. Fourteen bone units and 50 landmarks were used. No cut marks or gnawing are evident. Eleven specimens were unfused, indicating an age of under six years and 16 were fused without a line, indicating individuals older than this (Duffield 1973:133).

No butchering of the sacrum is evident. The damage observed to many of the wings of the first sacral vertebra may have resulted from the chopping of muscle attachments to separate muscle masses from the bone (Shortt 1993:95), although there are no cut marks as evidence for this at EgPn-440, and no spiral fractures are evident. The MNI of 22 for the sacrum is higher than for the lumbar vertebra, but lower than for the other vertebral elements. This confirms that the lumbar vertebrae were preferentially removed from the site, but also may suggest that the entire posterior portion of the vertebral column is underrepresented. If the lumbar vertebrae were removed for further processing, it seems plausible that the sacrum was sometimes riding along with the lumbar section. In addition, the pelvis and innominate are often fused and may be treated as a single anatomical unit. The lack of any evidence of fused sacrum and innominate at EgPn-440 may be a reflection of the complete removal of this unit from the site for processing. Binford (1981:113-114) notes that cut marks inflicted on the sacrum usually occur during secondary butchering, not primary. Additionally, the first three sacral vertebrae are more common than the distal part of the sacrum. This pattern arises from the removal of the tail along with the hide. Frison (1970a:11) notes that the fourth and/or fifth sacral vertebrae were probably chopped off to facilitate removal of the tail with the hide.

Caudal Vertebrae

Fifty-one specimens were identified as caudal vertebrae. Of these, 38 were essentially complete elements, 23 being relatively “large”, with all of the landmarks visible, and 15 “small”, on which not all of the landmarks could be seen. Assuming 20 caudal vertebrae per bison, this results in an MNI of two. Fifteen bone unit designations and 14 landmarks were used, although these were found to be insufficient due to the variety in morphology of the caudal vertebrae, particularly between the proximal and the distal elements. Bone units specifically oriented towards these different configurations of caudal vertebrae are suggested for future studies. No cut marks were observed on the caudal vertebrae, although one specimen exhibited rodent gnawing. Eight of the specimens were unfused, three were fused with a line, and 30 were fused without a line.

No evidence for butchering was observed on the caudal vertebra. The relative paucity of caudal vertebrae at EgPn-440 is likely due to the removal of the tail along with the hide, as previously discussed. This explanation is suggested to account for the lack of caudal elements at Head-Smashed-In (Brink and Dawe 1989:147).

Ribs

Specimens identified as ribs or rib fragments numbered 4087. MNE was determined by using the landmark for the head of the rib, which resulted in a value of 593. MNI was calculated by dividing 307 right ribs with the head intact by the 13 right ribs present in a bison, resulting in a value of 24 animals. Thirty-six specimens are essentially complete, although all of these are missing the distal tip. Other configurations include those specimens that have the complete proximal portion, including head, neck and tubercle (506), and specimens that are shaft fragments with no head or tubercle evident (3141). Twenty-two bone unit designations and 10 landmarks were used to indicate the portion present. Cut marks were noted on the shafts of 44 specimens, and four specimens appear to have been used as expedient tools. Unfused specimens number 243; if head epiphyses are removed from the sample, this number is reduced to 140

specimens that are unfused. Unfused specimens indicate individuals of under eight years of age. Forty-five specimens were fused with a line, indicating individuals in their eighth year, and 524 were fused without a line, indicating an age of over eight years (Duffield 1973:133). Forty-nine ribs had evidence of carnivore gnawing, and five had been gnawed by rodents.

The ribs demonstrate a large number of cut marks relative to other elements found at EgPn-440, due to butchering patterns already mentioned. Proximal portions of ribs are common, although the bulk of the specimens found are medial shaft fragments. Distal ends of ribs are extremely rare. This is due to the breakage and removal of ribs below the head and tubercle to facilitate the removal of side meat. As mentioned, the ribs were probably often removed in association with the sternal unit, the thoracic unit, or the lumbar unit. The presence of 163 ribs or rib fragments with spiral fractures strongly suggests that the ribs were broken when fresh for removal from the carcass for further processing.

Appendicular Skeleton

Scapula

Specimens identified as being part of the scapula numbered 623. A minimum number of individuals of 34 was determined by counting those specimens which had a complete glenoid fossa on the right side. No complete scapulae were present; this is expected due to the fragile nature of the blade of the scapula. However, 58 specimens consist of the complete proximal end and part or most of the blade. Fifteen specimens have part of the distal end only, 65 specimens are fragments of the spine, and 484 are fragments of the blade. Forty bone unit designations and 23 landmarks were used to indicate the portion present. Five specimens exhibited cut marks, two on the inferior border, one on the superior border, one exhibited chopping marks on the proximal spine, and one specimen had cut marks on a blade fragment. Three specimens exhibited

carnivore gnawing. Based on fusion of the coracoid process, no unfused scapulae were represented and 98 were fused without a line, indicating all specimens represent individuals over eight years of age (Duffield 1973:133). Seventeen specimens had spiral fractures.

Spiral fractures are generally consistent with regard to their location on the scapula. Six specimens consisted of essentially complete proximal ends with spiral fractures below the neck or part way down the blade of the element. This pattern of breakage may suggest that the scapula was broken below the neck, perhaps to remove the forelimb from the carcass. The remaining spirally fractured specimens are smaller fragments that could be related to this same pattern of breakage. Six specimens with spiral fractures were fragments of the caudal border of the element, three specimens were part of the spine, and the remaining two specimens were unidentified blade fragments. However, breaking the element below the neck is not a common procedure in ethnographic accounts of butchering. Binford (1978:52-53) notes that the Nunamiut remove the scapula of the caribou as an intact element. Breakage of the element for removal from the carcass is not necessary. Similarly, Mandelbaum (1979:58) notes that for the Plains Cree, the limbs were disarticulated and cut off, implying that the scapula would have been severed at the joint rather than the distal portion removed by cutting through the bone and associated meat. The spiral fractures noted at the neck of the scapula at EgPn-440 may therefore be related to some other process. Kehoe (1973:153) suggests that scapula at the Gull Lake site may have been struck with stones for marrow extraction, although Emerson's (1990) marrow utility index assigns a relatively low utility value for the scapula compared with most other appendicular elements.

The locations of cut marks at EgPn-440 are similar to those noted by Shortt for the Happy Valley Site. He notes cut marks on the posterior border, on fragments of the blade and on the spine where the acromion has been broken (Shortt 1993:104). These cut marks probably represent the removal of meat from the scapula, not the removal of the

scapula from the body. Brumley notes a similar pattern for the Cactus Flower site, where he suggests that the acromion is poorly represented due to crushing blows which removed the proximal end of the scapula from the distal portions (Brumley 1978:190). Kooyman (1981:153) states that "...the general procedure for processing the scapula seems to have been to break through the glenoid to remove the forelimb and also to sever the glenoid area from the remainder of the scapula." The spirally fractured specimens at EgPn-440 support the removal of the entire glenoid or proximal end, but the number of complete glenoids present at EgPn-440 does not seem to support the former statement.

Binford (1981:121) suggests that cut marks appearing on the scapula during primary butchering will usually be in the location of the glenoid fossa and the neck. This pattern does not seem to be present at EgPn-440. None of the five specimens exhibiting cut marks at this site are in the locations suggested by Binford. Rather, the cut marks occur on the borders, with one example of chopping to the spine and one of cut marks on an unidentified blade fragment. In contrast to Binford, Frison suggests that the scapula was usually separated from the humerus by chopping off the proximal end of the humerus, resulting in little damage to the scapula (Frison 1974:36). He suggests that long cut marks will occur on the infraspinous fossa or the supraspinous fossa due to removal of meat. Aside from the possibility that the small blade fragment with the cut mark is from one of these areas on either side of the spine, the EgPn-440 scapulae do not fit this pattern.

The large difference between the MAU of the scapula (29) and that of the humerus (14.5) supports the suggestion that the scapula and humerus were separated. The proximal scapula was probably left behind at the site whereas the humerus was preferentially removed. White (1955:255) notes that particularly for large species such as bison, the removal of the meat at the kill site would "lighten the load" in terms of transporting carcass units to a processing site. Since the meat of the scapula is relatively

easy to strip from the bone, this element is more likely to be left at the kill site (White 1955:255).

Humerus

The humerus is represented by 133 specimens. The MNI is 16 based on the identification of right specimens with both condyles present. None of the humeri specimens are complete, and only two are nearly complete, missing only small portions of one end. Thirteen fragments are part or all of the proximal end, and 48 are part or all of the distal end. Seventeen pieces are essentially the deltoid tuberosity only, and 12 have only the teres tubercle. The remaining 41 specimens are shaft fragments from various locations. Fifty-one bone unit designations, and 59 landmarks were used to indicate the portion of the element present. Two specimens exhibited cut marks, one on the distal lateral shaft and one on an unidentified shaft fragment. Four specimens had impact marks. Five pieces had evidence of carnivore gnawing. Eighty-one specimens had spiral fractures. One specimen was unfused at the distal end, indicating an individual in the beginning of the fourth year, and 48 were fused without a line, indicating ages greater than this (Duffield 1973:133).

The lack of complete elements, the fragmentary nature of the specimens found, and the high number of specimens with spiral fractures indicate that the humeri at EgPn-440 underwent significant cultural processing. Of the cut marks preserved, those on the distal lateral shaft may indicate that the humerus was separated from the radius/ulna, although the MNE values for these elements are relatively similar. Binford (1981:124) indicates that cut marks across the anterior portion of the distal humerus are usually the most common cut marks found on this element resulting from the primary butchering stage. Four specimens exhibit impact marks where a blow was struck to break the bone open, and 81 specimens exhibit spiral fractures, indicating that the bone was broken when fresh. At the Casper Site, Frison notes that the humerus and radius were often smashed open to remove the marrow after the meat had been stripped from the bone (Frison

1974:38). At EgPn-440, the distal end of the humerus is found in much larger numbers than the proximal end, and this may relate to the smashing of the element for marrow. For example, at the Gull Lake Site, humeri were butchered by breaking off the distal end to gain access to the marrow cavity, resulting in the shaft and proximal end being completely broken (Kehoe 1973:153). The fragmentation of the proximal half of the element suggests that a similar pattern occurred at EgPn-440, but the lack of impact marks may not support this. Kooyman (1981:155) notes that at the Cypress Hills site, impact marks are particularly common on the humerus, a pattern he relates directly to marrow extraction. Thus the lack of impact marks for the EgPn-440 sample (4 for an MNE of 29) may suggest that marrow was obtained only occasionally from the humerus.

Shortt (1993:106) suggests that the proximal ends of the humerus may be shattered due to the smashing of the lateral tuberosity in order to remove the supraspinatus and infraspinatus muscles, which are associated with the scapula and humerus. Similar patterns of breakage were also observed at the Estuary Bison Pound (Adams 1977:94). The fragmentation of this element may also be the result of the fragility of the element, particularly the proximal end which can be susceptible to damage. For example, Brain (1967:2) notes that, in a study of the effect of arid conditions on bones, goat distal humeri were commonly found whereas proximal humeri were absent. If the proximal end is being smashed open for marrow, it is expected that spirally fractured fragments of the proximal end will be present. Twenty-eight specimens exhibiting spiral fractures (of 81 total) were parts of the proximal end or pieces consisting of the most proximal shaft only. This number may support the hypothesis that proximal ends are being butchered for marrow, but the lack of impact marks cannot be ignored. It may be necessary to employ a number of factors to account for the fragmentation of the humerus.

Radius

A total of 109 specimens were identified as radii. The MNI was 20 based on the identification of left specimens with the complete distal end. Ten complete specimens were present, four left and six right. Fifteen specimens were part or all of the proximal end only, and three were part or all of the distal end. Three specimens were large pieces split longitudinally, 20 were shaft fragments which included part of the ulna or the scarred attachment surface, and 14 pieces were other shaft fragments. The distal shaft of the ulna was often fused to the distal end of the radius, but in no examples were the complete radius and ulna found still fused. Thirty-nine bone unit designations and 49 landmarks were used to indicate which part of the element was present. Two specimens exhibited cut marks, both found on the shaft near the distal end. Five specimens had impact marks. Evidence of carnivore gnawing was seen on five pieces. Forty-seven specimens had spiral fractures indicating that the bone was broken when fresh. Six specimens were unfused; one of these was unfused on both ends, and was very small, likely from a new-born animal. Two of the unfused specimens were distal ends of the diaphysis, both of a medium sized animal. Three specimens were unfused distal epiphyses, one medium in size and two quite large. In addition, one specimen exhibited a distal end fused with a line, and another exhibited a fused proximal end and a distal end fused with a line. The distal epiphysis of the radius fuses in the sixth year of life (Duffield 1973:133). Sixty-six specimens were fused without a line.

Cut marks present were found near the distal end of the element. These cut marks may relate to the separation of the humerus from the radius/ulna, as mentioned above. The similarity of the MNE values for these elements, however, may imply that they are being treated as a single anatomical unit after being removed from the proximal scapula.

The butchering patterns affecting the radius are often cited as being similar to those of the humerus. Elements are smashed open after the meat has been removed to expose the marrow cavity. As with the humerus, the presence of impact marks and spiral

fractures of the radius (5 and 47 respectively) suggests that this pattern is evident at EgPn-440. However, as with the humerus, the number of impact marks is unexpectedly low if marrow processing is taking place. It may be suggested from this that meat removal is the main goal here, and processing for marrow occurred on an occasional basis only for consumption at the site, perhaps while the butchering of the animals was taking place (Frison 1971:83). This possibility will be examined further in chapter seven, where meat and marrow indices are used separately for comparison.

Ulna

Specimens identified as ulna numbered 87. An MNI of 15 was derived from the presence of left specimens which have the proximal half of the large facet of the semi-lunar notch. Five were complete specimens, defined by Brumley as complete even if the very distal most part of the element is absent (since the distal portion is often fused to the radius) (Brumley 1991). Fourteen specimens included the complete semi-lunar notch and facets, whereas 16 consisted of only part of the semi-lunar notch and facets. Two specimens consisted of part of the cap only. Crushing of the cap was extremely common. The remaining 50 specimens were identified as shaft fragments. Twenty-three bone unit designations and 22 landmarks were used. Two specimens had cut marks on the shaft of the ulna, and three exhibited carnivore gnawing. Eight pieces had short spiral fractures. One specimen was unfused, indicating an individual under five years of age, and 12 others were fused without a line, indicating individuals older than this (Duffield 1973:133).

The cut marks observed on the shaft of the element can likely be attributed to the process of removing meat from the posterior of the front leg (Shortt 1993:111). Eight specimens exhibited spiral fractures, resulting from the separation of the fused shafts of ulnae from radii during butchering. At sites such as the Gull Lake Site (Kehoe 1973:154) and the Happy Valley Site (Shortt 1993:111), cut or hack marks appear on the posterior olecranon. This is suggested by Shortt to be related to the separation of radius and ulna.

At EgPn-440 however, no such cut marks are apparent. Rather, the end of the olecranon is nearly always crushed; this may be related to taphonomic processes such as carnivore gnawing, although there is little evidence in the form of carnivore tooth marks to support this. If taphonomic processes affecting the proximal end did occur, however, this may have impacted the visibility of cut marks on the posterior olecranon.

Carpals

Carpal bones found at EgPn-440 were generally very complete, as is expected due to their boxy, compact form. All six carpals were identified. The highest MNI value belonged to the magnum, with 23 complete lefts.

Twenty-five complete scaphoids were identified; no fractured specimens were present. One specimen exhibited rodent gnawing. The MNI was based on the presence of 13 rights. Thirty-eight magnum specimens were identified. One was broken with an irregular fracture and only the posterior lateral portion was recovered. One complete specimen was small in size, comparable to a nine month old bison from the comparative collection. One specimen, #43139, had a pathology which caused the element to look significantly flattened. As mentioned, the MNI was based on the presence of 23 left magnums.

Twenty-six complete or fragmentary lunates were recovered. One of these had an irregular fracture and the proximal half of the element was present. Specimen #35930 had a pathology which resulted in only the caudal half of the element being present. The remainder were complete. Twenty-four complete cuneiforms were identified, with an MNI of 15 based on rights. Twenty-four complete unciforms were identified, with an MNI of 14 based on rights. All cuneiforms and unciforms were complete. Twenty specimens were identified as pisiforms, with an MNI of 11 based on lefts. One specimen was incomplete with an irregular fracture and was represented by the articular facet and a small portion of the body. The remainder were complete.

No evidence of butchering was present on any of the carpals found at EgPn-440. When butchering marks are evident on carpals, particularly on the cuneiform and scaphoid (the lateral and medial surfaces of this area), this indicates that ligaments attaching the distal radius to the front foot were being cut to remove the front foot from the rest of the limb (Frison 1974:38). The lack of such cut marks at EgPn-440 may indicate that the front foot is not being detached from the radius during primary butchering. Additional evidence for this comes from the MNI values for the carpals, which are similar to those values for the humerus, radius and ulna. It appears that if the complete forelimb is being removed as a unit from the site, the foot bones are not being removed (see below).

Metacarpal

Sixty specimens were identified as metacarpals. The MNI was 19 based on the presence of the proximal cranial foramen on rights. Twenty-four of the metacarpals were complete, in sharp contrast to the other long bones (no complete humeri, ten complete radii). This is a reflection of the location of the metacarpal and the lack of meat on the lower part of the limb; the lower limb was probably not butchered due to the lack of muscle tissues present. Five specimens consisted of the complete proximal end and a large part of the shaft, and three consisted of just the complete proximal end. Five specimens were fragments of the proximal end. Eighteen specimens consisted of the complete distal end and a large portion of the shaft, and two specimens were fragments of the distal end. Three specimens were identified as shaft fragments. Two of the metacarpals exhibited cut marks, one on the cranial surface mid-way up the shaft and the other on the caudal surface near the distal end. One specimen had an impact mark and 19 exhibited spiral fractures. Three specimens were identified as expedient tools and three specimens exhibited carnivore gnawing. One specimen was unfused, indicating an age of under four and a half years (Duffield 1973:133). Forty-two others were fused without a

line. In addition, three specimens had fairly pronounced pathological growth on the cranial surface, two near the distal end, and one near the proximal end.

The presence of cut marks on two of the specimens may have resulted from the removal of the hide: "The hide was presumably cut around both front and hind legs by an encircling cut made with sawing strokes by a sharp chipped-stone tool." (Frison 1970a:10). The cut marks noted by Frison at the Glenrock Site varied from obvious marks to very faint marks which could only be seen under a microscope. The latter type made up the majority of examples. It is possible that this may also be true for the EgPn-440 assemblage. The presence of one impact mark and specimens with spiral fractures suggests that some of the elements were being smashed to obtain marrow, although the butchering of this element was clearly not a priority compared to other long bones.

Fifth Metacarpal

The fifth metacarpal is a vestigial metacarpal located caudally and laterally of the metacarpal. 16 specimens were identified at EgPn-440. Side was not determined, thus the MNI is 8, since there are two fifth metacarpals per individual. All specimens were complete with the exception of one specimen which was missing the distal tip only. No cut marks or butchering was evident on any of the fifth metacarpals.

Innominate

The innominate, or pelvis, was represented by 182 specimens. Due to the morphological complexity of this element, breakage patterns are difficult to ascertain. None of the specimens were complete; however, seven specimens consisted of large portions of all three of the bones that make up the pelvis (ilium, ischium, pubis). Three specimens had the ilium and ischium only, one had the ilium and pubis only, and six had the ischium and pubis only. The majority of specimens were portions of only one of the three components of the pelvis. Sixty-six pieces were part of the ilium, 55 were part of

the ischium, and 27 were part of the pubis. The borders of the ilium and ischium were rarely present. These outer borders are less dense and tend to preserve poorly and are also points of attachments for muscles and thus are more likely to undergo damage due to butchering. These borders are also the location of the bulk of the bone grease in the innominate, and are thus more likely to be removed from the site for further processing. Sixteen specimens were identified as part or all of the acetabulum, with little or none of the shaft portions present. One specimen is an unidentifiable portion of the obturator foramen. In no examples were the innominate and the sacrum articulated. Fifty bone units and 37 landmarks were used to indicate which portion of the element was present.

Five specimens exhibited cut marks. Two had cut marks on the ilium, one on the ventral border of the shaft and the other at the depression cranial to the acetabulum, represented by a number of cut marks. Two demonstrated cut marks on the ischium; one had very faint marks on the ventral border and the other had four cut marks on the lateral part of the shaft. The fifth specimen exhibiting cut marks had four cut marks on the cranial/dorsal border of the pubis. Two pieces exhibited carnivore gnawing, and one exhibited rodent gnawing. Three pieces were unfused at the acetabulum, indicating an age of under one year (Duffield 1973:133). Sixty specimens were fused without a line. Two pieces were identified as having spiral fractures.

Frison (1970a:19) notes that two key areas affected by the removal of meat on the pelvis are the ischial tuberosity and the coxal tuberosity, which both represent areas of muscle attachment. Both of these features are rarely present on the specimens recovered at EgPn-440; these areas appear crushed, although no cut marks are evident. The acetabulum and the shafts of the ilium, ischium and pubis are the most common portions recovered. Of these, the pubis is the section least frequently recovered; removal of meat probably involved chopping across the branch of the pubis and its attachment to the ischium, with the pubis being removed from the site with this unit of meat. According to Frison, for the Glenrock Buffalo jump:

...the fused symphyseal branches of the pubis and often part of the adjacent fused symphyseal branches of the ischii commonly formed a unit which was used to remove certain muscles since it was rarely found at the site. A common variation of this was that the pubis was lacking entirely since it often broke away from the ischium and ilium at the acetabulum but was rarely recovered in the bone deposits (Frison 1970a:19).

Cut marks on the innominates at EgPn-440 are evident on the shafts of the three bones. This probably indicates the removal of meat by cutting across the branches rather than separating the bones themselves at the acetabulum. Cut marks on the ilium and ischium near the acetabulum probably relate to the removal of the femur (Frison 1970a:16).

Femur

Ninety-two specimens were identified as femora. The MNI is 12 based on the presence of the right trochanter minor. This is the lowest MNI of the long bones. No complete specimens were recovered; only two examples had a complete proximal end, and none had a complete distal end. Fragments of the proximal end accounted for 17 specimens and fragments of the distal end accounted for 10. The remaining 63 specimens were shaft fragments, many of which were determined to be femur, but which could not be assigned a precise location on the shaft. Thirty-eight bone units and 44 landmarks were used to indicate which portion of the element was present. Two femora exhibited cut marks, found on the distal lateral shaft and on the caudal proximal shaft. Five specimens had impact marks and 51 specimens were spirally fractured. Three pieces exhibited carnivore gnawing and two specimens were identified as expedient tools. Three specimens were unfused; two were unfused on both ends and were relatively small, obviously from young animals. One specimen consisted of the proximal epiphysis, suggesting an age of under five and a half years. Nineteen specimens were fused without a line; 14 of these were fused at the proximal end and the remaining five were fused at the distal end.

The fragmented nature of this assemblage of femora and the frequency of specimens with spiral fractures suggests that the femora were heavily processed. Thirty-three shaft fragments had spiral fractures, suggesting that this element was processed immediately. As mentioned for the discussion of the innominate above, the femora were likely removed from the acetabulum by chopping the ligaments at the ilium and ischium. No cut marks are evident on the head or neck of the femur to support this, although the cut mark on the caudal proximal shaft may be related to this separation of elements. As an alternative method of butchering, Kehoe (1973:154) suggests that at the Gull Lake Site, the head of the femur is broken off and left at the site still attached to the acetabulum. White (1952:338) notes a similar pattern of separation of the femur from the innominate for two South Dakota sites. Six specimens that represent only the head of the femur were recovered from EgPn-440, suggesting that this method of removing the femur may have also occurred at this kill site. As further support for this hypothesis, eight specimens that consisted of most of the proximal end (including the head) exhibited spiral fractures.

The cut mark on the distal lateral shaft is probably related to the separation of femur and tibia, although Binford (1981:116) suggests that the femur and tibia often remain articulated until after initial field butchering. The large discrepancy between the MAU of the femur versus the tibia (9 and 19 respectively) supports the suggestion that these elements were separated at the kill site. The removal of the patella, which can be involved in the stripping of meat from the femur, may result in cut marks appearing on the distal femur (Frison 1970a:14). Removal of these muscles might also involve the chopping of the trochanter major to remove the muscle attachments, and support for this comes from the paucity of specimens with any part of the trochanter major. Only one specimen had the complete trochanter major and only five other fragments had any other part of this landmark. The fragmented nature of the femora and the frequency of spirally fractured specimens suggests that the femora were smashed for marrow at the site more often than the humerus and radius. The proportion of impact marks to the MNE for the

femora (5 to 18, as compared with 4 to 29 for the humerus) suggests that the femur underwent more intensive marrow processing at the site (see Kooyman 1981:155 for discussion of impact mark frequencies).

Patella

Seven patellae were identified at EgPn-440. All were essentially complete, although one specimen exhibited some degree of crushing. There appears to be a paucity of patellae compared to other elements; the MNE is 18 for femora, but only seven for patellae. A possible explanation for this may lie in butchering technique. As mentioned, Frison (1974:38) suggests that the lateral muscles of the hind limb were removed by first chopping into the trochlea to gain access to the patella, which was then used as a handhold to strip the muscles from the bone. This pattern in which a low frequency of patellae are present is also seen at nearby kill sites such as EgPn-230 (Vivian et al. 1998:93) and the Happy Valley Site (Shortt 1993:120-121). This pattern is also seen at the Glenrock Site in Wyoming (Frison 1970a:14). The opposite pattern is seen at such sites as the Estuary Bison Pound, where only one femur was identified but 13 patellae were present, and at the Gull Lake Site, where patellae are found isolated and unaltered throughout the site (Adams 1977:95; Kehoe 1973:154). This pattern may be the result of a different butchering pattern involving the removal of the patellae during separation of the femur and tibia which did not involve the stripping of meat at the kill site itself.

Tibia

Specimens identified as tibiae numbered 142. The MNI was calculated to be 21 based on the presence of the left complete distal end. One specimen was nearly complete, exhibiting only crushing on the proximal end. Three specimens were the complete proximal end and one was the complete proximal end with the anterior crest missing. Eight pieces were fragments of the proximal end. Thirty-eight specimens consisted of the complete distal end and three specimens were fragments of the distal

end. Shaft fragments made up the remaining 86 specimens. Thirty-seven bone units and 44 landmarks were employed. Five tibiae exhibited cut marks: three on the caudal shaft, one on the anterior crest, and one on the cranial medial shaft. Three of the pieces with cut marks were modified into expedient tools, and seven others were also used as tools. Frison (1974:42) notes that, at the Casper Site, the tibiae were the element most commonly used as choppers and other tools. Three specimens exhibited impact marks. Two pieces had carnivore gnawing and one exhibited rodent gnawing. Twelve specimens were unfused: two were complete unfused proximal ends, one was a proximal epiphysis, and two proximal end pieces fit together with an epiphysis; these specimens indicate individuals under six years of age. Three specimens were distal ends, and three were small associated fragments of distal epiphysis, indicating individuals of under four and a half years (Duffield 1973:133). Ninety specimens had spiral fractures.

The tibia has significantly less meat than the femur, and thus less evidence of butchering of this element is expected. However, cut marks are observed on the caudal shaft, likely from the removal of muscular tissues. According to Binford (1981:119), cut marks across the very distal portion of the element to detach the tibia from the tarsals are commonly reported from kill sites, but none are noted at EgPn-440. However, the number of intact distal ends present in this assemblage may indicate that the distal ends are being broken off to separate the foot from the tibia, rather than the ligaments at the tibia-tarsal joint being cut. This is supported by a high incidence of spiral fractures on the distal ends of the tibia (28).

The presence of some impact marks (3) and the high frequency of spiral fractures (including 60 on shaft fragments of the tibia and 28 on complete distal ends) again suggest that the tibiae were smashed to obtain the marrow. As mentioned for the humerus and radius, however, the relatively low number of impact marks as compared with the MNE (3 to 38) suggests that marrow was only occasionally obtained from the tibiae at the kill site. Distal ends of the tibia are far more common at EgPn-440 than the

proximal ends, suggesting again that this is the location where the foot is being detached from the rest of the limb and discarded at the site.

Tarsals

All six tarsals were identified at EgPn-440. The highest MNI value came from the calcaneus, where 26 rights were identified. A total of 43 specimens were identified as calcaneus. A number were complete, but several specimens were damaged. Two calcanei exhibited carnivore gnawing of the distal end, and six others were also missing the distal portion of the element. Six others were missing parts of the proximal end and/or the sustentaculum or articular surfaces. No butchering was evident.

Thirty specimens were identified as astragali and all were complete. MNI was based on 17 rights. Thirty-seven specimens were identified as being part or all of the navicular cuboid. 33 were complete, two were just missing the medial projection, and two fragments represented a complete specimen from which the medial projection was broken off during excavation, as shown by the colour of the broken surface. One specimen showed evidence of carnivore gnawing. The MNI was 23 based on rights. The cuneiform pes was represented by 33 specimens, all of which were essentially complete, although two were slightly damaged. MNI was based on the presence of 19 lefts. The lateral malleolus was represented by 27 specimens. All were complete, and the MNI was 14 based on rights. Thirteen first tarsals were recovered, all complete. Side was not determined for first tarsals; thus the MNI was 7 based on the fact that there are two first tarsals per bison. None of the tarsals showed any evidence of butchering marks.

As already mentioned, it appears that at EgPn-440 the lower limb was removed by smashing the tibia, rather than by cutting the ligaments at the joint between the tibia and tarsals. This variation in butchering technique probably explains why cut marks are absent on the tarsals. Any damage to the tarsals appears to be caused by taphonomic factors, including carnivore gnawing on two of the calcanei.

Metatarsal

Sixty specimens were identified as metatarsals. The MNI was 21 based on the presence of the cranial ridge between proximal articular surfaces on the rights. Twenty-one specimens were complete metatarsals. Again, this is in contrast to the other long bones of the hind limb (no complete femora, one nearly complete tibia). As with the forelimb, this pattern is predicted by the location of the metatarsal in the lower limb; since there is less meat, this part of the limb is likely to be left behind at the kill site. Eight specimens consist of the complete proximal end with a large part of the shaft, and four consist of the complete proximal end with little of the shaft. Eight fragments of the proximal end were also recovered. Nine specimens consist of the complete distal end and a large part of the shaft, whereas two consist of the complete distal end with very little shaft. Six specimens were identified as shaft fragments, and one piece was split along the longitudinal axis. One piece was the epiphysis of an unfused metatarsal. Twenty bone units and 45 landmarks were used to indicate which part of the element was present. Four metatarsals had cut marks on the shaft of the bone, three on the cranial surface and one on the caudal surface. One impact mark was also noted, and 26 specimens had spiral fractures. Two specimens were used as tools. Four pieces exhibited carnivore gnawing. Two specimens were unfused, although these pieces were shaft and epiphysis and fit together. Thus, they represent only one unfused individual. This individual was under four and a half years. Thirty-three specimens were fused without a line.

The cut marks on the shaft of the metatarsal are likely the result of the removal of the hide. As mentioned for the metacarpal above, circular cuts made around the lower limb at the metacarpal and metatarsal are a common method of removing the hide. One impact mark was noted, and 26 specimens exhibited spiral fractures. This indicates that some of the metatarsals were being smashed open for marrow, although the presence of 21 complete specimens suggests that smashing this element for marrow was not a priority.

Second Metatarsal

The second metatarsal is a vestigial metatarsal that is occasionally found in archaeological contexts. This element is a small round bone that is very difficult to side. Eight specimens were identified as second metatarsals at EgPn-440, resulting in an MNI of four.

Metapodials

Seven specimens were identified as metapodials, the distinction between metacarpal and metatarsal being impossible to determine. Three of these specimens were unfused single condyles, one was a fused single condyle, and one consisted of both condyles. Two specimens were shaft fragments that could be identified as metapodials based on the presence of the central groove. No butchering was evident on these metapodials.

Proximal Phalanges

Specimens identified as proximal phalanges numbered 145. The exact location of phalanges is difficult to specify – each limb has two proximal phalanges, one lateral and one medial. These are called “left” or “right”, but this simply refers to the position on that limb, not to which limb the phalanx is from. Proximal phalanges from the forelimbs are typically more robust than those from the hindlimb. However, this distinction was not made in this analysis. Seventy-three specimens were identified as “lefts” with the complete proximal outer articular facet. This number was divided by four, the number of left proximal phalanges in each bison, to provide an MNI of 19 animals.

The majority of the proximal phalanges recovered at EgPn-440 were complete. Occasionally damage occurred to the proximal or distal ends. Thirty-one bone units and 16 landmarks were used to indicate which part of the element was present. One proximal

phalanx exhibited cut marks, found on the dorsal and inner surfaces of the shaft. Four specimens had evidence of carnivore gnawing. Four specimens were classified as unfused; two of these were complete elements except for the epiphyses, and two specimens were unfused epiphyses only. Thus, a minimum of two unfused elements are represented. The epiphysis of the proximal phalanx fuses in the middle of the fourth year of life (Duffield 1973:133). Three elements were fused with a line, and 134 were fused without a line.

Cut marks found on phalanges are uncommon and difficult to explain. Binford notes that the Nunamiut have been observed to skin the foot of the caribou, which does result in cut marks appearing on the phalanges (Binford 1981:126). However, this has not been observed elsewhere in North America. The cuts on the proximal phalanx found at EgPn-440 may be the result of a misplaced cut when skinning of the animal was taking place, since the proximal phalanx is the element directly distal of the metapodial, where skinning marks are commonly found.

Middle Phalanges

Specimens identified as middle phalanges numbered 111. As with the proximal phalanges, distinguishing between the left limb and right limb and between forelimb and hindlimb is difficult for the middle phalanges. The MNI is therefore based on 64 left specimens which have the proximal inner tubercle, divided by four left middle phalanges per bison, resulting in an MNI of 16. Again, nearly all specimens were complete, with occasional damage occurring to the proximal or distal ends. Eighteen bone units and 15 landmarks were used. One specimen exhibited a possible cut mark on the shaft, although this mark is faint and may not represent a cut at all. One specimen was an unfused epiphysis, indicating an age of less than three years, and 102 specimens were fused without a line. The only identifiable fetal bone present at this site was identified as a middle phalanx that was approximately half the size of a comparative two-day-old bison.

Distal Phalanges

Specimens identified as distal phalanges, the hoof of the animal, numbered 116. Again, distinguishing distal phalanges between left and right and front and back is difficult. The MNI is 15 based on the presence of 58 “right” specimens with the outer dorsal foramen present, divided by four rights per bison. Nearly all specimens were complete, with several fragments of distal or proximal ends also present. Seventeen bone units and 14 landmarks were used to indicate which portion of the element was present. No cut marks or gnawing was evident, and third phalanges are essentially “fused” at birth.

Sesamoids

Sixty-nine unsided proximal sesamoids were recovered, all essentially complete. This element represents an MNI of 5, based on the presence of 16 proximal sesamoids per bison. Forty-eight distal sesamoids were recovered, again all essentially complete. An MNI of 6 is determined based on the presence of eight distal sesamoids per bison. In addition, two irregular sesamoids were recovered. The recovery of these small bones is an indication that the preservation and recovery techniques were both good for this assemblage.

Summary

The butchering at EgPn-440 seems to indicate a fairly typical pattern of animal use as represented at other bison kill sites on the Northern Plains. The focus was on the back and chest, and on the upper limbs. This pattern is not unusual as these are the parts of the bison with the largest amounts of meat, and it is therefore expected that these portions would be processed more extensively. Butchering marks were most commonly found on ribs and on thoracic vertebra, which demonstrates that the hump meat and the

sides, including the upper chest containing the sternum, were being relatively extensively processed.

The upper limbs, particularly the femur, were also being butchered at the site, but to a lesser extent. Cut marks on long bones are relatively rare. The humerus, radius and tibia demonstrated less intensive butchering than the femur as seen by a relative paucity of impact marks on these elements. However, fracturing of these elements at the site is evident from the presence of some spiral fractures. It is suggested that long bones, with the possible exception of the femur, are being broken open for their marrow only occasionally at the kill site. This may suggest that obtaining meat was the priority over the acquisition of other products such as marrow, or that the acquisition of marrow occurred mainly at a processing site removed from the kill site. These possibilities will be further explored in chapter seven.

Other parts of the bison exhibit evidence of butchering to a lesser degree. Cut marks present on the hyoid suggests that the tongue was probably removed. The absence of a large number of the transverse processes of the lumbar vertebrae also indicates that the side of the lower back is being removed from the site for further butchering. The pelvis shows some evidence of butchering, probably relating to meat removal rather than to the separation of the femur from the carcass for processing. The lower limbs, particularly the metapodials, exhibit cut marks, probably related to the skinning of the animal.

Figure 5.1 illustrates the general locations of butchering on the bison skeleton at EgPn-440. This includes the locations of cut marks and impact marks (which are both overall rare) and spiral fractures indicative of processing.

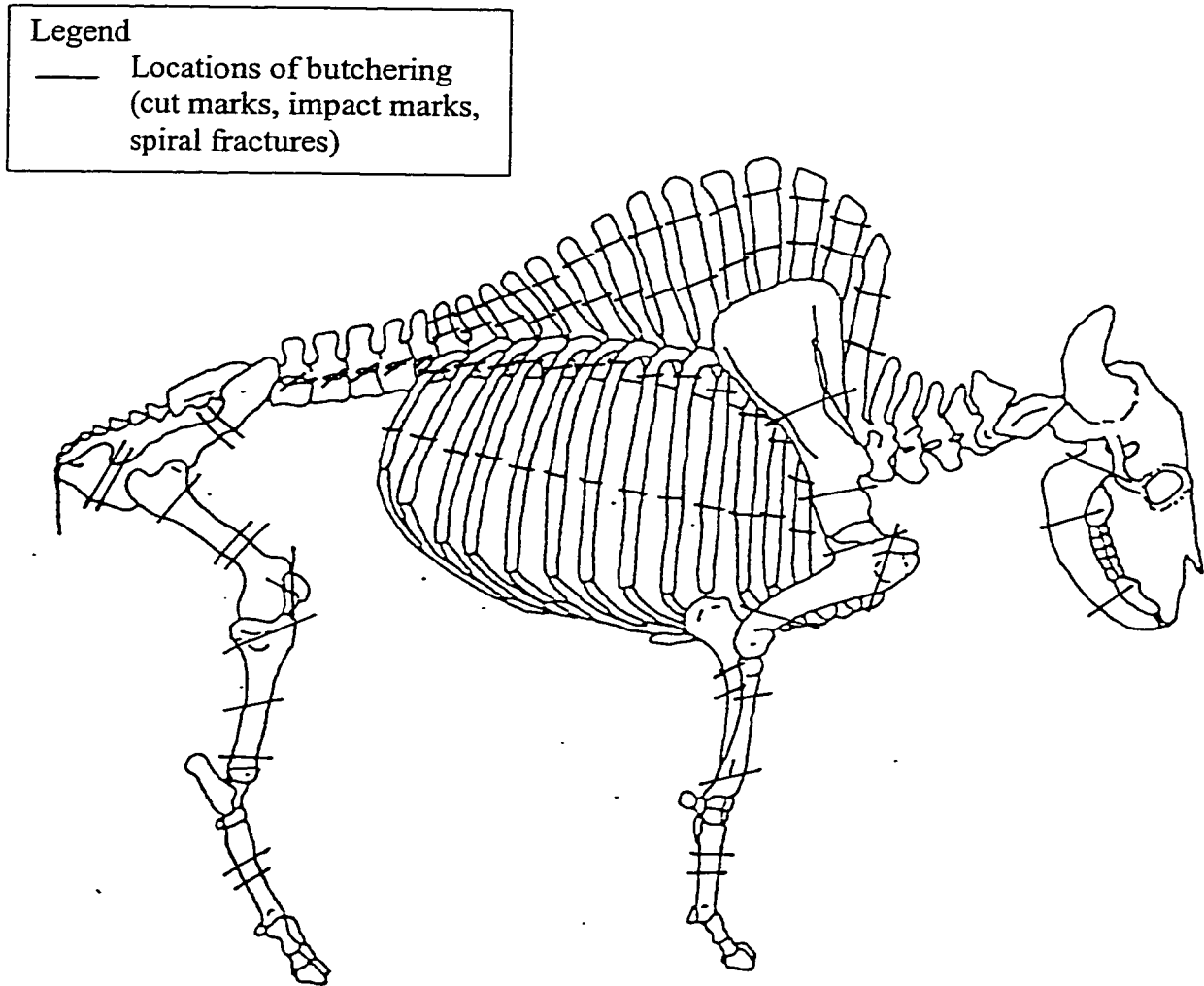


Figure 5.1. General locations of butchering on the EgPn-440 bison assemblage.
(Diagram adapted from Brown and Gustafson (1979)).

Bone Tools

Twenty-six tools or possible tools were identified from the EgPn-440 assemblage. The bulk of these, if not all of them, would be considered expedient tools, which would have been manufactured and utilized at the site only. Both “scraping” and “chopping” tools appear to be present. Tibiae are the most commonly chosen element in manufacturing expedient tools at EgPn-440, but femora, metapodials, ribs, crania and mandibles are also represented. Tools manufactured from appendicular elements will be discussed first, followed by axial elements.

Similar tools to the ones described below were recovered from the Ramillies bison pound and campsite in southeastern Alberta (Brumley 1976). Tool groups are described by Brumley and photographs are included, but no suggested functions are postulated. Many of the tools from EgPn-440 exhibit very pronounced polish and rounded ends, suggesting that they were used to scrape or burnish soft materials such as hides.

Seventeen appendicular specimens have evidence of being used as tools, although functions of these tools are difficult to suggest. Seven tibiae were modified into tools probably used as scrapers. In all examples these are shaft fragments ranging from medium-sized fragments (approximately 15 cm in length) to fragments representing nearly the entire length of the shaft. All of these specimens exhibited spiral fractures, and three had cut marks. The edge of each of these tools exhibits a rounded shape and polishing as evidence of their use as tools. Two femora were also modified into possible scrapers with rounded, polished ends. Two metatarsal fragments were utilized as scraping tools. One, specimen #4151, consists of the distal cranial end which has clearly been modified into a tool, probably a hide scraper (Plate 3, top). The other metatarsal scraper is manufactured from a shaft fragment and exhibits a rounded end and pronounced polishing. Two metacarpals were also likely used as scraping tools. Specimen #61204, the distal cranial end, is very similar to metatarsal #4151 in shape. The second metacarpal exhibiting evidence for use as a tool consists of the proximal end

of a metacarpal on which the spirally fractured edge shows some evidence of polishing, and thus may have been used briefly as a scraping tool.

Four other appendicular specimens were possibly used for chopping. Three tibiae were modified into expedient choppers; one of these specimens consists of the distal end of the tibia, and the other two are large shaft fragments. The utilized end on each is relatively pointed and shows clear evidence of polish resulting from their use. One specimen (#58365) exhibits flaking on one side of the utilized edge, which may indicate its use as a cutting tool. One metacarpal also appears to have been used as an expedient chopping tool. This specimen consists of the distal end of the element, and the fractured edge shows evidence of polishing and perhaps chipping of the edge due to use.

Four rib fragments show possible evidence of use as tools. Two of these are mid-sized to large-sized shaft fragments on which the proximal end has evidence of polishing. A third specimen is a small rib shaft fragment on which the end is very rounded in shape. These three specimens show some evidence of wear and polish from use, although their function is not immediately apparent. The fourth rib specimen (Specimen #33339) identified as a tool shows very clear evidence of use as a tool (Plate 3, bottom left). This is a relatively small fragment, but the end is highly polished, rounded, and has striations indicative of use. It is hypothesized that this tool and possibly the other rib fragments described as well may have been used as scraping tools. Verbicky-Todd (1984:170) notes that, according to H.H. Turney-High, ribs were commonly made into hide scrapers. This may be supported by the high degree of polish on these tools, characteristic of scraping and burnishing soft surfaces such as hides.

One mandible fragment also shows clear evidence of use as a tool. Specimen #5512 is a portion of the ventral border of the mandible which has been formed into a rounded and smoothed end which comes to a soft point, and polishing is very pronounced (Plate 3, bottom right). Again, this specimen was probably used as a hide scraping tool. Four other fragments also show evidence of polishing that may indicate their use as tools.

One specimen is a fragment of a nasal bone that is slightly polished at one end. The other three are unidentified fragments that each show relatively pronounced polishing, again possibly indicating that they functioned as hide scrapers.

Pathology

A number of specimens exhibit varying degrees of pathology, ranging from minor extra bone growth to fused elements. The more severe examples of pathologies noted for the EgPn-440 assemblage will be discussed here.

Specimen #49115, a mandible, exhibits a severe pathology of the tooth row around the area of the second molar. This pathology is actinomycosis, or lumpy jaw, caused by infection as a result of vegetal material working down to the gums between the teeth (L.V. Hills, personal communication). Three teeth exhibit pathology of the roots and/or tooth, including an incisor which actually consists of two incisors that have grown together. According to Wilson (1988:203), dental pathologies are an indicator of environmental stress. However, as will be demonstrated in subsequent chapters, the population at EgPn-440 is likely composed of many older individuals and age may be a factor contributing to the pathologies recorded. A petrous bone (internal auditory meatus) also exhibits extra bone growth.

Specimen #44058 is an atlas that demonstrates extra bone growth on the right wing. Specimen #25222 has already been briefly mentioned; this element consists of a fused axis and third cervical vertebra. Several thoracic vertebra spinous processes exhibit extra bone growth on the distal portion of the spine, and one specimen has an unusually thick spinous process with a ridge down the centre. Two lumbar vertebrae exhibit pathologies; one has incompletely formed transverse foramina, and the other is significantly asymmetrical, the spinous process leaning to the left side of the animal.

Five ribs exhibit significant pathologies. Three of these are clearly the result of healed fractures that have resulted in abnormal bone growth. The other two examples may also result from fractures and an ensuing infection.

As mentioned, two carpals demonstrate pathologies, one magnum which appears flattened, and one lunate which appears to be missing half of the element. A third possible carpal may be represented, but the specimen cannot be identified. The proximal end of a radius exhibiting unusually porous growth on the caudal surface was also identified, as well as an ulna exhibiting a great deal of extra plate-like bone growth on the medial surface. Specimen #60679, a possible portion of the innominate, exhibits unusual bone growth, possibly the result of a healed fracture.

A number of less severe pathologies are also present in the assemblage, mainly in the form of extra bone growth around muscle attachments. I suggest that the relatively frequent occurrence of pathological growth may be an indication of the age of the animals in the kill. Older animals would be expected to have incurred more injuries over their lifetimes (such as the fractured ribs described), and would also be expected to have a greater frequency of abnormal bone growth due to such age-related causes as arthritis. This assemblage may therefore represent a herd or herds consisting of a significant number of older individuals. This possibility will be examined in greater detail in chapter six.

In addition, the presence of fractures such as those exhibited on several ribs and the abnormal growth on the atlas may have resulted from injuries sustained during the rut, when fighting occurred among the males (Roe 1972:96). This may suggest that adult male bison are prevalent in the population represented at EgPn-440. As will be shown in chapter six, the sexing data will confirm this hypothesis.

CHAPTER SIX

AGING AND SEXING

Aging

Determination of the age at death of the individuals at a bison kill site has implications for the nature of the kill, seasonality, and preferential selection or butchering of animals. Brumley also suggests that knowledge of age is "...important in estimating the amount of usable meat represented by the animals" (Brumley 1978:179). Two main techniques have been suggested for assigning age at death to bison. These include epiphyseal fusion (e.g. Duffield 1973), and tooth eruption and wear (e.g. Fuller 1959; Frison & Reher 1970; Reher 1970; Haynes 1984; Wegrzyn & Serwatka 1984). Watson (1978) lists a series of potential problems associated with using epiphyseal fusion data in aging specimens, including differential preservation of fused and unfused specimens, differential recovery, and variations in the age of fusion. Tooth wear of mandibles is considered to provide the most specific estimates of age at death, and this method will be used here.

Prior to describing the methods and results for the aging determination, a brief discussion is warranted regarding the obvious lack of one age group, the fetal group. Only one identifiable fetal bone was recovered, a middle phalanx. Eight other pieces of fetal bone were recovered, but these were fragments that could not be identified to element or even to species. Seasonality for this kill site is unknown, but knowledge of the season in which the kill took place could provide an explanation for the lack of fetal bone recovered from the site. At the Ramillies bison pound site in southeastern Alberta, for example, the presence of fetal remains was suggested to indicate a spring or early summer kill (Brumley 1976:20). Quigg (1978) provides a summary of sites in Alberta from which fetal bone remains were recovered to suggest winter kills. A late summer or fall kill would lack fetal bone.

Driver (1983:141) has noted that younger animals may be underrepresented in archaeological assemblages due to the rapid deterioration of their bones as compared with those of adults. However, preservation is not likely to be a cause of the lack of fetal bone at EgPn-440 as preservation of bone at this site was overall very good. Little weathering had taken place, and even small and fragile elements such as the hyoid and the sesamoids were relatively abundant. Fetal bone may have been selectively removed from the site by the hunters. Frison (1971:83) notes that at the Ruby Site in Wyoming, fetal bone is not found at the kill site, but is more common at the processing site. This suggests that fetal bison were being taken for food. However, Driver (1983:148) questions the suggestion that younger animals are desirable food products, particularly due to the low fat content of the meat in younger animals. As an alternative explanation, Morlan suggests that carnivores may have been responsible for removing any fetal bone from the archaeological record at the Harder Site (Morlan 1994:770).

Another more likely explanation for the lack of fetal bone recovered may lie in the composition of the herd or herds killed at this site. As will be demonstrated later in this chapter, the majority of animals were probably males, and thus fetal bone would not be expected to be recovered from the site in significant amounts.

The methodology employed for the aging of the EgPn-440 assemblage involved the use of mandibles with socketed teeth only. Brumley (1990:6) notes that unsocketed teeth can be studied as well using this method, but the difficulty in differentiating isolated first and second mandibular molars precluded including these specimens in this research. Two methods of determining age were employed. The first is Tooth Eruption and Wear Stages (TEWS) as defined by Brumley (1990). Brumley's TEWS stages are based primarily on detailed descriptions of the bison eruption and wear sequences provided by Frison and Reher (1970) and Reher and Frison (1980). Todd and Hofman (1987) also describe age groups as defined by tooth eruption and wear.

First, second and third mandibular molars were compared to the diagrams presented by Brumley and a TEWS value was assigned to each tooth. These values correspond to ranges of ages at death, details of which are presented in Brumley (1990). This technique is only useful for determining the age of young individuals (younger than five years of age), which were rare at EgPn-440.

The second technique involved the measurement of the height of the metaconid of the first molar (M1), a technique originally developed by Frison and Reher (1970). "Height is measured from the crest of the metaconid to the base of the enamel on the medial surface of the tooth" (Brumley 1990:9-10). Reher (1970:51-52) suggests that plots of the measurements of the M1 metaconid height may separate specimens into multimodal groups which indicate age categories. Digital callipers were used to take this measurement. In seven specimens the first molars were still deeply rooted, and a section of the bone had to be removed in order to measure the base of the enamel. This task was performed with the use of a Dremel saw, and care was taken to do as little damage to the element as possible. The decision to cut away the bone so that these elements could be used was made due to the relatively small sample size (36 without these seven specimens) and due to the fact that the specimens with deeply rooted molars tend to be younger - ignoring these specimens would have introduced a systematic bias to the sample.

For the sake of comparison, a second researcher also measured the metaconid height of each specimen. Although no measurements except for the 0.0 mm (no enamel) measurements were identical, the differences in measurements were small, ranging from 0.0 mm to 4.56 mm, with the average difference between researchers being 0.82 mm. Most differences in measurements were thus very small. There was no pattern in terms of one researcher producing consistently higher or lower values. Those specimens for which noticeably different values were obtained by researchers were remeasured, and I found that my initial measurements were closely replicated. Thus, only my measurements were used.

Estimation of Age from Tooth Eruption and Wear Stages

Only one mandible (specimen #1591) exhibiting a deciduous dentition was recovered (Table 6.1). This mandible contained deciduous premolars (DP) two, three and four. DP4 was worn to TEWS stage 7. The eruption and wear patterns indicated that the age at death was approximately 0.5 years, based on descriptions presented by Frison and Reher (1970:46). A second mandible demonstrated the permanent dentition of a young individual (specimen #68420). Premolar four was not yet erupted, premolar three was erupted but not worn, and premolar two was just starting to erupt. The probable age of this specimen was approximately 3.0 years, as the stages of eruption appeared to be between Frison & Reher's Group III (2.5 years) and Group IV (3.5 years).

The remainder of the mandibles recovered from EgPn-440 exhibited permanent dentitions. Tooth eruption and wear stages (TEWS) were identified for socketed molars one, two and three, where present. The frequencies of TEWS stages for each of these teeth are presented in Tables 6.2 through 6.4 below.

Table 6.1. Deciduous/immature mandible eruption stages (based on Frison & Reher 1970:46-47).

Catalogue Number	Eruption Data	Approximate Age
1591	Deciduous – DP4 at TEWS 7 (mandible broken posterior to DP4)	0.5 years
68420	Immature – P4 not erupted, P3 not worn, P2 starting to erupt	3.0 years

Table 6.2. Frequencies of TEWS stages for first mandibular molars.

TEWS Stage	Frequency
16	1
17	2
19	2
20	18
21	6
23	3
24	6
25	8
TOTAL	46

Table 6.3. Frequencies of TEWS stages for second mandibular molars.

TEWS Stage	Frequency
16	5
17	2
18	1
19	9
20	28
21	7
22	1
23	2
25	3
TOTAL	58

Table 6.4. Frequencies of TEWS stages for third mandibular molars.

TEWS Stage	Frequency	Est. Age in Days	Est. Calendar Date
3	1	767-796	June 20 – July 20
10	2		
12	2		
13	2		
14	1	Approx. 1643	Approx. Nov 12
15	1		
16	3		
17	5		
19	34		
20	19		
21	5		
22	2		
> 22	1		
TOTAL	78		

For the first mandibular molars, the lowest TEWS stage is 16, which indicates too great a degree of wear to make aging possible. TEWS stages beyond 13 for the first molar simply indicate an age of over one year. The highest frequency occurs in TEWS stage 20. Second mandibular molars indicate a similar pattern, with the youngest TEWS stage at 16 and the highest frequency at 20. Any TEWS stage over 13 for the second molar indicates that the animal was over two years old when it died.

The third mandibular molars also appear to indicate a herd composed of primarily older animals, with the highest frequency TEWS being 19 and 20. However, one specimen has a TEWS of 3, indicating a probably age of between 767 and 796 days, or a calendar date of June 20 to July 20 based on a calving date of May 15. Two specimens each have a TEWS of 10, 12 and 13; Brumley does not provide age estimates for these stages. One specimen has a TEWS of 14, which indicates an age at death of approximately 1643 days, or a calendar date of November 12 based on a date of May 15 for calving.

The four to five month difference between these estimated dates is a significant one. These specimens are suggested to represent an animal just over two years of age, and an animal of four and a half years of age. One possible explanation may be a birth outside of the normal calving season. Frison (1991:276) suggests that calves born outside of the six week range of the calving season (which peaks about May 15) have a poor chance of survival, and thus will usually not affect the structure of the population. At EgPn-440, it is unfortunate that the assemblage allows age estimates for only two specimens using TEWS. One of these two animals may have been born outside the calving season, although this is unlikely given the extremely small sample size. Other possibilities may also explain these results, such as differential tooth wear due to diet. A third possible explanation for these results is that two kill events took place at this location in different seasons. One kill event may have taken place in the spring, and one in the fall. This possibility will be explored in greater detail in this chapter and in chapter eight.

Estimation of Age from First Molar Metaconid Height

Measurements of the first mandibular molar metaconid height were taken with digital callipers and plotted to determine if multimodal distribution was exhibited. Following the example of Shortt (1993), height was first plotted against itself to allow clusters, if present, to be observed (Figure 6.1). Forty-three socketed first molars were intact enough to take measurements of the metaconid height. According to Reher (1970), measurements of the second and third molar metaconid heights can also be taken and plotted. However, first molars are the first to wear, and taking the metaconid height of this tooth can often be done without destroying part of the mandible. The second and third molars remain more deeply rooted for a longer period of the animal's life, and cutting away part of the bone is thus often necessary in order to take measurements. The decision was made in this study to measure the metaconid height of the first molar only.

Figure 6.1 shows a plot of metaconid heights from the socketed first mandibular molars. Reher's (1970) average measurements of the Glenrock mandibles will be used as a comparison here. It should be noted, however, that other assemblages demonstrate a different correlation of metaconid height and age groups. For example, Reher and Frison (1980) measured MI metaconids for four different levels at the Vore Site. These four samples produced different results from each other, and significantly different results from the Glenrock sample. The Glenrock sample will be used here as a comparison since Reher provides metaconid height averages for specific age groups (ie., 1.5 years, 2.5 years) while the Vore Site data are presented for a range of ages (for example, 5.6 to 6.5 years). The best results would be obtained from a comparison with a large sample of individuals of known age for which specific metaconid heights for each individual (rather than averages) are presented. Unfortunately, I was unable to obtain such data.

Figure 6.1 indicates that some degree of multimodality is exhibited. The first cluster occurs at 0.00, where nine specimens overlap. A measurement of 0.00 mm for the M1 metaconid indicates animals with "... such advanced tooth wear that they might be older than 13.5 years." (Reher 1970:52). One specimen has a height of 5.47 mm, which corresponds with Reher's age estimation of approximately 11.5 years. A cluster of five specimens at approximately 10.00 mm suggests an age of around 10.5 years, according to Reher. Beyond this height, the clusters still appear to be present, but are much more vague. The next "cluster" is relatively evenly spread between 13.67 mm and 20.44 mm. This would cover Reher's suggested age of 7.5 through 9.5 years. Two specimens cluster at approximately 23.50 mm, and another vague cluster follows at 28.54 through 31.87 mm. A possible cluster occurs from 36.21 to 39.79, and another very vague "cluster" occurs from 43.29 to 46.19, involving only three specimens.

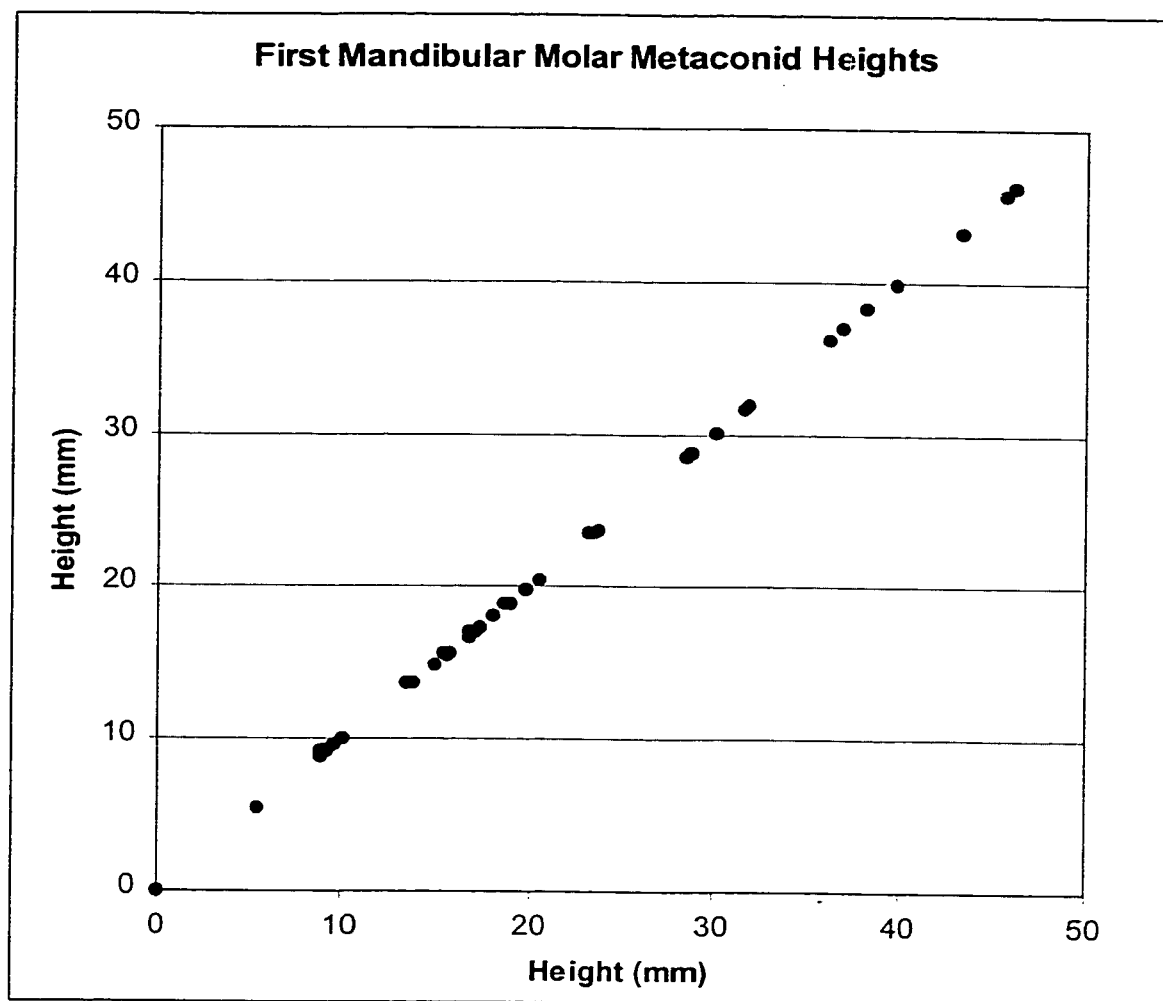


Figure 6.1. First mandibular molar metaconid heights, demonstrating only a minor degree of clustering. Note that nine specimens occur at the 0.0 mm height measurement.

From this figure, it appears that some degree of multimodality is present. How these clusters correspond to actual age groups is less clear. The clusters occurring for the EgPn-440 assemblage do not correspond to the clusters suggested by Reher (1970). Rather, they appear to be clustered into larger groups covering several different age groups. An attempt to clarify patterns which may have been blurred by plotting height against height was undertaken. This involved using Reher's (1970) age estimations and extrapolating for the finer age groupings (for example, finding the projected metaconid heights for 4.75, 5.00 and 5.25 age groups from Reher's average metaconid heights for the 4.5 and 5.5 age groups). The frequencies of each of these finer age groups were then plotted, and are shown in Figure 6.2.

Figure 6.2 illustrates a multimodal pattern, but little regularity is evident. There are some possible indications of seasonality, however. For example, among the older individuals (seven to twelve years), there does appear to be definite peaks at the half year mark which would suggest a fall kill event. However, the younger animals demonstrate peaks at both the half year mark (1.5 and 4.5, for example) and at the year mark. This suggests that more than one kill event may be represented at this site, and that those kill events likely took place in different times of the year.

Lithic evidence (chapter four) only weakly supported the hypothesis of more than one kill event based on morphological attributes of points. However, these criteria require that the kill events (if multiple) would have taken place several hundred years apart, since changes in point morphology are not less time specific than this. If this bison pound was being used over a shorter period (in the scale of months or only a few years, for example), multiple uses would not be evident from the lithic evidence. I suggest that the lack of regular patterning for the metaconid heights (meaning that peaks would occur at regular intervals at either the half year or year age marker) may be an indication that this pound was used more than once, and at varying seasons. The possibility of EgPn-440

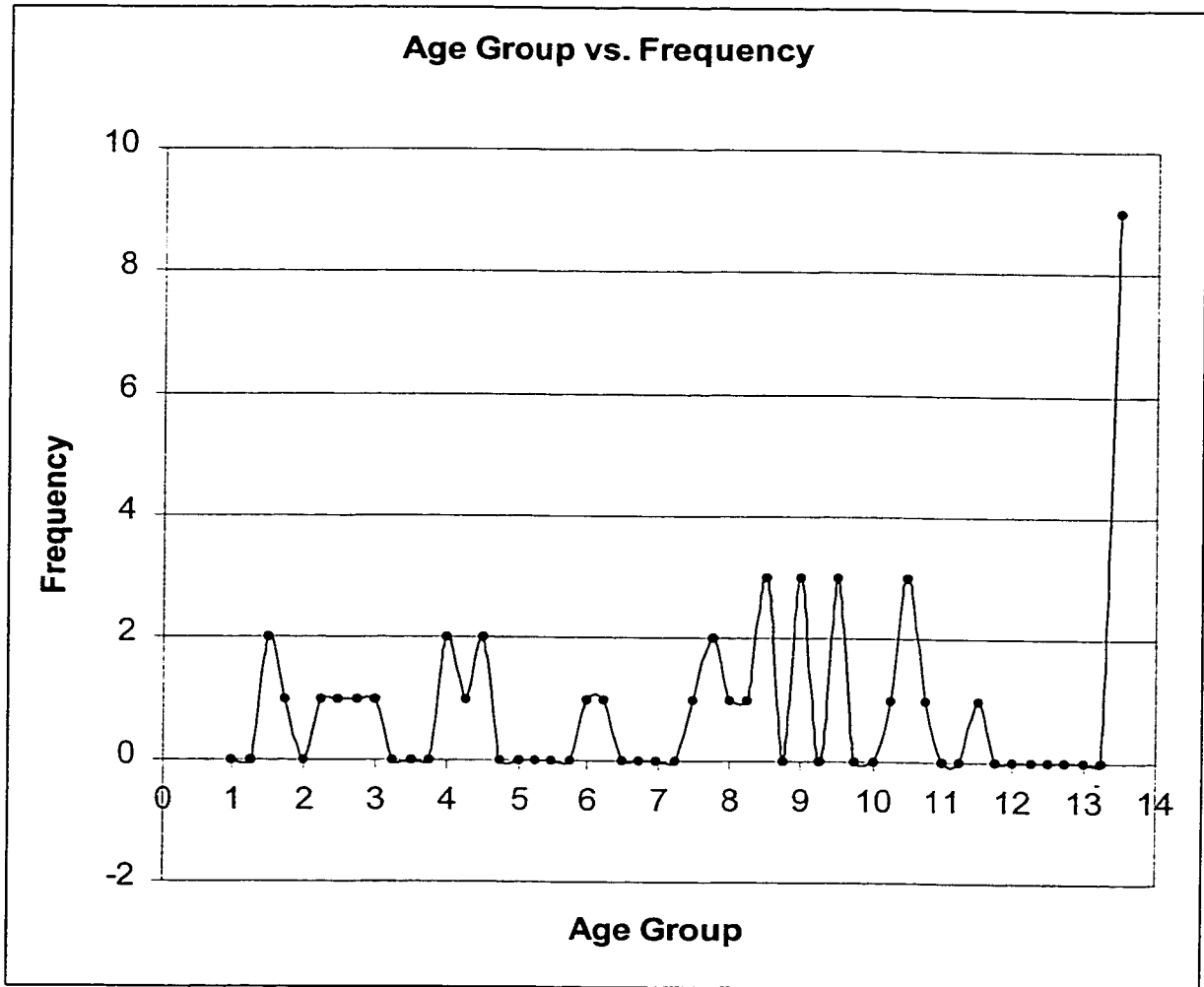


Figure 6.2. Age groups vs. frequencies of those age groups. Peaks occur at both the half year age groups and the full year age groups, although more frequently at the half year age groups. Although fewer, some peaks do occur at the quarter year age groups.

representing multiple kill events will be discussed again in chapter eight with a spatial analysis of the faunal elements.

There are problems associated with using metaconid heights in age estimation. The small sample size available for the EgPn-440 assemblage may be a factor in the irregular multimodality in Figure 6.2, since artificial “gaps” may exist simply because of a lack of specimens. Differential rates of wear are also undoubtedly a factor in examining the wear on bison teeth. Haynes (1984:488) suggests that the rate of wear for the first molar in bison from Wood Buffalo National Park is 1.7 mm per year. He compares this to the calculated rate of wear in bison from the Vore site, which Reher and Frison (1980) calculated at 3.5 to 3.8 mm per year. Size, diet (and deficiencies in diet), and ground cover are suggested to be factors influencing the rate of wear on bison teeth (Haynes 1984:488), and I suggest that some individual variation also contributes. This could include factors such as individual variation in tooth eruption scheduling (which would affect the wear schedule) or individual preference of an animal to chew on one side of the mouth over the other (Grant 1978:103-104). In addition, the overall sexual dimorphism of bulls and cows means that male and female bison have different size teeth, which will further blur any clustering of tooth measurements. Although Reher and Frison (1980:70-74) discuss the sexing of mandibles, no attempt was made to sex the mandibles from EgPn-440 due to the overall fragmentary nature of the sample. However, as will be demonstrated later in this chapter, sexing analyses of appendicular elements indicate that this assemblage consists mainly of males. Thus, sexual dimorphism may not be a factor affecting the distribution of metaconid heights for this site. Finally, as noted above, observer error is also a factor. Although the comparison of measurements taken by two different researchers indicated that differences are overall minor, there is little question that different researchers will obtain different measurements. The small scale of these measurements means that any errors may be compounded, resulting in distortion of the results.

Sexing

A number of methods for sexing bison remains from archaeological assemblages have been presented. The process of determining sex from measurements of certain elements is based on sexual dimorphism, which is extremely pronounced in *Bison bison*. Male bison can weigh up to twice what a female weighs, and this difference is reflected in the size of the bones (Todd 1987:157). Methods for sexing bison remains include the bimodal distribution of measurements of metapodials (Duffield 1973; Bedord 1978; Peterson & Hughes 1980), phalanges (Duffield 1973), the humerus and radius (Todd 1986), and carpals and tarsals (Morlan 1991). Discriminant function analyses have also been presented by Roberts (1982) for phalanges, and by Walde (1985; n.d.) for long bones.

Two methods of sexing bison remains were undertaken for the materials at EgPn-440. The first method involved taking measurements of carpals and tarsals as described by Morlan (1991) and plotting measurements to determine if a bimodal distribution could be observed. The second method involved taking measurements of long bones for use in discriminant function analysis, using measurements described by Speth (1983) and discriminant functions described by Walde (n.d.). These methods are described in more detail below.

Sexing Using Carpals

The first method of sexing bison remains discussed here is Morlan's (1991) measurements of bison carpals and tarsals from the Sjøvold Site in Saskatchewan. In this work, Morlan suggests that plotting various measurements of carpals and tarsals against each other will provide a bimodal pattern, with one cluster representing adult bulls and the other representing combined cow/calf groups. Morlan presents illustrations and

descriptions of the measurements taken, and presents the bivariate plots in which he noticed a bimodal distribution. In addition, an individual of a known sex (male) from Elk Island is included in the bivariate plot for comparison. Carpals and tarsals were relatively abundant at EgPn-440 (see Table 5.3); specimens were between two and five times more abundant than at the Sjøvold Site. This larger sample should therefore serve as a test of Morlan's method, since a larger sample size should be more statistically significant. It should be noted that some specimens could not provide all the measurements due to damage; if a certain measurement could not be taken, that specimen is absent from the bivariate plot.

Measurements of the EgPn-440 carpals and tarsals were taken with digital callipers according to Morlan's descriptions and diagrams. Bivariate plots were made using the same variables presented by Morlan for comparisons, but plots involving other variables were also examined. These will be discussed individually for each element below. Results are presented in Figures 6.3 through 6.18, and are discussed below for each carpal and tarsal. The results of bivariate plots for each of the carpals are presented in Figure 6.3 through 6.8.

Scaphoid

Three measurements are taken for the scaphoid (radial carpal): length, depth and width. Morlan presents a bivariate plot of length vs. width for four specimens, which demonstrates bimodality to some degree. The same variables were plotted for 24 EgPn-440 specimens in Figure 6.3. The bivariate plot of length vs. width for the EgPn-440 specimens demonstrates a bimodal pattern, with all but one specimen belonging to the "adult bull" group. The points clustering here are similar in size to those from the Sjøvold Site as well as the known individual from Elk Island. The single outlier is significantly smaller (particularly in length) than even the cow/calf specimens identified by Morlan. A similar pattern results from plotting both length vs. depth and depth vs. width.

Lunate

Length, width and depth are again the measurements taken for the lunate (intermediate carpal). Morlan presents a bivariate plot of width vs. depth for eight specimens, which results in a stronger bimodal pattern than that obtained for the scaphoid. The EgPn-440 assemblage includes 24 specimens identified as lunates for which both depth and width could be measured. The bivariate plot is exhibited in Figure 6.4. Unlike the Sjøvold Site materials, no evidence of bimodality can be detected in the EgPn-440 lunate assemblage. All specimens had measurements comparable to the adult male specimens in Morlan's project. Plotting length vs. width and length vs. depth also resulted in a single cluster of specimens. This result correlates with the result from the scaphoid in that the majority of the specimens appear to be male.

Cuneiform

Anterior length, posterior length and depth are the measurements defined by Morlan for the cuneiform (ulnar carpal). Morlan presents a plot of anterior length vs. depth for seven specimens, which produces a bimodal pattern. The EgPn-440 assemblage consisted of 24 cuneiforms. The bivariate plot is shown in Figure 6.5. When the EgPn-440 specimens are plotted, a bimodal pattern similar to that of the scaphoids results, demonstrating a large cluster of "males", and only one specimen representing the cow/calf group.

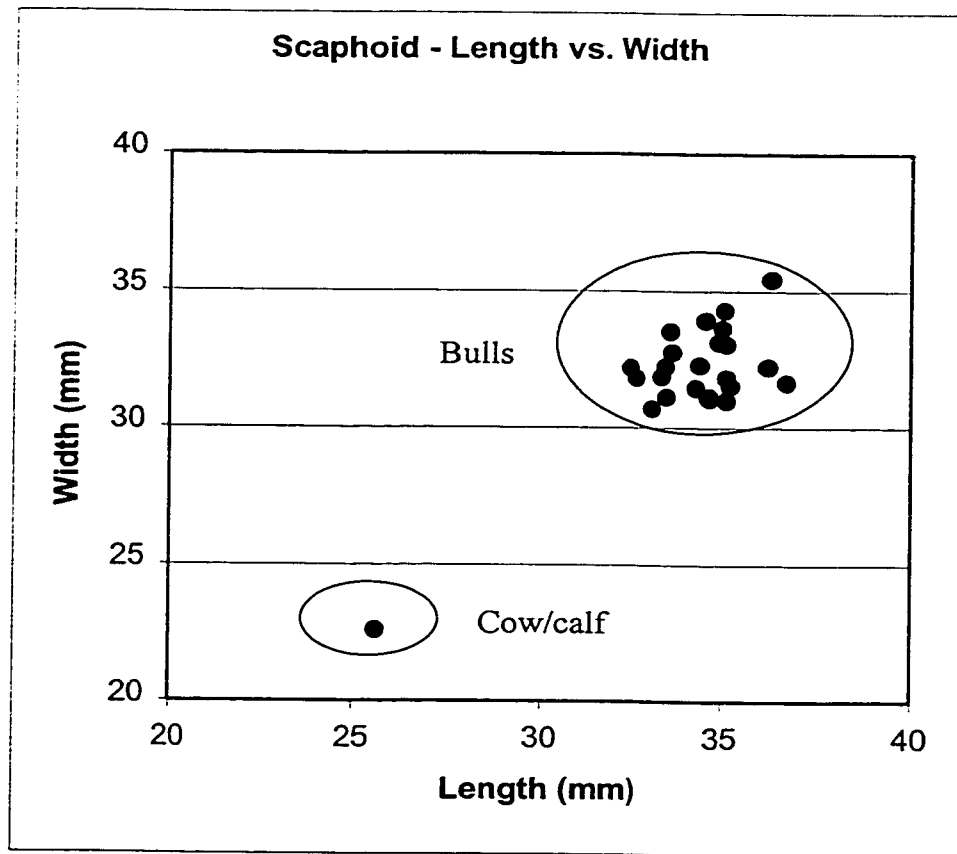


Figure 6.3. Bivariate plot of scaphoid measurements (length vs. width).

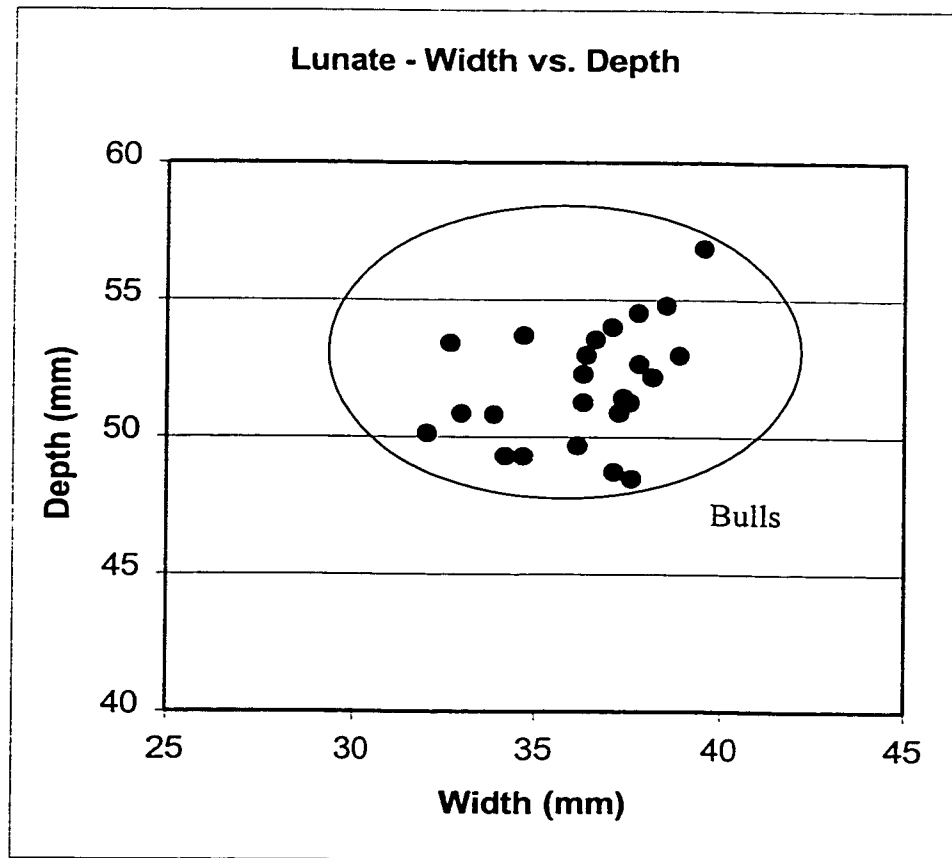


Figure 6.4. Bivariate plot of lunate measurements (width vs. depth).

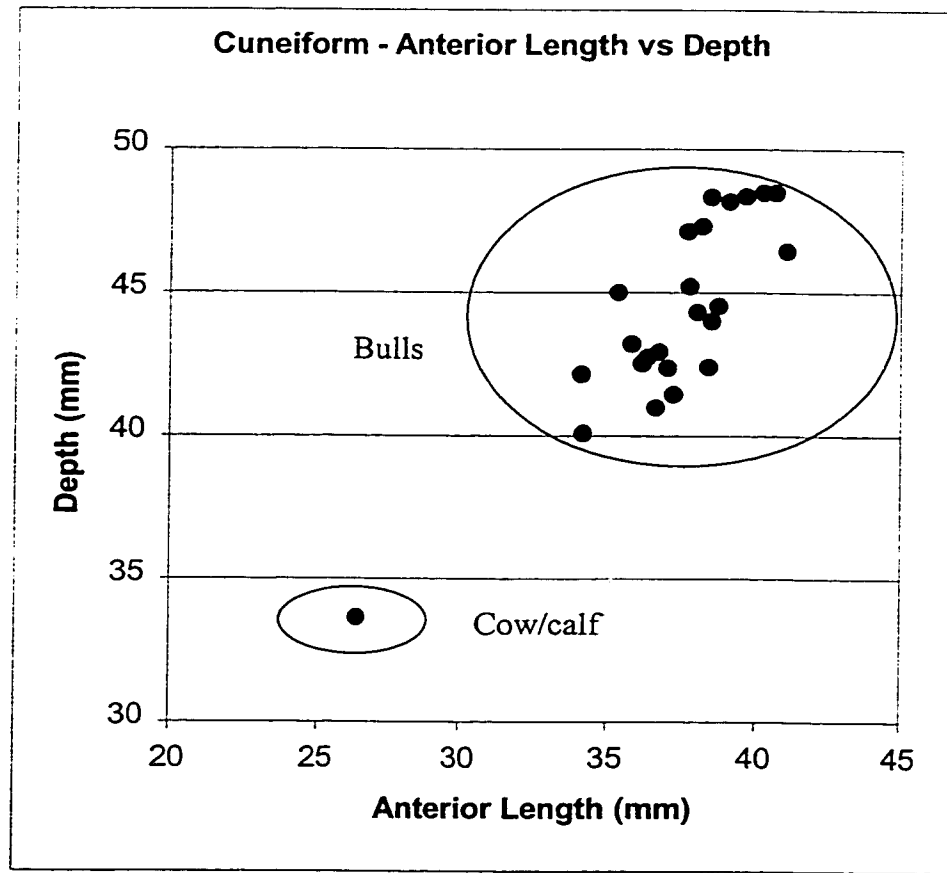


Figure 6.5. Bivariate plot of cuneiform measurements (anterior length vs. depth).

Pisiform

Length, width and depth are the measurements defined by Morlan for the pisiform (accessory carpal). Morlan does not provide a bivariate plot for this element, since his small sample size of only three provided no evidence of bimodality. However, at EgPn-440, 19 specimens could be measured and bivariate plots were thus constructed. In plotting length vs. width, a bimodal pattern similar to the others described so far was the result (Figure 6.6). Again, one specimen appeared to belong to a cow/calf group whereas the others all clustered in a bull group. Plotting length vs. depth and width vs. depth provided no evidence of bimodality.

Magnum

Width and depth were measured for 34 magnum (carpal 2 + 3) specimens from EgPn-440. Length is defined by Morlan, but is difficult to measure due to problems in defining the points of measurement; this attribute was left out due to the potential errors that could result. Morlan's plot of width vs. depth provides a bimodal pattern for eight specimens, although the clusters tend to be somewhat amorphous. Plotting the measurements for EgPn-440 results in a bimodal pattern that again has only one specimen that appears to be a member of the cow/calf group (Figure 6.7). The remaining specimens group together as adult males, although two individuals appear to be intermediate between the bulls and the cow/calf group. Based on the measurements alone, these would be grouped with the cow/calf group in Morlan's sample.

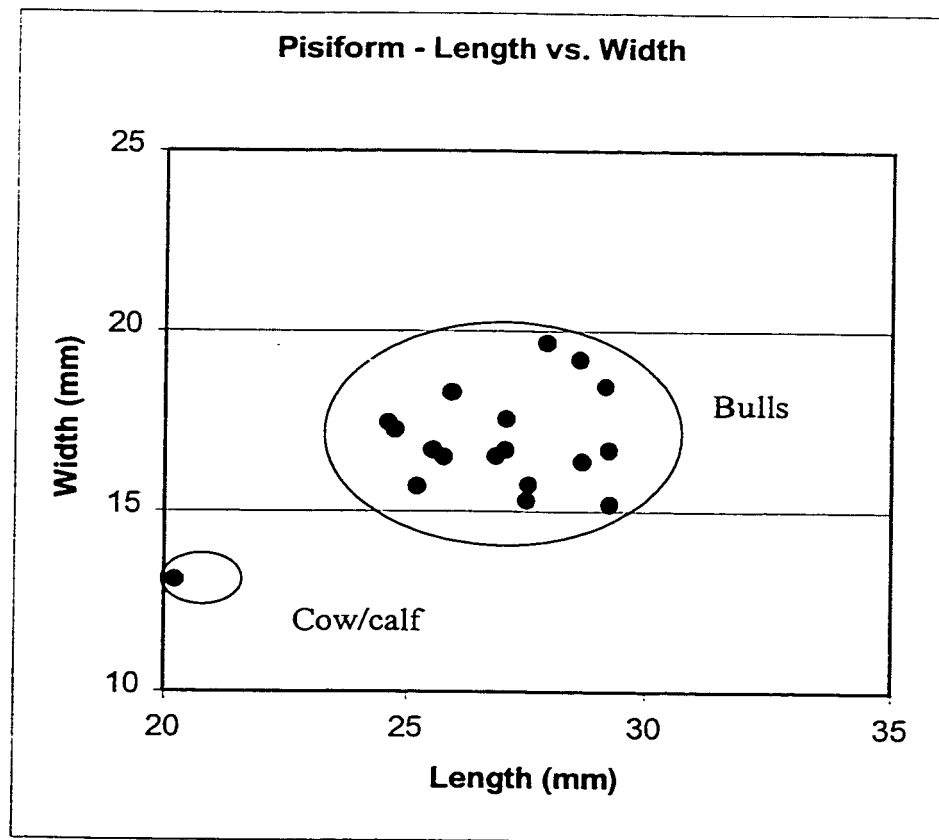


Figure 6.6. Bivariate plot of pisiform measurements (length vs. width).

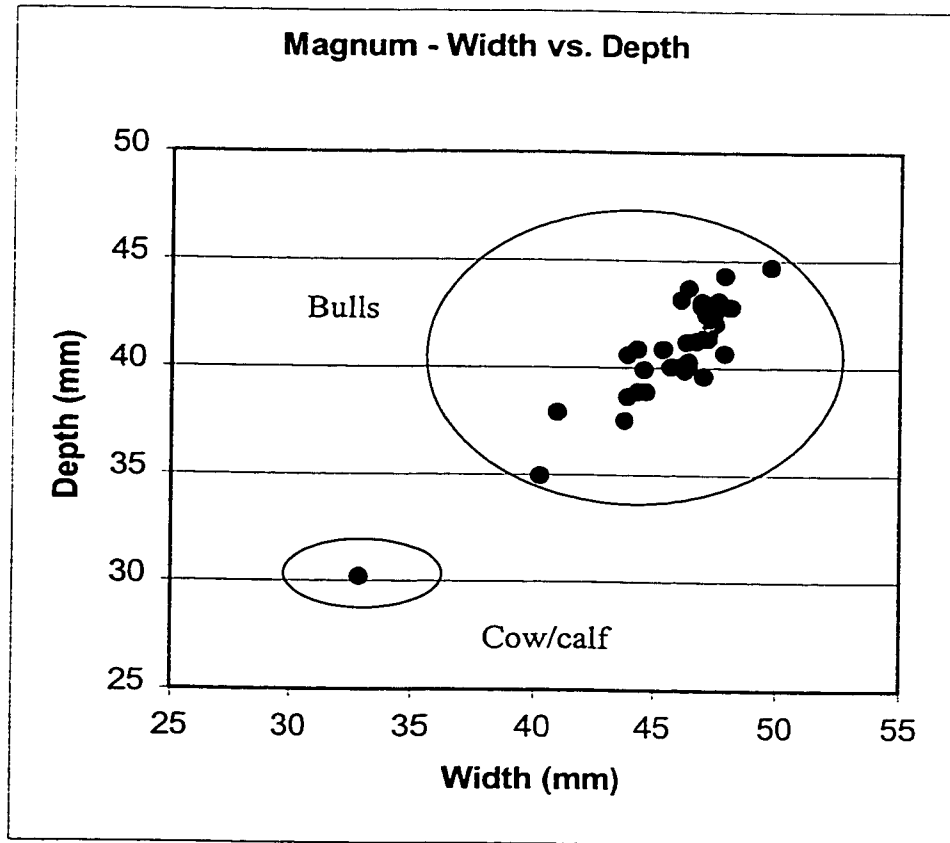


Figure 6.7. Bivariate plot of magnum measurements (width vs. depth).

Unciform

The measurements defined by Morlan for the unciform (carpal 4) included length, width and depth. This element provided Morlan's largest sample at nine specimens. No apparent bimodality resulted from the plot of width vs. depth. A similar plot for EgPn-440 involved 22 specimens, and is shown in Figure 6.8. The result was again a single individual in the cow/calf group, with the remaining specimens in a fairly scattered group of "bulls". The single cow/calf specimen is smaller than any of the specimens measured by Morlan, and probably represents an immature individual. Similar patterns resulted from the plots of length vs. depth and length vs. width.

Discussion of Sexing Using Carpals

Although five of the six carpals demonstrate some degree of bimodality for the EgPn-440 assemblage, the patterns are all biased strongly towards the adult bulls group. There are several potential explanations for this. First, the results from the Sjøvold Site assemblage, on which Morlan bases his methodology, may be biased based on the small sample size. Morlan's observation of bimodality may simply result from a sample size that is not large enough to represent the true distribution of sizes. However, this does not explain the lack of members identified as cow/calf (ie. those at the smaller end of the scale) for the EgPn-440 assemblage.

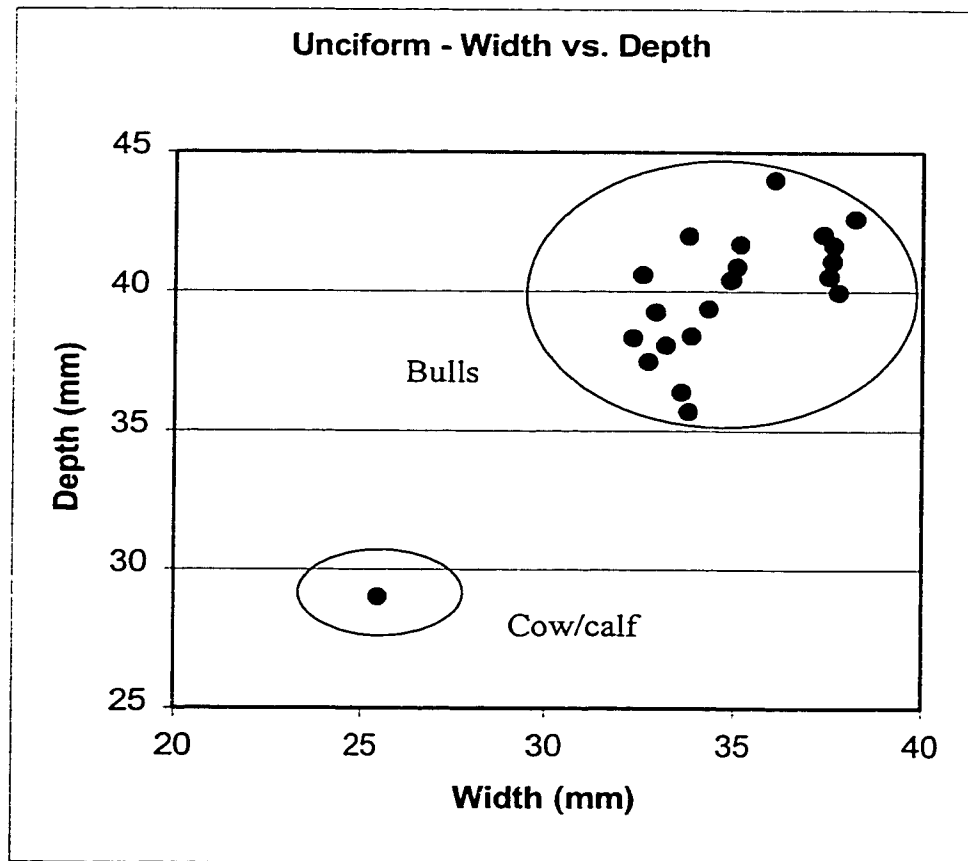


Figure 6.8. Bivariate plot of unciform measurements (width vs. depth).

Another possible explanation may lie in the idea of a bimodal distribution as indicative of a male/female distinction. It is possible that the bimodality demonstrated at the Sjøvold Site indicates a distinction between a calf group and a male/female group, since fusion data cannot be obtained from carpals. If this were true, the EgPn-440 data would indicate a kill of both males and females, with a noticeable absence of young individuals. The absence of young animals may be a true reflection of the composition of the herd; or, it may be a result of the removal of the remains of the immature animals by either taphonomic or cultural processes. However, this explanation is not necessarily supported by other data in the faunal assemblage. As noted in chapter five, unfused elements were common, and the dentition data (presented earlier in this chapter) also indicates that some immature animals were indeed present.

A third explanation for the pattern observed at EgPn-440 is that the bison group killed at this site was represented overwhelmingly by males. This theory is supported by the fact that the measurements recorded for the carpals were overall large compared to those in Morlan's sample, generally as large or larger than the comparative male from Elk Island. Based on these factors, I suggest that the results from the carpal measurements strongly support the suggestion that the bison population represented at EgPn-440 represents a kill of almost exclusively males.

Sexing Using Tarsals

The results for bivariate plots for each of the tarsals are presented in Figures 6.9 through 6.18.

Astragalus

Six measurements of the astragalus (talus) are defined by Morlan, including lateral length, medial length, proximal width, distal width, lateral depth, and medial depth. The Sjøvold Site assemblage includes eight astragali which provide a vaguely bimodal pattern when medial length and distal width are plotted. The EgPn-440 assemblage includes 30 specimens. When the same variables were plotted (medial length and distal width), the result was a pattern that illustrated the presence of four individuals belonging to a cow/calf group, and a much larger number of individuals belonging to a bull group (Figure 6.9). Unfortunately, these groups are not clearly clustered, but the actual measurements for the cow/calf group correspond reasonably well to those in Morlan's Sjøvold sample. As with many of the carpals, the measurements for those individuals in the bull group ranged from similar values to much larger ones.

Other variables were also plotted against each other to determine if other measurements would provide some evidence of bimodal distribution. Several of the plots provided evidence suggestive of bimodality. Medial length vs. proximal width (Figure 6.10) provides some evidence of bimodality with five specimens representing a cow/calf group and the remainder representing a bull group. This is a similar pattern to that exhibited in the plot of medial length vs. distal width (Figure 6.9). Similarly, lateral length vs. proximal width also shows some degree of bimodality, although the distinction between the cow/calf group and the bull group is less clear (Figure 6.11). Two specimens appear to belong to the cow/calf group, and a large number belong to the bull group, but several individuals appear to be intermediate, and are considered to be of indeterminate sex here. However, some degree of bimodality is exhibited in these two plots, and this may indicate that proximal width is bimodal. Future investigations should focus more on this measurement as an indicator of bimodality. Other bivariate plots for the astragalus provided weak evidence for bimodality, and in most examples the distribution was strongly concentrated on the higher values, suggesting all-male groups.

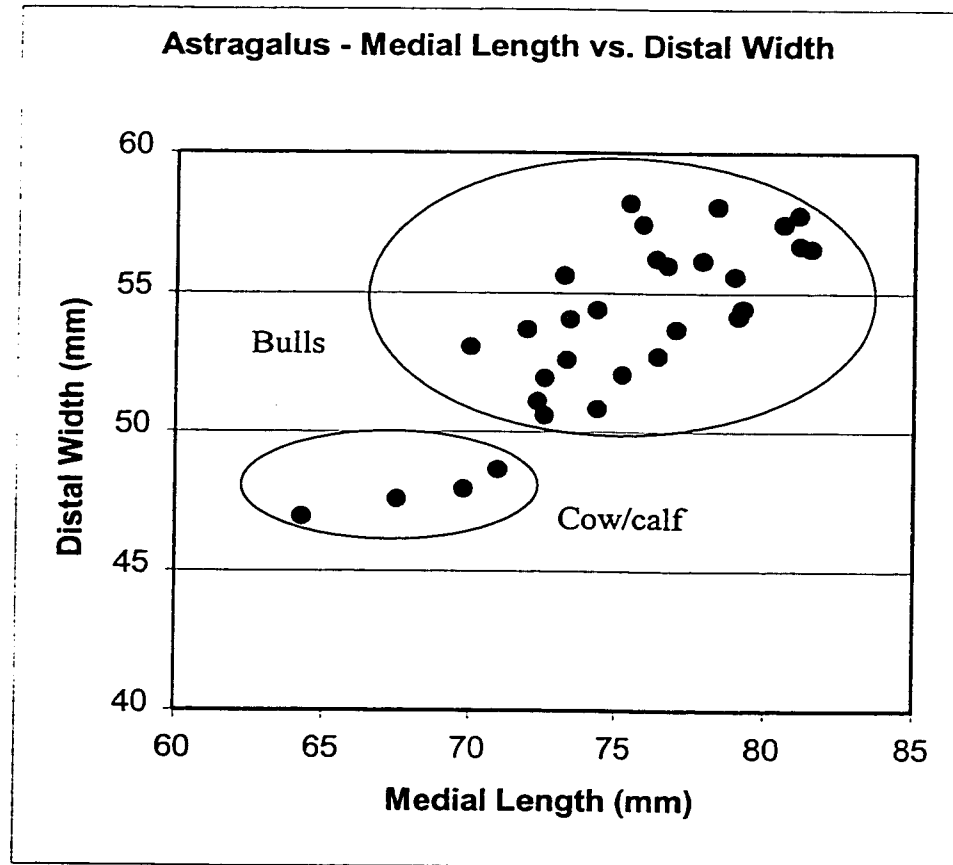


Figure 6.9. Bivariate plots of astragalus measurements (medial length vs. distal width).

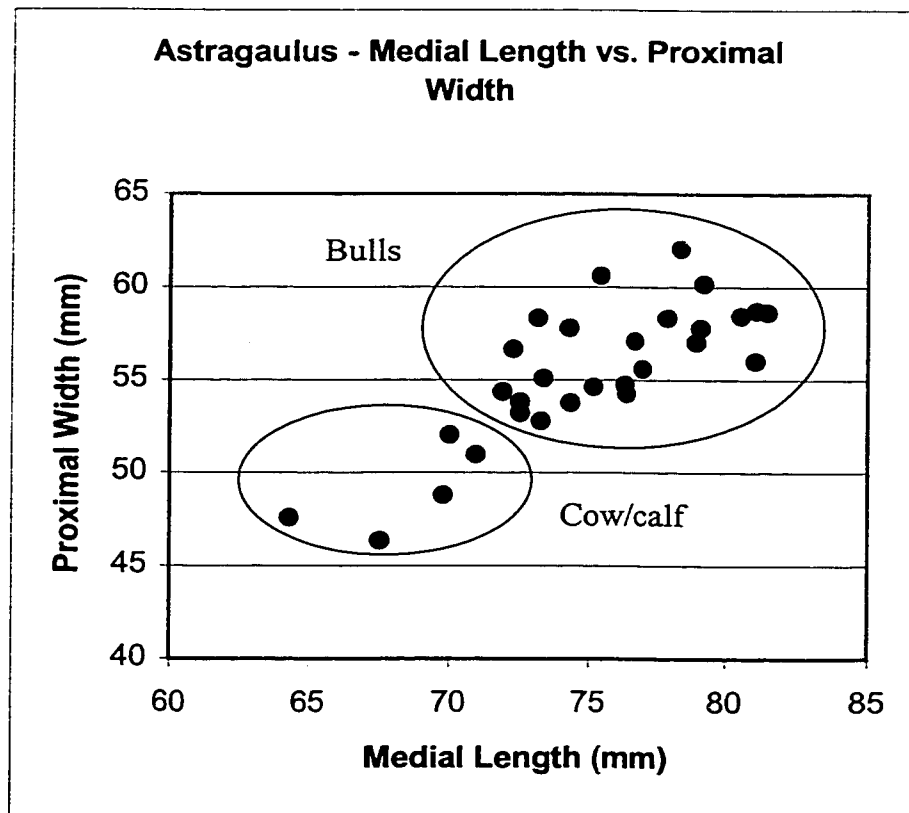


Figure 6.10. Bivariate plots of astragulus measurements (medial length vs. proximal width).

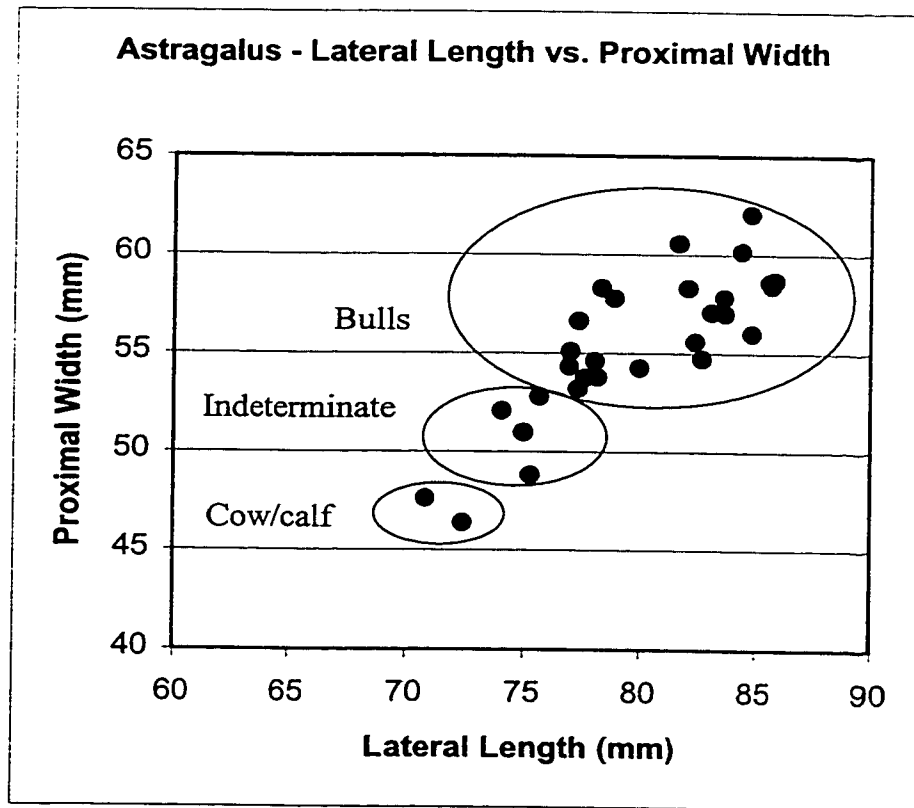


Figure 6.11. Bivariate plots of astragalus measurements (lateral length vs. proximal width).

Calcaneus

Morlan (1991:223) defines seven measurements for the calcaneus, including length, proximal width, proximal depth, distal width, distal depth, length of the navicular cuboid facet and length of the astragalus facet. Morlan provides two bivariate plots for the Sjøvold assemblage, each involving nine specimens. Distal width vs. distal depth provides a bimodal pattern, the cow/calf group being tightly clustered and the bulls being somewhat more scattered. The plot of length of navicular cuboid facet vs. length of astragalus facet results in a slightly bimodal distribution, although the Elk Island individual falls between the two clusters.

Calcanei for which at least two measurements could be taken numbered 42. Many specimens were complete, and most incomplete specimens were only missing the proximal end. Bivariate plots using the same variables as those presented by Morlan were constructed for the EgPn-440 data. Distal width vs. distal depth provides an indication of bimodality (Figure 6.12). Three individuals cluster due to smaller measurements, and this may indicate a cow/calf grouping. The remaining individuals are scattered, and seem to indicate a bull grouping. The measurements for these individuals are also consistently larger than those presented by Morlan. The second bivariate plot of length of navicular cuboid facet vs. length of astragalus facet provides little evidence of bimodality for the EgPn-440 assemblage (Figure 6.13). Five specimens at the left of the plot may represent a cow/calf group, and the remaining individuals may represent bulls. These two groups are not clearly divided, but values for the cow/calf group are very similar to those recorded by Morlan. The measurements for the bull group are again overall larger than those recorded by Morlan.

Two other bivariate plots provide further evidence for bimodal distribution. Proximal depth vs. distal width shows bimodality, with two specimens classified as cow/calf and the rest as bulls (Figure 6.14). Proximal width vs. distal width also shows a fairly strong bimodality, with two individuals present in a cow/calf grouping, and the remaining individuals in a scattered bull group (Figure 6.15). The actual specimens placed in the cow/calf group for these four bivariate plots tend to remain the same. For example, specimen #26847 is present in the cow/calf group in all four plots; specimen #35690 is present as cow/calve in three plots; and specimens #9915 and #8582 each appear as cow/calves in two plots. Specimens #46372, #60678 and #35100 appear as a cow/calve in only one plot; the latter two of these appear in the bivariate plot of the facet lengths, the least bimodal plot of the four.

Navicular Cuboid

Length, width and depth are measurements defined by Morlan for the navicular cuboid (tarsal C + 4). Morlan plots width vs. length for 11 specimens and the result is a bimodal distribution in which the bulls are tightly grouped. The EgPn-440 assemblage has 34 specimens. When width vs. depth is plotted for this assemblage, the result is a bimodal distribution that resembles most of the carpal distributions due to the presence of a single representative of the cow/calf group (Figure 6.16). The “bulls” in this case are extremely scattered with a huge range of values, particularly for width. When compared with Morlan’s measurements, these values would include both the cow/calf grouping and the bull grouping. I thus suggest that this large group does not represent bulls but represents both males and females. The outlier, which has a very low value probably represents an immature individual. From this assemblage, it does not appear that the navicular cuboid is a valuable indicator of bimodality related to sexual dimorphism.

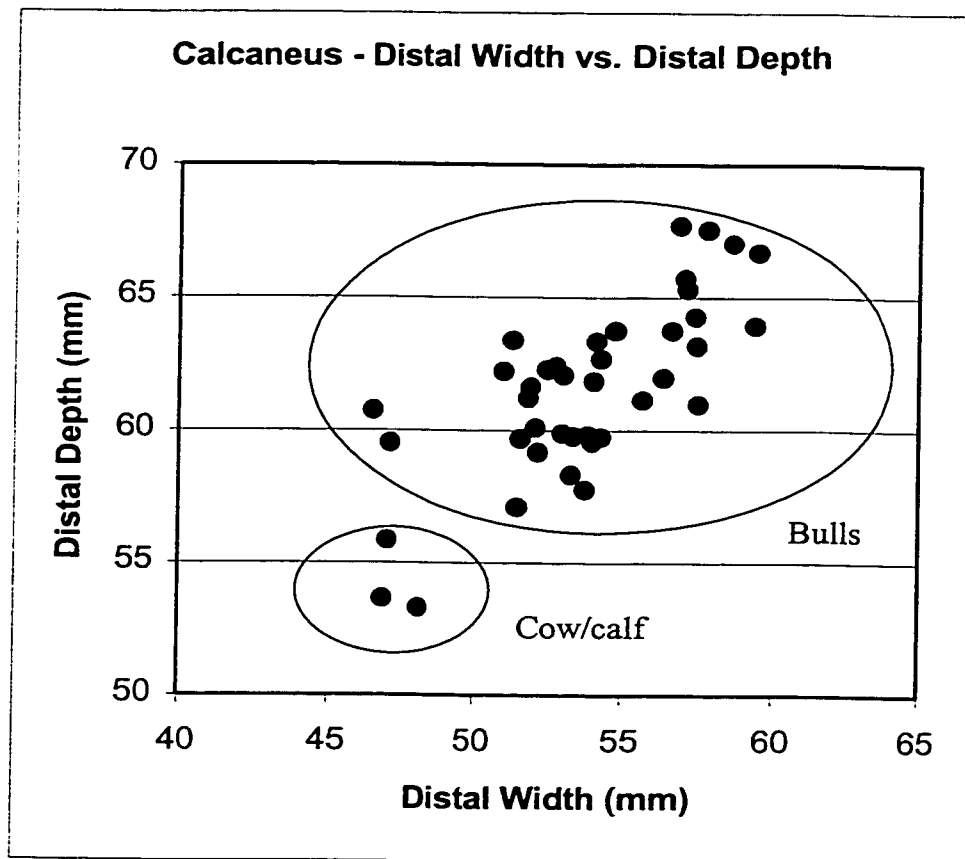


Figure 6.12. Bivariate plot of calcaneus measurements (distal width vs. distal depth).

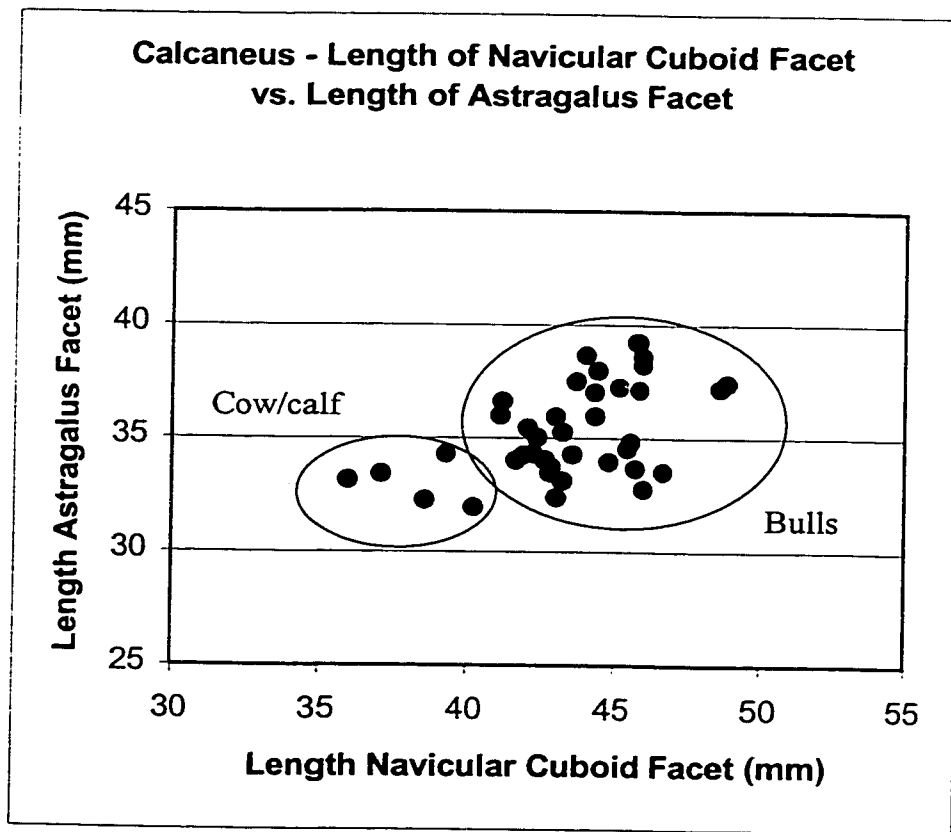


Figure 6.13. Bivariate plot of calcaneus measurements (length of navicular cuboid facet vs. length of astragalus facet).

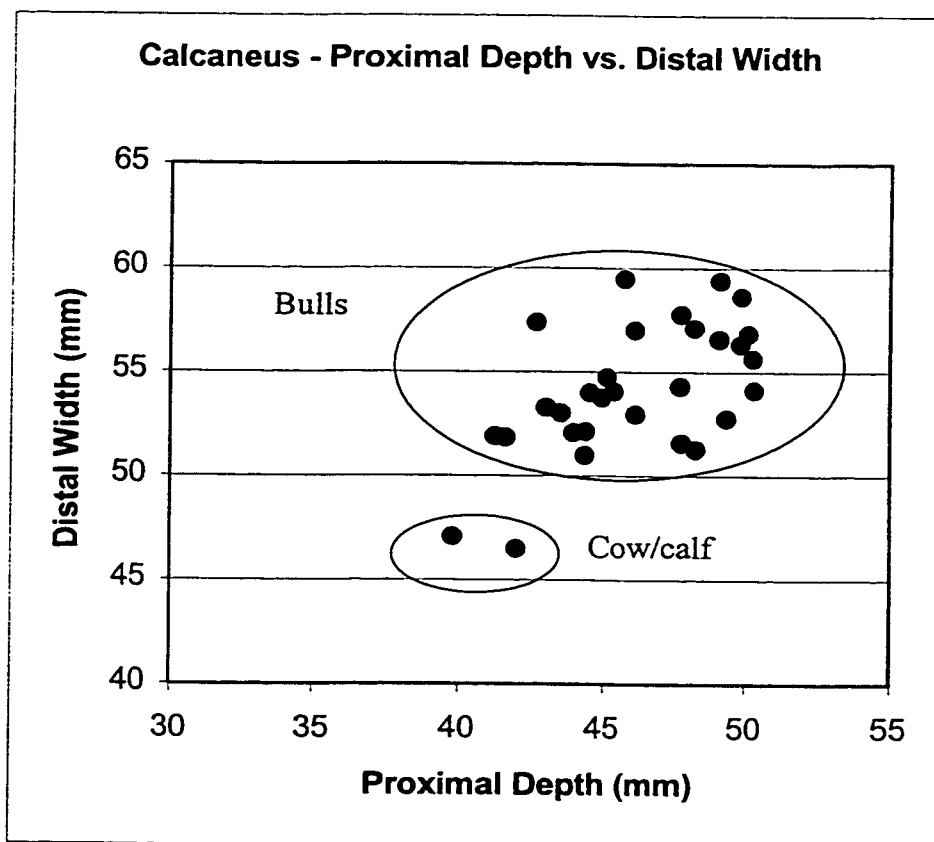


Figure 6.14. Bivariate plot of calcaneus measurements (proximal depth vs. distal width).

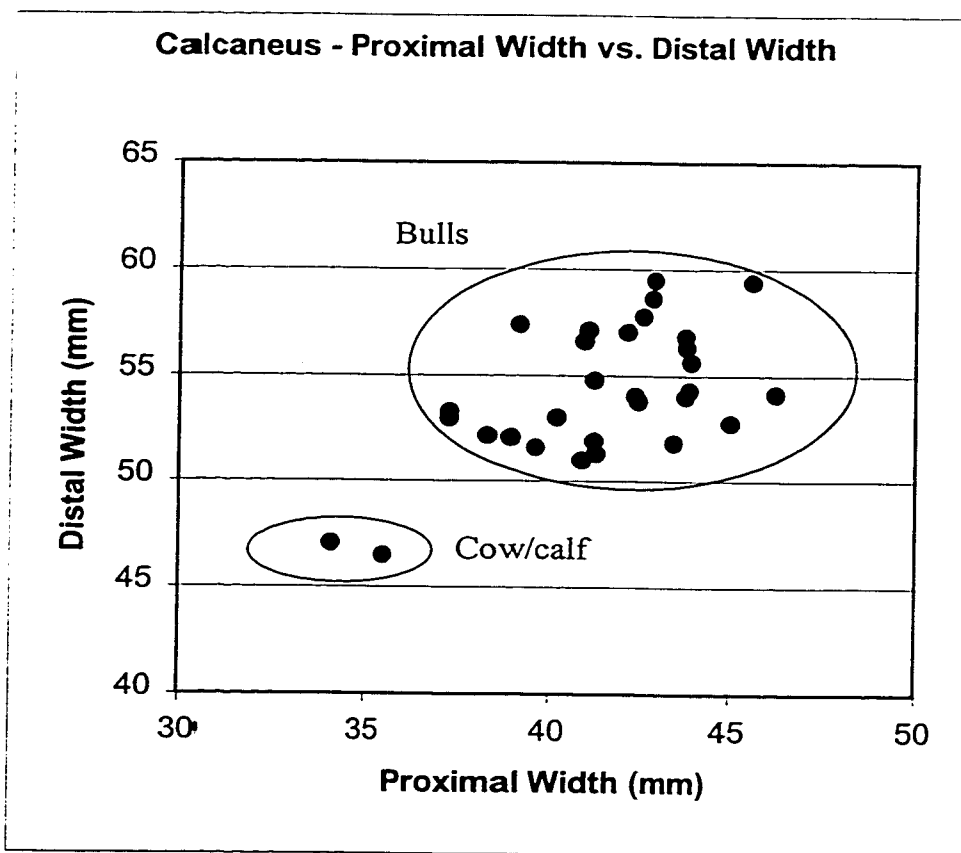


Figure 6.15. Bivariate plot of calcaneus measurements (proximal width vs. distal width).

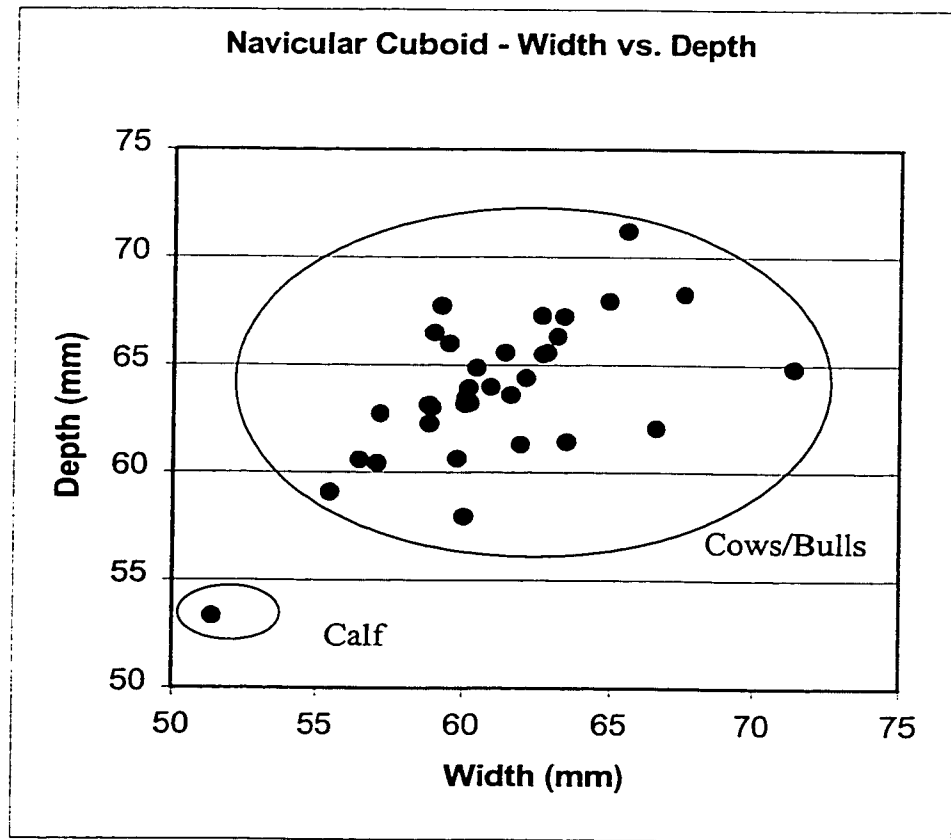


Figure 6.16. Bivariate plot of navicular cuboid measurements (width vs. depth).

Cuneiform Pes

Width and depth measurements were taken for the cuneiform pes (tarsal 2 + 3). Morlan also defines length, but this measurement is difficult to take consistently due to difficulties in defining the points of measurement. The Sjøvold Site data has nine specimens for which Morlan plots width vs. depth. A bimodal distribution is the result. The EgPn-440 assemblage consists of 31 specimens for which both width and depth could be measured. When width and depth are plotted, the result is a bimodal distribution in which two specimens appear to belong to the cow/calf grouping, and the remainder belong to a scattered bull grouping (Figure 6.17). The measurements of the two cow/calf specimens match closely those noted by Morlan. The smallest bull measurements are also similar, but at EgPn-440, there are clearly also a number of larger animals than those recorded for the Sjøvold Site.

Lateral Malleolus

Length and depth were measured for the lateral malleoli at EgPn-440. Morlan also defines width, but this measurement is difficult to take consistently, again due to difficulties in defining the points of measurement. Morlan's assemblage consists of 11 specimens, and a bivariate plot of depth vs. length results in a distribution that exhibits very weak (if any) bimodal distribution (Figure 6.18). The EgPn-440 assemblage has 27 specimens for which both length and depth measurements could be taken. A bivariate plot of depth vs. length results in a distribution that exhibits weak bimodality. Three specimens appear to belong to a cow/calf group, and a number of individuals belong to a scattered bull group.

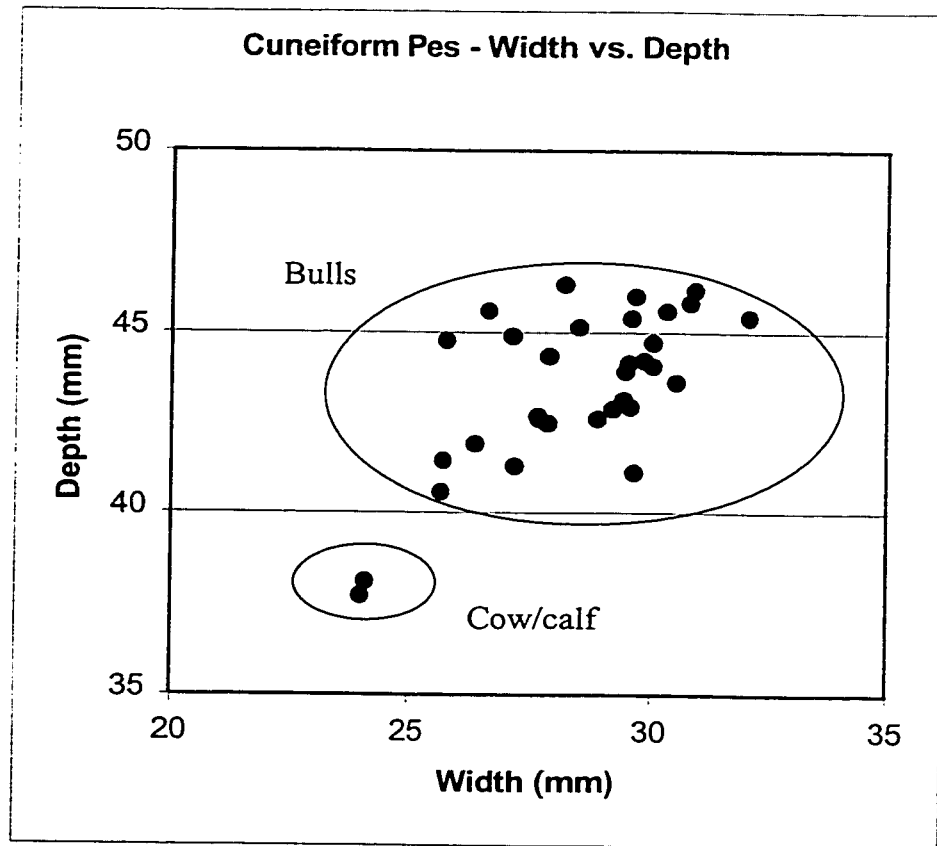


Figure 6.17. Bivariate plot of cuneiform pes measurements (width vs. depth).

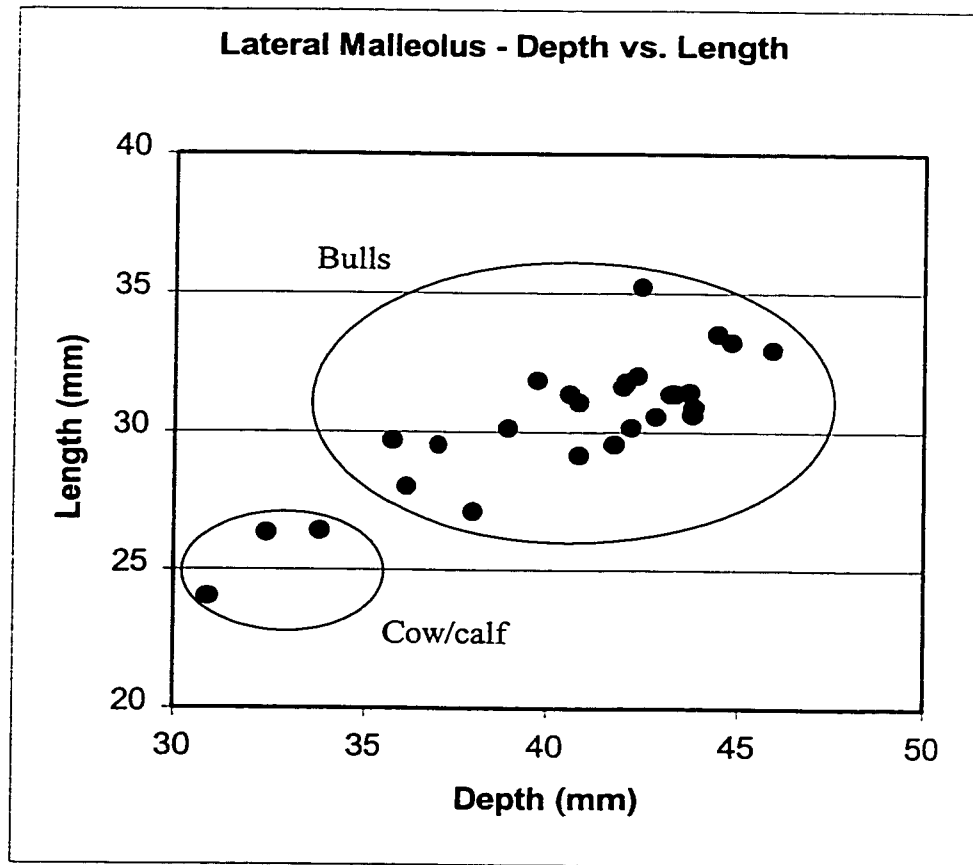


Figure 6.18. Bivariate plot of lateral malleolus measurements (depth vs. length).

Discussion of Sexing Using Tarsals

Of the five tarsals investigated, all elements exhibit some degree of bimodality. The calcaneus exhibits bimodality in several plots (see Figures 6.12 to 6.15), but the criteria considered best by Morlan (length of the articular facets) provides the weakest evidence for bimodality for the EgPn-440 sample. The navicular cuboid exhibits a similar pattern to that observed for most of the carpals in that bimodality was observed, but the measurements suggest that males and females are clustering together rather than the males clustering separately from females and calves. The possible explanations listed for the carpal results above may apply to this element as well, including the possibility that this bison group consisted mainly of males. The third tarsal to exhibit bimodality is the cuneiform pes, in which two specimens appear to belong to a cow/calf grouping and the remainder belong to a very scattered bull grouping. The astragalus and the lateral malleolus demonstrate weaker bimodality than the other tarsals.

Compared to the carpals, the bimodal distributions for the tarsals tend to be slightly more evenly distributed, with more individuals being present in the cow/calf group (as opposed to only one individual for each of the carpal distributions). The tarsals again appear to indicate that bulls were far more prevalent at this site than cows or calves. But, as with the carpals, the stronger concentration of points in the upper half of the graphs may actually represent a combined male/female grouping, and the smaller grouping at the bottom left might represent immature individuals. However, as with the carpal data, I suggest that for this assemblage, there appears to be a large number of adult males present. Many of the carpals and tarsals exhibit upper ranges that exceed the measurements taken by Morlan. This, along with the consistency with which the bull groupings dominate both the carpal and tarsal plots suggests that this assemblage is indeed composed mainly of large adult males.

Sexing Using Long Bones

The second method to be employed in this study in the determination of sex of bison remains is the measurement of aspects of long bones and their use in discriminant functions. The methodology used here follows Walde (n.d.), which includes modifications of equations presented in Walde (1985). Measurements are taken based on those presented by Speth (1983), and those measurements are then incorporated into discriminant functions as defined by Walde. Walde presents one or more sets of equations for proximal and distal ends of the humerus, radius, metacarpal, femur, tibia and metatarsal. Each equation set includes one male and one female equation. The required measurements are entered into each, and the equation resulting in the higher value indicates the sex. Elements measured are all adult animals as determined by the complete fusion of epiphyses.

Measurements were taken with digital callipers as described in Speth (1983). The applicable measurements were then inserted into each of Walde's discriminant function equations in Excel (Microsoft 1996), and the resulting values were compared to determine if that equation provided a male or female result for the specimen. In a number of examples more than one equation could be used for a single specimen; usually the same sex determination resulted, but some specimens provided both female and male results. Each element will be discussed in more detail below.

Humerus

No proximal ends were complete enough to take measurements for Walde's discriminant functions, so only distal equations were used for the EgPn-440 assemblage. The results are shown in Table 6.5 below. The results show a clear emphasis towards males; 28 of 33 specimens are classified as male, including 15 right and 13 left. Many of these specimens could be classified based on the results of all eight equations, although four specimens are determined to be male based on only one equation. Only one

specimen appears to be female. Four specimens have mixed results, and are therefore considered to be of unknown sex.

Table 6.5. Sexing results of discriminant functions for the humerus.

Humerus	Side	Distal Equations							
		1	2	3	4	5	6	7	8
1214	L	M	M	M	M	M	M	M	M
5627	L	-	-	-	-	-	-	M	-
17918	R	M	M	M	F	F	M	M	M
24097	R	M	M	M	M	M	M	M	M
24475	R	M	M	M	M	M	M	M	M
24673	R	M	M	M	M	M	M	M	M
24676	R	-	-	-	-	M	-	-	-
25226	R	M	M	M	M	M	M	M	M
25302	L	-	-	-	-	-	-	M	-
30586	R	M	-	M	-	-	M	M	-
31579	R	M	M	M	M	M	M	M	M
32947	L	M	M	M	M	M	M	M	M
35037	L	M	-	M	-	-	M	M	-
35045	R	M	M	M	M	M	M	M	M
39312	R	M	M	M	M	M	M	M	M
43220	L	M	M	M	M	M	M	M	M
43945	L	M	M	M	M	M	M	M	M
45616	L	F	F	F	F	F	F	F	F
47646	R	M	M	M	F	F	M	M	M
49126	L	M	-	M	-	-	M	F	-
50529	R	M	M	M	M	M	M	M	M
54675	R	-	-	-	-	-	-	M	-
55691	L	M	M	M	M	M	M	M	M
58056	R	M	M	M	M	M	M	M	M
58199	L	M	M	M	M	M	M	M	M
58968	L	-	M	-	M	M	-	M	-
62745	R	M	M	M	M	M	M	M	M
62746	R	M	M	M	M	M	M	M	M
62943	L	M	M	M	M	M	M	M	M
64123	L	M	M	M	M	M	M	M	M
66577	R	-	M	-	M	M	-	F	-
66729	R	M	M	M	M	M	M	M	M
68271	L	M	M	M	M	M	M	M	M

Radius

Both proximal and distal measurements could be taken for a number of radii, including nine complete specimens. The radius provided the largest number of specimens for measurements to be taken of all the long bones, but also resulted in the largest number of specimens for which mixed results occurred. Results are shown in Table 6.6 below. The sex determination was again overwhelmingly male, with 35 of 47 specimens being classified as male (11 right and 24 left). Only two of these were based on one equation only, and six were based on complete specimens. Only two specimens were classified as female (both right). Ten specimens had mixed results. Of these, three may be tentatively classified: #24671 (Male), #62515 (Male) and #25593 (Female) since only one result of each of these is contrary to the overall result, and by small margins. However, it may be best to consider all ten of these to be questionable.

Metacarpal

Only complete metacarpals were measured; since the proximal end is essentially “fused” at birth, the maturity of the animal cannot be determined if only the proximal end is present, so these specimens cannot be used in sexing analysis. Distal ends were also ignored since siding can be difficult. Twenty-four complete metacarpals were measured for discriminant functions. Only one specimen was classified as female; the rest were male (nine right and 14 left). No mixed results were obtained, and the margins between the male and female resulting values were generally large, suggesting that the results are secure. Results are shown in Table 6.7 below.

Table 6.6 (continued). Sexing results for discriminant functions for the radius.

Radius	Side	Proximal Equations						Distal Equations			
		1	2	3	4	5	6	1	2	3	4
66291	R	M	M	M	M	M	M	M	M	M	M
66292	R	F	F	M	F	F	M	-	-	-	M
66293	L	-	-	-	-	-	-	M	M	M	M

Table 6.7. Sexing results from discriminant functions for the metacarpal.

Metacarpal	Side	Proximal Equations			Distal Equations			
		1	2	3	1	2	3	4
892	R	M	M	M	M	M	M	M
4624	R	M	M	M	M	M	M	M
5314	R	M	M	M	M	M	M	M
5622	L	M	M	M	M	M	M	M
11260	L	M	M	M	M	M	M	M
13295	R	M	M	M	M	M	M	M
15256	L	M	M	M	M	M	M	M
15399	R	M	M	M	M	M	M	M
16335	L	M	M	M	M	M	M	M
23827	L	M	M	M	M	M	M	M
25595	R	M	M	M	M	M	M	M
28627	R	M	M	M	M	M	M	M
30446	L	M	M	M	M	M	M	M
32948	L	M	M	M	M	M	M	M
38367	L	M	M	M	M	M	M	M
39161	R	F	F	F	F	F	F	F
40059	L	M	M	M	M	M	M	M
44148	L	M	M	M	M	M	M	M
47770	L	M	M	M	M	M	M	M
62517	L	M	M	M	M	M	M	M
63174	L	M	M	M	M	M	M	M
63306	L	M	M	M	M	M	M	M
66970	R	M	M	M	M	M	M	M
68212	R	M	M	M	M	M	M	M

Femur

As discussed in chapter five, the femora at EgPn-440 are highly fragmented, likely to due marrow extraction. Complete femur ends were absent. Only two specimens were complete enough to use in any of Walde's discriminant function equations. These are shown in Table 6.8 below. Proximal Equation 2 was the only equation that could be used, and both specimens were classified as male on this basis. The minimal number of specimens makes it difficult to make any conclusions based on the femora.

Table 6.8. Sexing results from discriminant functions for the femur.

Femur	Side	Proximal Equations		Distal Equations	
		1	2	1	2
34547	R	-	M	-	-
35082	R	-	M	-	-

Tibia

Results from the discriminant function equations for the tibiae are shown in Table 6.9 below. The proximal tibia was overall highly fragmented, and only two specimens permitted sufficient measurements of the proximal end to allow their use in proximal discriminant function equations. One of these (a right) was determined to be female, based on two equations. One specimen (a right) was determined to be male, also based on two equations. Distal ends were far more commonly found at EgPn-440. The sexing results leaned strongly towards males. Twenty-four specimens (12 right and 12 left) of 31 were classified as male and seven (two right and five left) were female. In addition, two specimens produced mixed results, with one equation indicating male and one indicating female.

Table 6.9. Sexing results from the discriminant functions for the tibia.

Tibia	Side	Proximal Equations				Distal Equations	
		1	2	3	4	1	2
419	L	-	-	-	-	M	M
631	L	-	-	-	-	M	M
4622	L	-	-	-	-	M	M
5024	L	-	-	-	-	F	F
5216	L	-	-	-	-	M	M
9944	R	-	-	-	-	F	F
12849	L	-	-	-	-	F	F
15257	R	-	-	-	-	M	M
16411	R	-	-	-	-	M	F
18866	R	-	-	-	-	M	M
19350	L	-	-	-	-	M	M
19351	R	-	-	-	-	M	M
19352	L	-	-	-	-	M	M
20203	R	-	-	-	-	M	M
23782	R	-	-	-	-	M	F
24478	R	-	-	-	-	M	M
24670	L	-	-	-	-	M	M
25785	R	-	-	-	-	M	M
27100	R	-	-	-	-	M	M
28897	L	-	-	-	-	M	M
34000	L	-	-	-	-	M	M
35837	L	-	-	-	-	M	M
35928	R	-	-	-	-	M	M
36680	R	-	-	-	-	M	M
37133	L	-	-	-	-	M	M
37134	L	-	-	-	-	F	F
46368	L	-	-	-	-	F	F
58057	R	-	-	F	F	F	F
58198	R	-	M	-	M	-	-
62519	R	-	-	-	-	M	M
62747	L	-	-	-	-	M	M
62897	R	-	-	-	-	M	M
68213	R	-	-	-	-	M	M
68432	L	-	-	-	-	F	F

Metatarsal

Results for the metatarsals are shown in Table 6.10 below. As with the metacarpals, only complete metatarsals were measured. Twenty complete metatarsals were measured, and the results indicated 18 males (14 right and four left) and two females (one right and one left). No mixed results were observed. As with the other long bones, this suggests a bison kill heavily weighted with males versus females.

Table 6.10. Sexing results from discriminant functions for the metatarsal.

Metatarsal	Side	Proximal	Distal Equations		
		1	1	2	3
2417	L	M	M	M	M
2423	R	M	M	M	M
9936	R	M	M	M	M
19829	R	M	M	M	M
21103	R	M	M	M	M
21104	R	M	M	M	M
23784	L	M	M	M	M
24095	L	M	M	M	M
24096	R	M	M	M	M
30447	R	M	M	M	M
31114	R	M	M	M	M
31360	R	M	M	M	M
37395	L	F	F	F	F
37488	R	F	F	F	F
39510	R	M	M	M	M
44493	L	M	M	M	M
49110	R	M	M	M	M
49125	R	M	M	M	M
59562	R	M	M	M	M
63176	R	M	M	M	M

Discussion of Sexing Using Long Bones

The sexing results from the long bone discriminant functions are overwhelmingly male. The lowest percentage of males comes from the tibia (78% male), with all other long bones being above 90% male. The Happy Valley Bison Kill Site, located just to the east of EgPn-440, provides a comparison. At that site, Shortt (1993) used Walde's (1985) discriminant functions to sex the long bones. Although the sample is significantly smaller than at EgPn-440, there is a similar pattern of a larger percentage of males versus females. With the exception of the proximal radius, Shortt found that specimens determined to be male were approximately twice as common as females. Although the Happy Valley Bison kill is a Besant kill, the similarity in proportion of males to females suggests that similar processes are taking place. Shortt suggests that the procedure presented by Walde may be biased due to changes in sex-based size differences between bison in prehistory and those in modern populations from which discriminant functions were derived (Shortt 1993:172, see also Wilson 1969). However, the recent age of the EgPn-440 assemblage means that this is not an issue. The fragmentation of archaeological assemblages compared to comparative modern specimens may also affect the outcome of discriminant function analysis. For example, Walde (n.d.) suggests that female distal humeri may tend to fracture longitudinally during butchering whereas male distal humeri tend to stay intact during butchering simply because of their size. If this is true, the result will be a bias towards male distal humeri. However, the sexing results for the humeri tend to parallel those for the other long bones from EgPn-440, suggesting that this may not be a factor.

Although factors such as these must be taken into account, I suggest that the high proportion of elements classified as male is a real pattern that represents a higher proportion of male bison killed at this site. This is supported by the carpal and tarsal results in which the majority of the specimens appeared to be adult males. This may be considered to be an unusual pattern in bison kills on the plains. Frison states that:

After the rut, the older mature males separate from the herd and remain so singly or in groups of up to as many as a dozen. This is the most favourable period for driving the animals... (t)he older males which are difficult to drive are mostly off to themselves leaving the more desirable cows, calves and young adult animals in large groups (Frison 1974:20).

However, ethnographic accounts collected by Arthur (1978) and Verbicky-Todd (1984) clearly indicate that male bison were hunted using jumps or pounds. Although a great deal of debate exists regarding the seasonal migration of bison as it relates to the seasonal round of Plains peoples (see, for example, Moodie and Ray 1976; Morgan 1980; Vickers 1991; Chisholm et al. 1986; Malainey and Sherriff 1996), enough evidence seems to exist to support the communal hunting of bison in all seasons. All-male groups would have been more prevalent in the late fall, winter and spring: "At the close of the rutting season, the buffalo separated into smaller herds comprised mainly of either bulls or cows." (Verbicky-Todd 1984:5; but see also Quigg 1978 for an opposite view). The large proportion of males at EgPn-440 might thus indicate that the kill took place in late fall or winter. However, the large number of animals present (a minimum number of individuals of 67) would suggest that this is either a summer kill, when larger groups of bison congregated for the rut (Roe 1972:97), or that this site represents a number of separate kill events over a series of months or years. Bull groups are generally smaller than mixed groups, ranging from only one or two animals up to a dozen (Hanson 1984:99).

The former suggestion (a summer kill) would likely result in both male and female animals being killed. In this situation, the high proportion of males might be explained by the preferential butchering of females and young. Arthur (1978:236) suggests that the meat of the cows was preferred over that of the males at all times of the year except the calving season (although Berger and Cunningham (1994) suggest that this may vary by geographic region). In addition, Schaeffer (1978:244) notes from a historic account from 1809 that just an hour after the kill, the bulls remained essentially untouched whereas the cows had been butchered. Unfortunately, a season is not provided

for this account, but it does suggest that the bulls were being ignored at this Alberta site. If this is true then female remains might be preferentially removed from the site, or may be butchered to a greater degree, resulting in fewer intact specimens. The assemblage would therefore be biased towards males. However, if females were preferentially butchered, elements with less economic utility such as the carpals and tarsals would still remain at the site. This does not appear to be the case, as seen from the carpal/tarsal sexing results.

The latter suggestion (a late fall or winter kill) might indicate that although the site does not appear to have been used over a long period of time (as indicated by the lithic remains, radiocarbon dates, and the presence of a single bone bed), the location may have been used over a series of months or years to hunt smaller groups of bison, particularly (but not exclusively) males.

Conclusions from Aging and Sexing

A suggestion as to the season in which this kill took place is difficult to make based on the aging and sexing information. Individuals for which tooth eruption sequences could be examined were extremely rare (numbering only two), and appeared to indicate two different seasons. This may suggest that at least two kill events occurred at this site in different seasons, although this conclusion is tentative. Similarly, information gleaned from the tooth eruption and wear stages suggest use of the site at different times of the year. All first and second molars were too worn to determine a TEWS age, and only two third molars provided an estimation of age. Again, these two specimens seemed to indicate two different seasons for the kill, one in late spring and one in late fall. Some degree of clustering was observed in the measurements of metaconid heights, but again the data seem to suggest that some animals died in the spring, some in the fall, and others perhaps at other times of the year (although the majority of the results indicate either a spring or a fall kill). The small sample size may obscure patterns, and factors already

discussed, such as variation in rate of wear, sex of the animal and researcher error may also be affecting the results. Thus, the suggestion that this kill site represents two kill events should be taken tentatively. Chapter eight will further examine the possibility of multiple kill events.

Sexing data from both the bivariate plots of carpal/tarsal measurements and from the long bone discriminant function analyses strongly suggest that males far outnumber females in this assemblage. The large minimum number of individuals of 67 (see chapter five) suggests that this was either a late summer/early fall kill, when larger groups of bison gather for the rut, or a series of late fall/winter/spring kills involving smaller groups. If this were a summer/fall kill, the implication would be that this site represents a single kill involving a herd consisting of a mix of males, females and immature animals. In this case, the females and young must have been preferentially removed from the site, or may be underrepresented due to taphonomic factors. Instead, I would suggest that the evidence implies a series of kills taking place in both the spring and late fall, involving herds composed mainly of males. This hypothesis would explain the large number and proportion of males represented in the assemblage, as well as the aging data that suggests multiple seasons of use.

CHAPTER SEVEN

ECONOMIC UTILITY

The examination of the economic utility of animals butchered at bison kill sites has in the past relied, for the most part, on utility indices created by Binford (1978) for sheep and caribou. The main utility index defined by Binford was the Modified General Utility Index, or MGUI. It was Binford's belief at the time that these utility indices would serve as models for other small ungulates, but a lack of models for larger ungulates meant that Binford's models were the only option for studying larger animals such as bison. Binford also defined indices for meat, marrow, and bone grease taken individually, but did not take into account fat as a separate resource. Age and sex differences were also not considered by Binford, except as they reflected overall size differences (Emerson 1990:7).

Speth (1983), went two steps further than Binford in his recognition that sex and age differences affected decisions regarding butchering, and in his recognition that fat was an important criterion affecting choices. Speth used Binford's caribou model in his analysis of the Garnsey Site but applied it independently to males and females. He concluded that males and females were being treated differently in terms of butchering at the Garnsey site (Speth 1983:94). He also included a discussion of animal fat and its importance in the diet of ethnographically studied hunter-gatherer groups; the acquisition of fat from animals has become another component to take into account in terms of butchering and utility of animal resources.

Metcalf and Jones (1988) defined a more simplified version of Binford's indices called the Food Utility Index (FUI). This index was considered to be a simplification of Binford's set of "needlessly complex" indices in that it was derived from the Meat Utility Index alone and used weight of products rather than caloric values. Metcalf and Jones concluded that patterns were nearly identical using the FUI to those resulting from Binford's indices for caribou data. However, this generalized index did not allow

researchers to study variations in the choices of specific animal products. In addition, the use of weight of products rather than caloric values did not take into account the varying caloric values of different products, such as meat versus fat.

Other studies were initiated in the 1980's to create utility indices for various fauna. These include Kooyman (1984) who created a meat utility index for moa; Brink and Dawe (1989) who created a utility index for the amount of grease in the leg bones of three bison for use at Head-Smashed-In; Borrero (1990) who published a meat utility index for the South American guanaco; and O'Connell et al. (1990) who used the frequency of transport of anatomical units (rather than the actual utility) to look at the butchering of African ungulates (see Lyman 1992).

Emerson (1990), using similar methodology to that of Binford, examined in detail the quantitative differences in meat, marrow and bone grease, and carcass fat components of four bison, each of a different class based on sex, age and season of collection. These include a spring collected adult male (SAM), a spring collected adult female (SAF), a fall collected adult female (FAF), and a fall collected yearling male (FYM). In addition, the spring female was carrying a fetus that Emerson included in the study.

From this, Emerson produced a number of models which dealt with the utility of specific anatomical parts and concluded that quantitative differences in components such as meat, marrow, grease and fat do affect the selection of animals and anatomical units removed from a kill site. Brink (1997) went a step further and examined the bone grease content of bison limb bones in further detail. He concluded that bone grease may have been the most dependable fat available to bison hunters, more so than marrow or intramuscular fats.

Utility indices produced by Emerson are used in this thesis to compare predictive models with the remains recovered from EgPn-440 with the goal of recognizing patterns of selection and butchering.

Binford (1978:81) defines a series of curves that are used to compare the frequencies of elements recovered from a site with frequencies predicted from models based on utility indices. The element frequency is plotted on the “y” axis against the modified utility index on the “x” axis, producing a “curve” (frequencies and utility indices will be discussed in more detail below). Binford defines a “bulk” curve as one which reflects “...strategies that select for large quantities of parts of both high and moderate value and abandon parts of the lowest utility at rapidly accelerating rates”. A “gourmet” curve is one which reflects “...strategies that select for high frequencies of parts of the very highest value and abandon parts of moderate and low value” (Binford 1978:81). Binford sees these curves as ranging from the maximizing of quantity (bulk curves) to the maximizing of quality (gourmet curves). An unbiased curve is one which reflects “...the removal of body parts in direct proportion to their economic utility” (Metcalf & Jones 1988:495).

Figure 7.1 is adapted from Binford’s bulk and gourmet curves for body parts remaining at kill-butcher sites. The gourmet curve indicates a utility strategy in which anatomical units which have a low or moderate utility value are left behind at the kill-butcher site in greater frequencies, and elements with high utility values are preferentially removed from the site. In other words, the highest quality parts are preferentially removed. The bulk curve indicates a strategy in which a sharp drop in frequencies is evident for anatomical units with low and moderate utility values, while the frequencies for higher value units decreases at a lesser rate. This results from lower value elements also being removed from the site in addition to higher value ones, in an attempt to maximize the quantity of products removed. The unbiased curve (a straight line) represents a strategy in which elements are removed from the kill site in direct proportion to the utility value of the element.

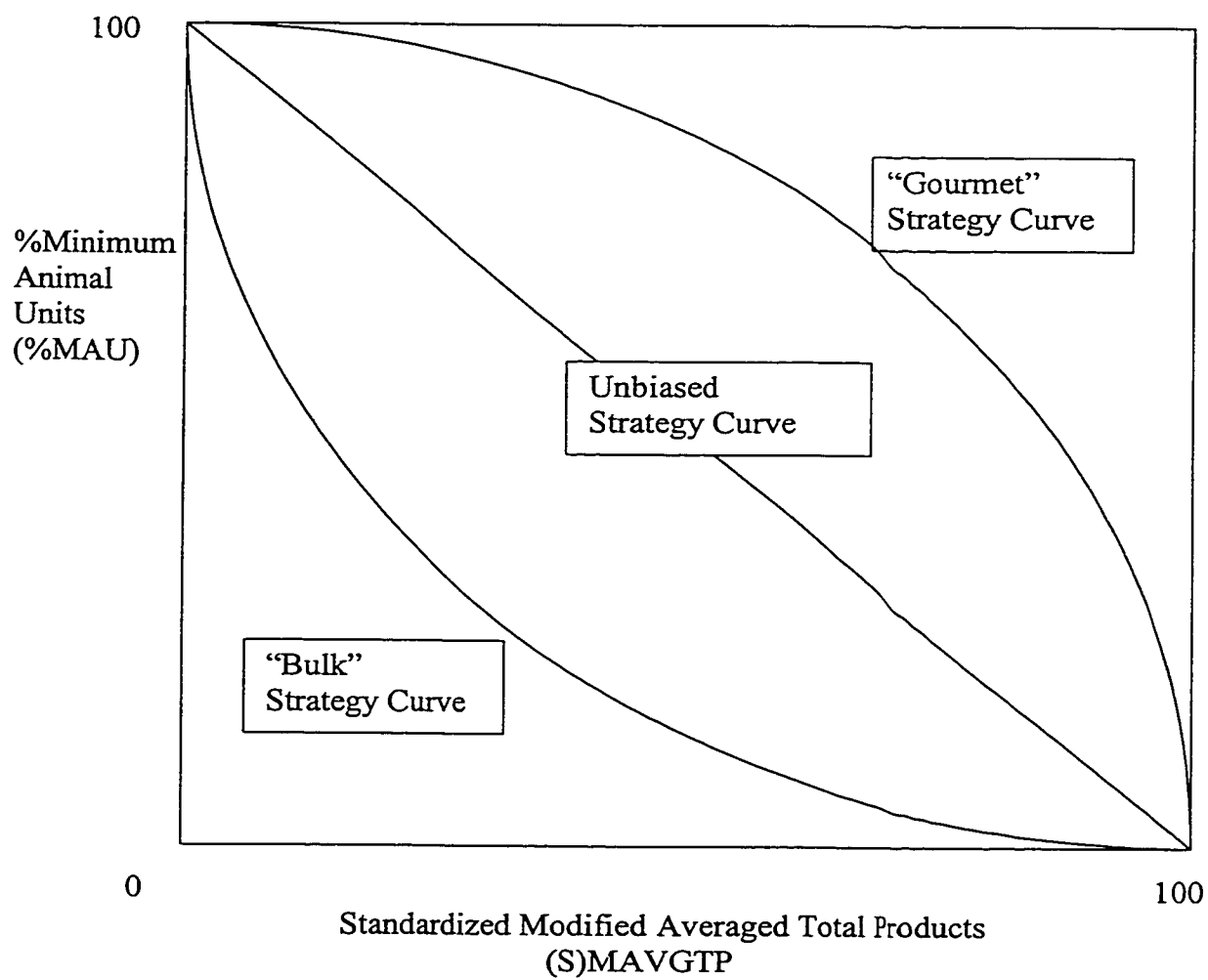


Figure 7.1. The “bulk” and “gourmet” curves for body parts remaining at kill-butcher sites, adapted from Binford (1978:81) and Metcalfe & Jones (1988:496).

These curves will serve as guidelines for discussions of the patterns observed at EgPn-440. However, rather than trying to force patterns to “fit” one of these curves, the locations of specific elements will be discussed in detail, and possible explanations for the positions of these elements will be addressed.

In this thesis, frequencies of elements will be examined in terms of several utility indices defined by Emerson (1990). All models used here are “standardized” (“S”) against the element with the highest values and “modified” (“M”). Modified values take into account “riders”, or anatomical parts that are assigned a higher utility value because they usually ride along with other anatomical parts in close proximity that have high values (Binford 1978:74). In addition, the “averaged” (“AVG”) values for all four bison examined by Emerson are used. The use of the averaged models allows relationships and patterns to be identified without knowing the ages and sexes of animals in the sample. As discussed in the previous chapter, aging of the EgPn-440 assemblage was extremely difficult. Sexing was more successful, but given the fact that only certain elements could be sexed, the use of an averaged index is the best choice.

The first model used is the Averaged Total Products index ((S)MAVGTP), which includes the caloric yields of meat protein and fat (Emerson 1990:Table 8.6). This model was chosen as the primary model used due to its inclusion of all products. This is a general model that does not require knowledge about the specific requirements motivating butchering selection. In addition, Emerson notes:

It is doubtful, however, that recovery of a single product was ever the objective of a bison kill...the combined influence of the relative productivity of multiple products in individual carcass units must be evaluated to determine whether selection, as represented by the bone remains of bison at kill and processing sites, reflects differences in the economic value of the associated carcass units (Emerson 1990:596).

However, at varying times of the year, the dietary needs of hunters who rely mainly on bison as a food source may change. For example, Speth (1983:157-158) notes that, particularly in the winter when vegetable foods are scarce, protein poisoning is a potential problem that can be countered by an increased focus on obtaining fat (see also Speth and Spielmann 1983). For this reason, four other models will also be used here to identify possible patterns of decision making in butchering. These are: the Averaged Protein Model ((S)MAVGPRO), which includes only the caloric yield from meat protein; the Averaged Marrow Fat Model ((S)MAVGMAR), which includes only the caloric yield of bone marrow fat; the Averaged Bone Grease Fat Model ((S)MAVGGRE), which includes only the caloric yield of bone grease; and the Averaged Total Fat Model ((S)MAVGTF), which includes the caloric yield from all fats, including intramuscular fat, bone grease fat, bone marrow fat, and carcass fat (Emerson 1990:Appendix C, Tables 11, 12, 15, 17). These models will be applied to determine if the acquisition of more specific products were motivating the butchering techniques at EgPn-440.

Total Products

Table 7.1 shows the Minimum Animal Unit (MAU) values and the %MAU values. %MAU is the MAU value standardized against the element with the highest value in the assemblage (Binford 1984:51). %MAU is the frequency measure used to compare the EgPn-440 assemblage with Emerson's utility indices. The EgPn-440 MAU values presented in Table 7.1 were obtained from chapter five, with one exception: MNI, MNE and MAU values in the quantification portion of this thesis were calculated for the entire element. However, in Emerson's utility indices, the long bones (humerus, radius, metacarpal, femur, tibia and metatarsal) are given two values, one for the proximal end and one for the distal end. This methodology would have made the use of these indices difficult for the EgPn-440 assemblage. The decision was made to return to the original database and calculate MNE and MAU values independently for the ends of the long bones for use in the examination of economic utility. Emerson also combines the radius

and ulna into one anatomical unit. For the EgPn-440 data, the MAU for these two values were very close; the radius (being the load-bearing element, as well as having the larger value) was thus chosen. These altered long bone units are included in Table 7.1.

Table 7.2 shows the %MAU values for EgPn-440 and the standardized Modified Average Total Products values as presented by Emerson (1990:Table 8.6). All anatomical units presented by Emerson are included with the exception of anterior phalanges and posterior phalanges; these were not distinguished in the EgPn-440 sample.

%MAU values for the EgPn-440 assemblage are standardized based on the mandible, as discussed in chapter five. These values are maintained for Table 7.2. However, it should be noted that since Emerson does not include the mandible in her study, the highest value for the EgPn-440 data comes from the atlas, with a standardized value of 85.71. Thus, the values exhibited in the graphs in the remainder of this chapter will be slightly depressed (by approximately 15%) as compared to Emerson's values. This will not affect the patterns exhibited by the placement of the elements, but will affect their positions on the graph in that all frequency values will be shifted downwards.

Many of the anatomical units examined in this part of the analysis vary from the elements described in this thesis so far. Emerson defines different units than those originally chosen in the analysis of the EgPn-440 assemblage. First, Emerson defines the skull without the tongue, and does not include a utility index for the mandible. All other axial portions remain the same with the exception of the sacrum and innominate (which Emerson refers to as the pelvis). Emerson groups these together as a single anatomical unit, so the highest %MAU from the EgPn-440 data (which was the innominate) was chosen. This choice reflects the fact that, as mentioned in chapter five, the sacrum and innominate are often fused and thus the sacrum will often ride along with the innominate. Choosing the sacrum would thus underestimate the amount of meat being considered, so the %MAU for the innominate was chosen. This anatomical element is considered to be axial in this analysis.

Table 7.1. EgPn-440 Minimum Animal Units (MAU) and Standardized Minimum Animal Unit (%MAU) values.

Element	MAU	% MAU
Mandible	63	100
Skull	10	15.87
Hyoid	11.5	18.25
Sternum	1	1.59
Atlas	54	85.71
Axis	49	77.78
Cervical vertebra	47.4	75.24
Thoracic vertebra	35.2	55.87
Lumbar vertebra	18.7	29.68
Sacrum	22	34.92
Caudal vertebra	2	3.17
Ribs	22.8	36.19
Scapula	29	46.03
Humerus (proximal)	3.5	5.55
Humerus (distal)	14.5	23.02
Radius (proximal)	16	25.40
Radius (distal)	17.5	27.78
Ulna	14	22.22
Scaphoid	12.5	19.84
Magnum	19	30.16
Lunate	13	20.63
Cuneiform	12	19.05
Unciform	12	19.05
Pisiform	10	15.87
Metacarpal (proximal)	18	28.57
Metacarpal (distal)	14.5	23.02
Fifth metacarpal	8	12.70
Innominate	26.5	42.06
Femur (proximal)	9	14.29
Femur (distal)	3	4.76
Patella	3.5	5.56
Tibia (proximal)	5	7.94
Tibia (distal)	19	30.16
Astragalus	15	23.81
Calcaneus	20.5	32.54
Navicular cuboid	18	28.57
Cuneiform pes	16.5	26.19
Lateral malleolus	13.5	21.43
First tarsal	6.5	10.32
Metatarsal (proximal)	17	26.98

Table 7.1 (continued). EgPn-440 MAU and %MAU values.

Element	MAU	% MAU
Metatarsal (distal)	13	20.63
Second metatarsal	4	6.35
Proximal phalanx	17.4	27.62
Middle phalanx	13.5	21.43
Distal phalanx	14	22.22
Proximal sesamoid	4.3	6.83
Distal sesamoid	6	9.52
Irregular sesamoid	0.5	0.79

Table 7.2. EgPn-440 %MAU values and Emerson's (1990) (S)MAVGTP values.

Element	Element Abbreviation	%MAU at EgPn-440	(S)MAVGTP value
Skull without tongue	Skwot	15.87	14.20
Atlas	At	85.71	6.40
Axis	Ax	77.78	7.80
Cervical vertebra	Cerv	75.24	56.6
Thoracic vertebra	Thor	55.87	84.7
Lumbar vertebra	Lumb	29.68	82.9
Sacrum-Pelvis (innom.)	Spel	42.06	54.7
Caudal vertebra	Caud	3.17	1.5
Ribs	Ribs	36.19	100.00
Sternum	Stern	1.59	52.9
Scapula	Scap	46.03	31.6
Proximal Humerus	Phum	5.55	31.6
Distal Humerus	Dhum	23.02	25.1
Proximal Radius-Ulna	Pradul	25.40	16.5
Distal Radius-Ulna	Dradul	27.78	12.1
Carpals	Carpals	30.16	6.6
Proximal Metacarpal	Pmc	28.57	3.9
Distal Metacarpal	Dmc	23.02	2.6
Proximal Femur	Pfem	14.29	69.4
Distal Femur	Dfem	4.76	69.4
Proximal Tibia	Ptib	7.94	40.90
Distal Tibia	Dtib	30.16	25.5
Tarsals	Tarsals	32.54	13.6
Proximal Metatarsal	Pmt	26.98	7.5
Distal Metatarsal	Dmt	20.63	4.5

As already discussed, the long bones were separated into proximal and distal ends by Emerson to reflect the varying utility at different parts of the limbs. This correction for the EgPn-440 data has been described. In addition, Emerson groups all carpals together and all tarsals together, whereas these were treated separately in the EgPn-440 analysis. Again, the highest values for each (the magnum for the carpals and the calcaneus for the tarsals) were chosen. As discussed in chapter five, all carpals are likely treated in a similar manner in terms of butchering. The choice of the carpal to be used in this situation is thus somewhat arbitrary, so the carpal with the highest value was chosen in order to avoid underestimations. Similarly, most tarsals are likely treated somewhat similarly in butchering. The calcaneus is the tarsal most likely to be affected by butchering (Frison 1970a:16), so choosing this element, which also has the highest %MAU, seems reasonable.

Figures 7.2 through 7.4 show the relationship between the %MAU values for the EgPn-440 assemblage and Emerson's (1990) (S)MAVGTP values. Figure 7.2 shows both the axial and appendicular elements, figure 7.3 shows the labelled axial elements, and figure 7.4 shows the labelled appendicular elements. Elements are labelled with abbreviations to avoid clutter; these abbreviations can be found in Table 7.2.

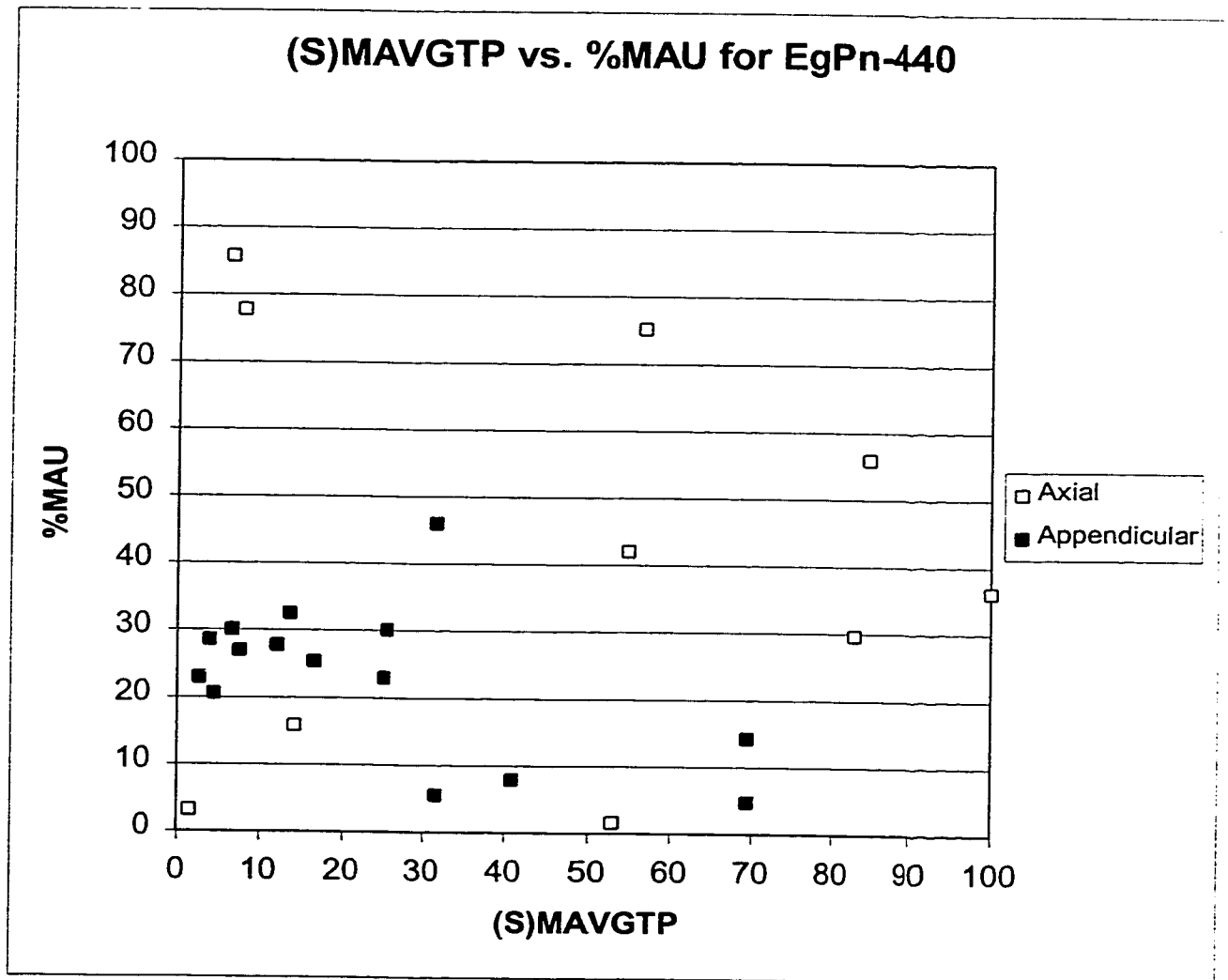


Figure 7.2. (S)MAVGTP vs. %MAU for axial and appendicular elements at EgPn-440. This figure illustrates that the axial elements are exhibiting an unbiased curve, whereas the appendicular elements are exhibiting a bulk curve (refer to Figure 7.1).

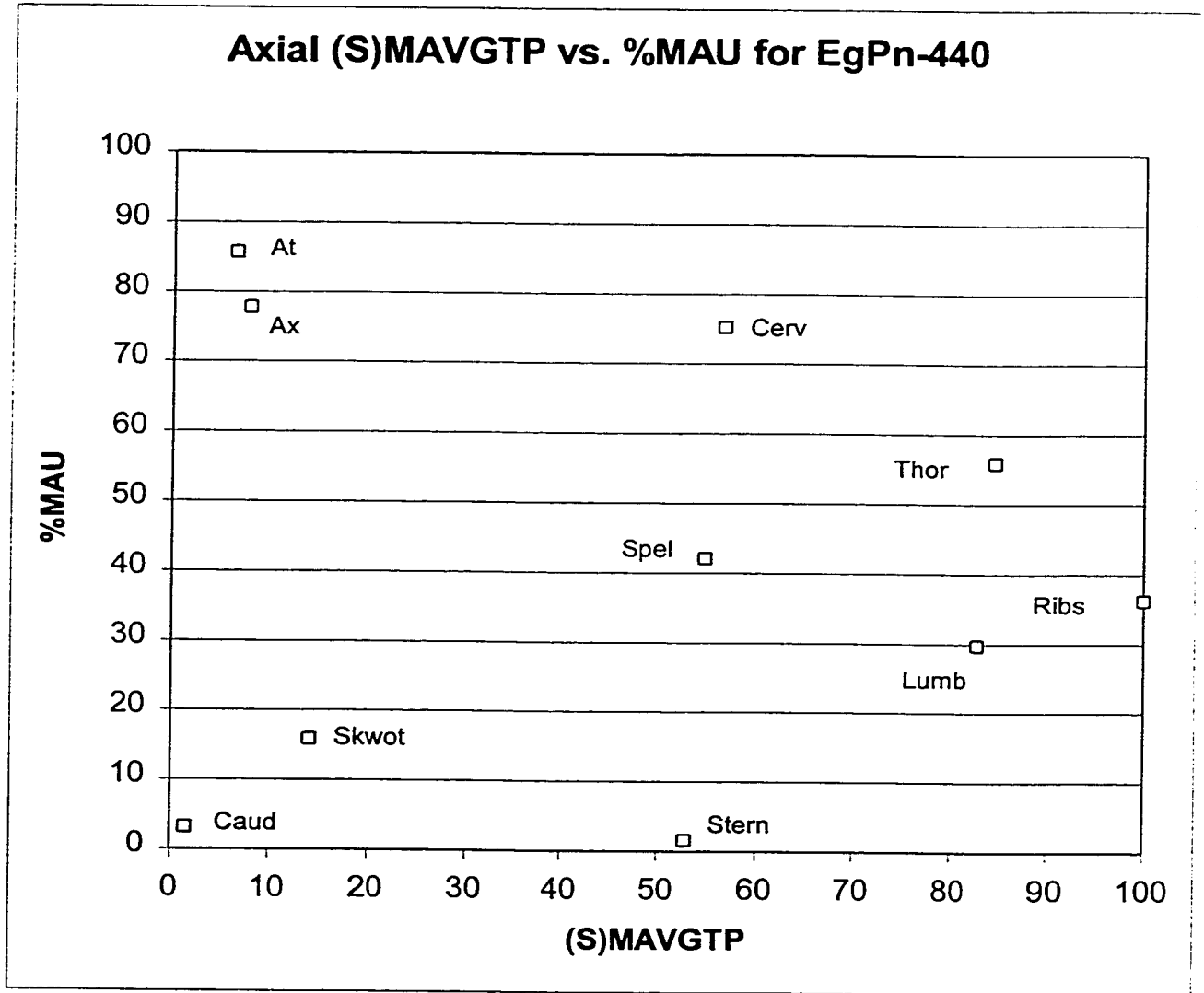


Figure 7.3. Axial (S)MAVGTP vs. %MAU for EgPn-440. Most axial elements exhibit a generally unbiased curve. See Table 7.2 for element abbreviations.

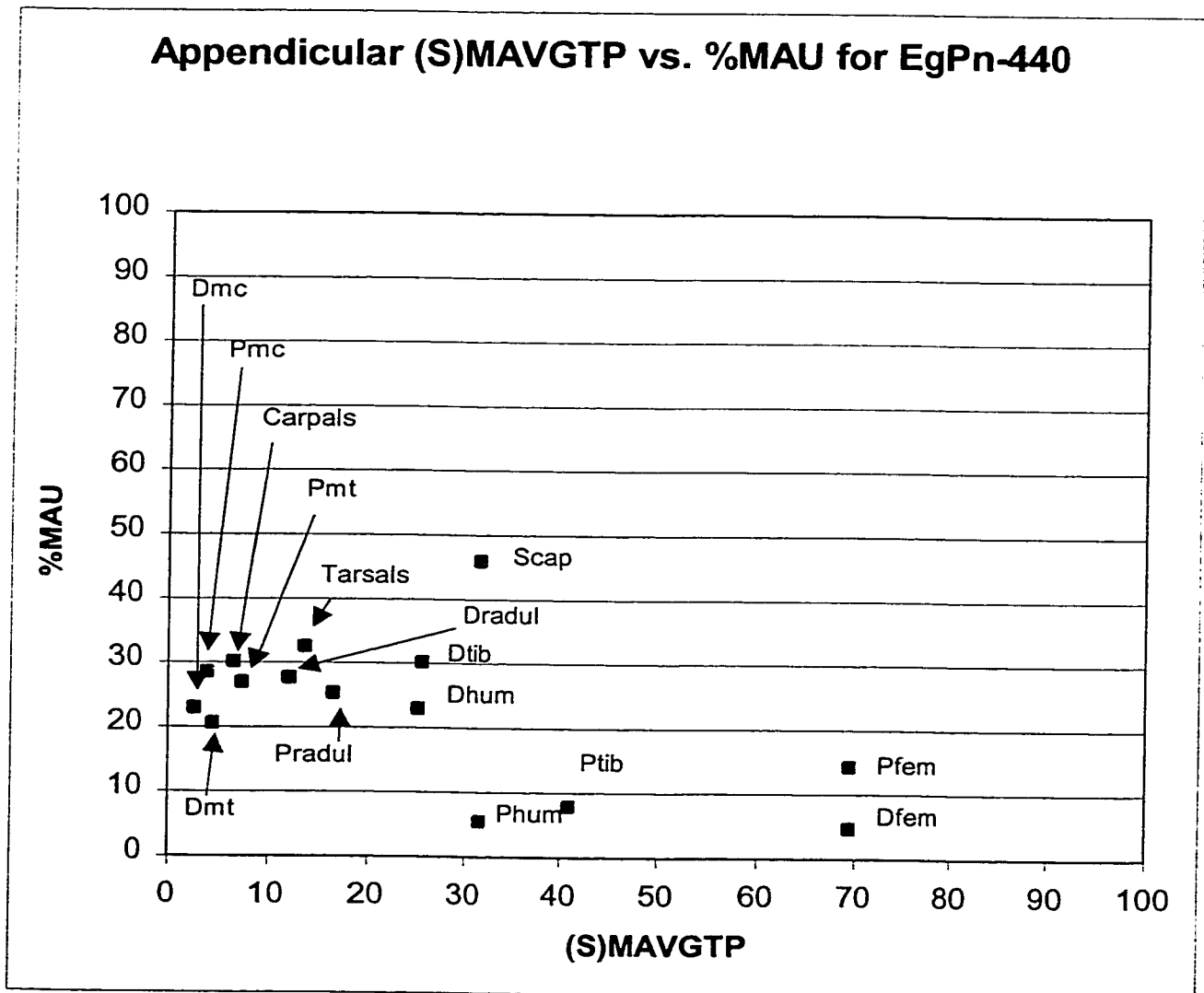


Figure 7.4. Appendicular (S)MAVGTP vs. %MAU for EgPn-440. This figure illustrates that, with the possible exception of the scapula, the appendicular elements exhibit a bulk utility curve. See Table 7.2 for abbreviations.

Looking at Figure 7.2, it is clear that the appendicular elements are being treated differentially when compared with the axial elements. Overall, it appears that the axial elements exhibit a generally unbiased curve whereas the appendicular elements exhibit a bulk curve. Each of these will be discussed individually with reference to the labelled graphs in Figures 7.3 and 7.4.

Axial Elements

Figure 7.3 shows the relationship of the frequencies of axial elements at EgPn-440 (%MAU) to the Total Products Utility index ((S)MAVGTP). The best fit line is generally a straight line, suggesting an unbiased strategy. Several elements are positioned higher on the graph, such as the cervical, thoracic and lumbar vertebrae and the ribs, and these elements considered separately appear to indicate a “gourmet” strategy. However, elements such as the sacrum-pelvis and the lumbar vertebra are positioned slightly lower, and these elements suggest an unbiased strategy, indicated by a relatively straight line. Overall, I would suggest that an unbiased strategy is the best interpretation of the distribution, although some elements are found in unexpected frequencies for this strategy. Elements present in unexpected quantities include the caudal vertebrae, skull and sternum. However, there are probable explanations for these unexpected frequencies. The caudal vertebrae and skull are each represented by very low frequencies, whereas the extremely low utility value would predict that these elements are found in high frequencies at a kill site. However, possible explanations for the paucity of these elements have already been mentioned. Caudal vertebrae may be removed from a kill site for other reasons besides economic utility, such as removal of the tail with the hide. The skull is a relatively fragile element, and this may partially explain the low frequency. However, the dense petrous portion was used to calculate MAU. This portion of the skull was essentially always complete, and thus fragility is not a reasonable explanation for the paucity of skull elements. Another possibility is that the

skulls are removed from the site for ceremonial purposes. Therefore, when the caudal vertebrae and skull are ignored, the result is an essentially straight curve.

Given that the meatier elements such as the vertebrae and ribs are following a gourmet curve, the position of the sternum in this graph is unexpected. The cervical vertebrae, sacrum-pelvis and sternum have relatively similar utility index values. The cervical vertebra unit is relatively frequent at EgPn-440, the sacrum-pelvis unit is less frequently recovered, and the sternum is almost unrepresented. The cervical vertebrae are present in higher frequencies than would be expected from an unbiased strategy, and this element seems to be left behind in favour of other elements. The sacrum-pelvis is present in expected frequencies for an unbiased strategy, but the sternum is underrepresented. The low frequency of sternbrae does not appear to be proportional to the moderately high utility of this element. Preservation of the sternbrae is a factor noted at other sites to account for low frequencies of this element recovered. However, as discussed in chapter five, preservation at EgPn-440 is good, with low degrees of weathering of bones and preservation of fragile elements such as hyoids. Thus it does not appear that preservation can be used to account for the paucity of sternbrae.

Appendicular Elements

Unlike the axial elements, the appendicular anatomical units follow a bulk utility curve. Elements such as carpals, tarsals and the metapodials, which have low utility indices, are more abundant than those portions with high utility values, particularly the proximal and distal femur. This data set represents a “bulk” utility curve in that the frequencies of elements drop sharply beyond the very low utility elements (carpals/tarsals, metapodials), indicating an attempt to maximize quantity.

The carpals, tarsals and metapodials are, due to their low utility index, tightly clustered at the left side of the graph. However, their frequencies are unexpectedly low when compared to many of the axial elements, such as the atlas and axis, which have very similar utility index values to the carpals/tarsals and metapodials (Figure 7.2). This may suggest that although the feet were left behind more frequently than long bones, they were often removed from the site with the upper limb bones. This is a recurring pattern that is also observed in a number of the models that will be discussed later in this chapter. This pattern is evidence that a “threshold” process may be in operation. Elements below a certain utility value do not result in a curve when plotted, but rather result in a cluster of elements. This cluster is not a reflection of their low utility, it is a reflection of their being “riders”. For example, low utility elements such as carpals and tarsals may be removed from the site along with higher utility elements due to factors such as time constraints which make it impractical for the hunters to spend time removing the feet. This is likely to occur particularly with elements such as the carpals, tarsals and metapodials since carrying small extra portions like the feet does not result in a great deal of excess energy expenditure. As a result, all elements below a specific level of economic utility will be recovered from the site in essentially equal quantities despite differences in their individual utility values.

The proximal ends of the tibia and humerus were recovered less frequently than the distal ends of the elements. This is an expected pattern given that the distal ends of these bones have lower utility indices. As mentioned in chapter five, the proximal ends of each of these elements were found to be highly fragmented at EgPn-440 and obviously underwent a great deal of processing. In addition, the utility value of the proximal humerus is increased due to its proximity to the scapula. What is unusual here is the frequencies of the proximal humerus and tibia when compared with the femur. The proximal and distal ends of the femur have higher utility index values than the proximal ends of the humerus and tibia, and yet these elements are found in essentially the same frequencies. This suggests that the proximal humerus and tibia were removed from the

site in higher than expected frequencies. Possible explanations for this pattern will be suggested with respect to other utility indices later in this chapter.

The frequency of scapulae recovered is also unexpected. This element has a relatively high utility value, but is the most abundant appendicular element recovered at EgPn-440. However, this is easily explained with reference to butchering practices which involved separating the scapula and humerus at the joint. The meat is then stripped from the scapula for removal from the site, perhaps sometimes along with distal portions of the blade and spine, as suggested for the Glenrock Buffalo Jump (Frison 1970a:14). This may be supported by the presence of some spirally fractured blade fragments remaining at the kill site. This process means that the proximal scapula is left behind after the meat has been removed. Since %MAU values were obtained using the proximal scapula, the %MAU values may be elevated and may not be correctly indicating the butchering practices taking place.

Some of the patterns observed for the (S)MAVGTP model, both expected and unexpected, may be explained with reference to the models involving individual products only. The remainder of this chapter examines the EgPn-440 assemblage with reference to four other utility indices derived by Emerson: the Averaged Protein Model ((S)MAVGPRO), the Averaged Marrow Fat Model ((S)MAVGMAR), the Averaged Bone Grease Fat Model ((S)MAVGGRE), and the Averaged Total Fat Model ((S)MAVGTF).

Protein, Marrow, Bone Grease and Total Fats

The relationship of the EgPn-440 assemblage to the protein, marrow, bone grease and total fat models is undertaken in the same manner as the total products. Table 7.3 shows the %MAU for the EgPn-440 assemblage and Emerson's values for protein yield, marrow yield, bone grease yield and total fat yield. Figures 7.5 through 7.12 show both axial and appendicular elements as they compare with each of these utility indices. Two

graphs are provided for each model: the first is unlabeled for clarity, and the second is labelled with the element abbreviations (see Table 7.2 for abbreviations)

Table 7.3. EgPn-440 %MAU values and Emerson's (1990) (S)MAVGPRO, (S)MAVGMAR, (S)MAVGGRE, and (S)MAVGTF values.

Element	%MAU at EgPn-440	(S)MAVG PRO	(S)MAVG MAR	(S)MAVG GRE	(S)MAVG TF
Skull w/o tongue	15.87	10.9	0.0	---	16.7
Atlas	85.71	6.6	0.0	2.4	5.9
Axis	77.78	8.1	0.0	1.6	7.1
Cervical vert.	75.24	59.0	0.0	4.8	50.7
Thoracic vert.	55.87	62.9	0.0	24.1	100.00
Lumbar vert.	29.68	60.0	0.0	29.8	99.5
Sacrum-pelvis	42.06	51.3	6.7	97.6	54.0
Caudal vert.	3.17	0.9	0.0	4.5	1.8
Ribs	36.19	100.0	0.0	55.0	93.0
Sternum	1.59	42.4	0.0	4.6	58.6
Scapula	46.03	43.7	36.9	43.6	16.7
Prox. humerus	5.55	43.7	71.5	71.8	17.1
Dist. humerus	23.02	33.1	69.2	58.5	15.3
Prox. radius-ulna	25.40	20.6	68.0	51.9	11.2
Dist. radius-ulna	27.78	14.3	50.3	48.5	8.9
Carpals	30.16	7.1	36.2	38.2	5.0
Prox. metacarpal	28.57	3.6	29.2	33.0	3.9
Dist. metacarpal	23.02	1.8	18.2	30.4	3.1
Prox. femur	14.29	94.1	97.2	100.0	38.7
Dist. femur	4.76	94.1	98.2	100.0	38.7
Prox. tibia	7.94	52.7	100.0	71.7	25.4
Dist. tibia	30.16	32.0	84.5	56.9	17.1
Tarsals	32.54	16.0	55.2	49.6	10.0
Prox. metatarsal	26.98	8.0	40.6	38.9	6.4
Dist. metatarsal	20.63	4.0	25.2	33.5	4.6

Protein Model

Figures 7.5 and 7.6 illustrate the relationship of (S)MAVGPRO (Averaged Protein Model) with the frequency of elements recovered at EgPn-440. This model involves the caloric values of meat protein only.

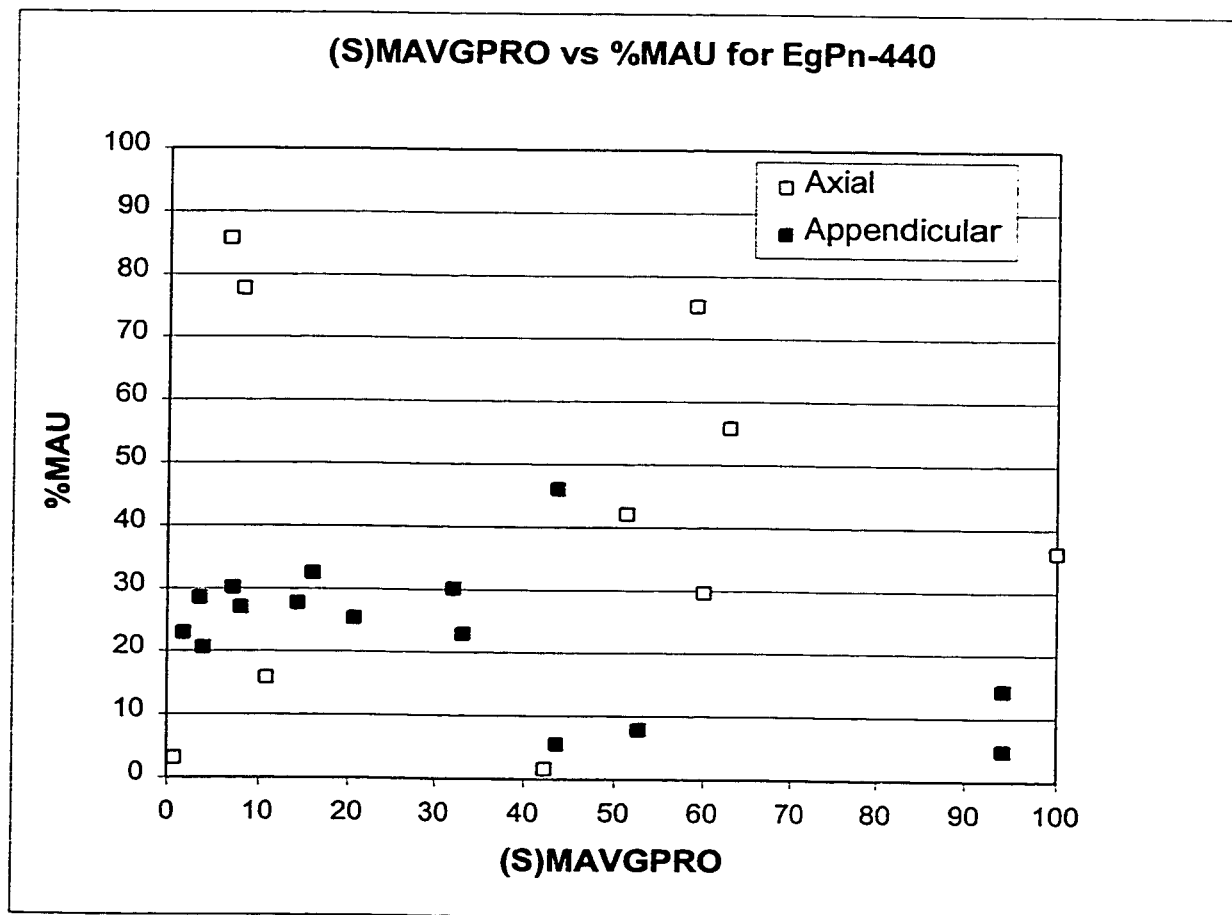


Figure 7.5. Relationship of (S)MAVGPRO and %MAU for EgPn-440. This figure demonstrates a very similar pattern to that observed in the total products model (Figures 7.2 to 7.4). With some exceptions (described in the text), axial elements exhibit an unbiased curve, whereas appendicular elements exhibit a bulk curve.

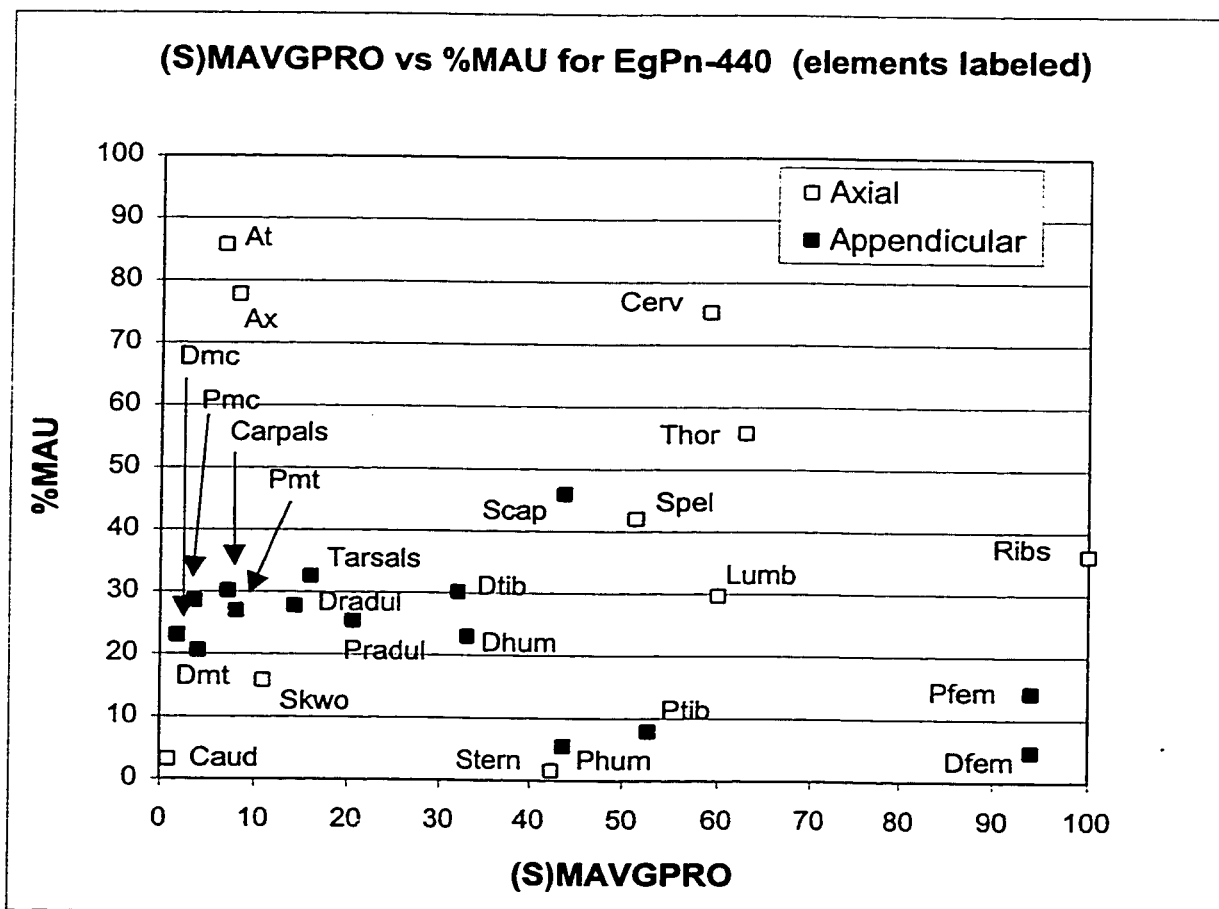


Figure 7.6. Relationship of (S)MAVGPRO and %MAU for EgPn-440 (elements labelled, see Table 7.2 for abbreviations). This figure demonstrates a very similar pattern when the protein model is applied to that observed in the total products model (Figures 7.2 to 7.4). With some exceptions (described in the text), axial elements exhibit an unbiased curve, whereas appendicular elements exhibit a bulk curve. See Table 7.2 for element abbreviations.

Overall, the pattern exhibited by the application of the protein model is extremely similar to the pattern seen in the Total Products model above. This is perhaps expected; as mentioned earlier in this chapter, Metcalfe and Jones (1988:491) found that their Food Utility Index (FUI), based on meat utility only, produced a very similar pattern to that produced by Binford's Modified General Utility Index (MGUI), which suggests that protein has a strong influence on general utility indices such as the Total Products Index.

Thoracic and lumbar vertebra have a slightly lower utility index when only protein is taken into account, which shifts the position of these two elements and creates the impression of a stronger "unbiased" strategy for the axial elements. Both the scapula and the femur have increased utility indices when only protein is considered. As with the total products model, the high utility value of the scapula suggests that this element should be found in lower frequencies, but it is the most frequently recovered appendicular element. This issue has already been addressed with the suggestion that meat was removed from the scapula at the site since the meat can be easily stripped and the bone left behind. The shifting of the proximal and distal femur towards the right side of the graph due to the increase in utility value in the protein model has the effect of lengthening the curve produced, although the shape remains essentially unchanged; a "bulk" strategy is still represented by the appendicular elements. As with the Total Products model, the carpals, tarsals and metapodials remain tightly clustered due to their low utility index values, although they are again underrepresented when compared with axial elements that have similar utility values (such as the atlas and axis). This is explained by the apparent existence of a threshold level of utility, as discussed for the total products model above.

As with the total products model, selection for elements based on protein appears to occur at EgPn-440, but to varying degrees depending on the element discussed. Roughly linear patterns are observed, although the positions of several elements, such as the sternum, are difficult to explain based on the protein model alone. This model

applied in conjunction with other models may provide more explanation regarding outlying elements.

Marrow Model

Figures 7.7 and 7.8 illustrate the relationship between the Averaged Marrow Fat Model (S)MAVGMAR and the EgPn-440 assemblage. The marrow index involves only the caloric yield of bone marrow fat.

As can be seen from Figures 7.7 and 7.8, the application of the marrow utility index to the EgPn-440 assemblage dramatically alters the position of the axial elements on the graph. Only the sacrum-pelvis has any marrow content; all other axial elements have a utility value of 0.0 and are thus plotted directly on the y-axis. It therefore seems clear that for the axial elements, marrow utility has no effect on the frequencies of elements remaining at a kill-butcherer site.

The appendicular elements exhibit a very vague linear utility curve when the marrow index is used, but the frequencies of appendicular elements are all low and this curve does not correlate with Emerson's indices. As with the other models used, the scapula is the appendicular element most frequently recovered. In terms of marrow content, this pattern is expected given the low marrow utility value assigned to the scapula. A pattern which is more difficult to explain using the marrow model is the position of the metapodials and carpals. These elements have low marrow utility values, but they are found in similar frequencies to elements with much higher values, such as the distal humerus, distal tibia and proximal radius-ulna. This indicates that marrow may not be a factor affecting the selection of elements.

As would be predicted, elements with high marrow content such as the proximal and distal femur and the proximal tibia are present in low frequencies. This could be seen as a factor of both the removal of these elements from the site for marrow

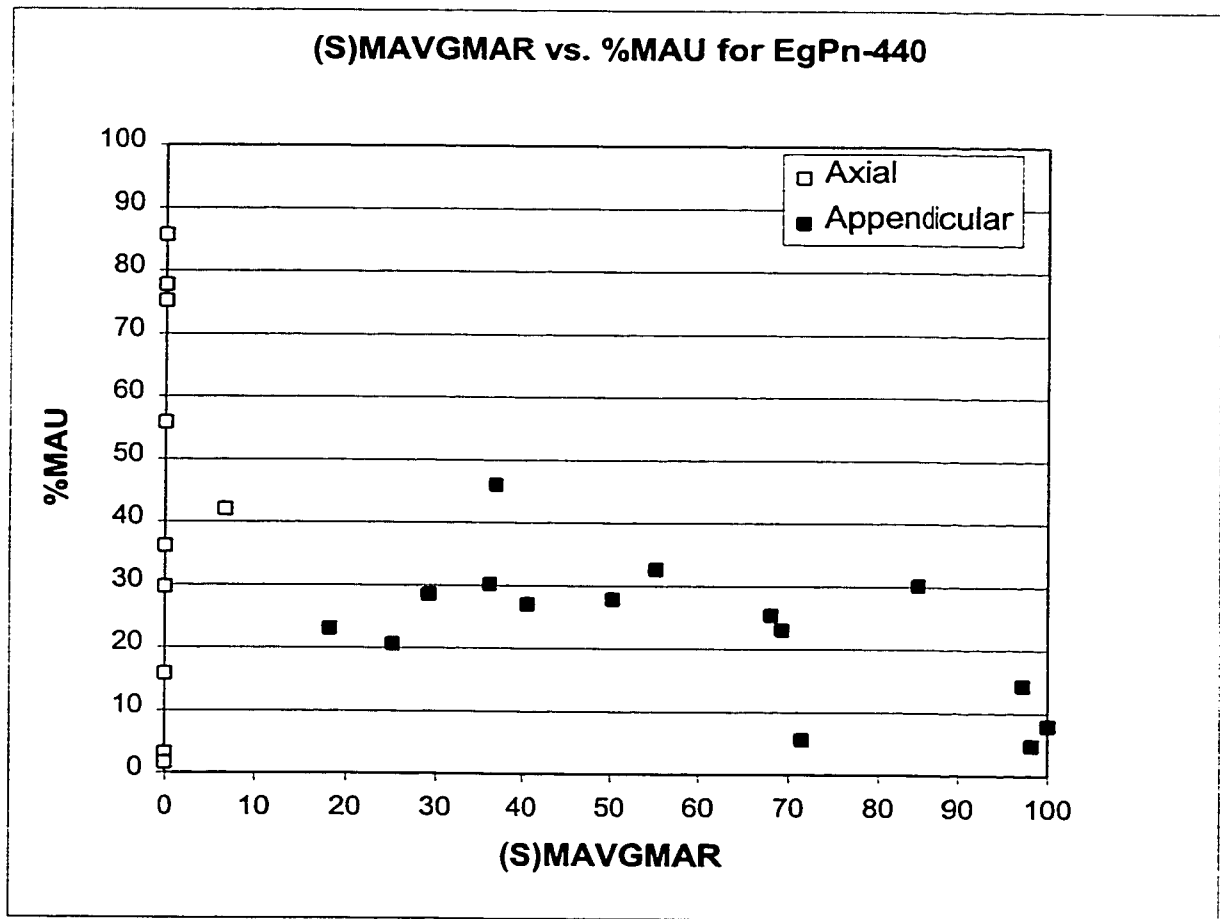


Figure 7.7. Relationship of (S)MAVGMAR and %MAU for EgPn-440. This figure illustrates that axial elements are present in frequencies unrelated to marrow content (marrow being absent in all but one axial element). Appendicular elements demonstrate a slightly linear curve, with all frequencies relatively low regardless of marrow utility index value.

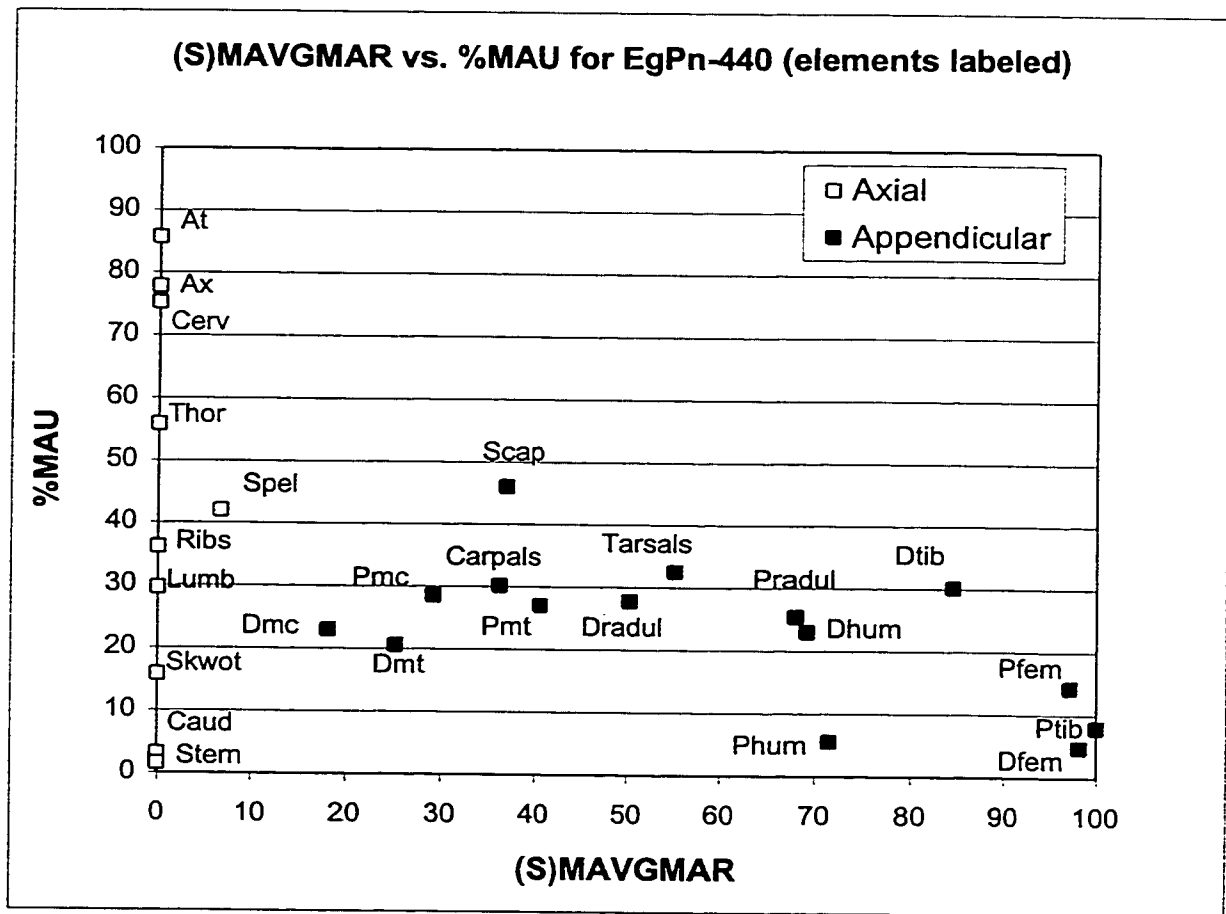


Figure 7.8. Relationship of (S)MAVGMAR and %MAU for EgPn-440 (elements labelled). Axial elements are present in frequencies unrelated to their marrow utility value. Appendicular elements exhibit a roughly linear but horizontal pattern indicating that elements are present in similar frequencies, regardless of their marrow utility value. See Table 7.2 for element abbreviations.

processing (although they are also valuable for meat), and the destruction of these elements at the site itself for marrow removal, as seen in the highly fragmented nature of these portions at EgPn-440. The proximal humerus is something of an outlier on this graph, having a similar utility value to the distal humerus and the proximal radius-ulna, but being found far less frequently. In the protein model used above, the proximal humerus and the scapula are assigned the same utility values when only meat is considered due to their proximity. In the marrow index, the humerus has a much higher utility value, but even when this is taken into consideration, the scapula is found in unexpectedly high frequencies and the proximal humerus is found in unexpectedly low frequencies. I suggest that these patterns may be best explained when other utility indices are employed instead of, or in conjunction with, the marrow index. With reference to the marrow model, I suggest that the lack of a real curve and the similar frequencies of all appendicular elements (despite varying utility values) indicates that marrow content does not have any effect on how elements have been selected. Thus, for the EgPn-440 assemblage, marrow content does not appear to have been a significant factor influencing the selection of elements.

One further consideration in terms of marrow should be added. For marrow bones, seasonal differences in the quality and quantity of marrow will affect selection. For example, Speth suggests that the higher than expected frequencies of certain elements at the Garnsey site, such as proximal tibiae and proximal femora, was related to the identified kill season of spring. He concluded that these portions were left behind due to the poor condition and lack of marrow in the female marrow bones as a result of the calving season (Speth 1983:91-92). The opposite pattern is observed at EgPn-440, in which the proximal humerus is being removed from the site in higher frequencies than expected. This may suggest that this kill took place at a time of year when marrow was plentiful and high quality, such as early summer, after the calving season but before the rut. The high quality and quantity of marrow in the summer could result in a higher than expected removal of marrow bones such as the humerus from the site.

Overall then, it seems that the acquisition of marrow is taking place, but it is probably a minor factor affecting the butchering practices at EgPn-440. Spiral fractures are identified on some long bones, but these are not common enough to suggest that acquisition of marrow was an important factor at this site. The acquisition of other products appears to be affecting the frequency distributions of elements far more strongly. Clearly the frequencies of axial elements cannot be explained with any reference to marrow content; these elements are present in varying frequencies, but marrow content is non-existent except in the sacrum-pelvis. As for the appendicular skeleton, for which marrow extraction is expected to be a factor, evidence for the selection of elements for marrow content is tentative. With the exception of the femur, proximal tibia and proximal humerus, which demonstrate impact marks and are highly fragmented, marrow extraction does not appear to be affecting the selection of elements.

Bone Grease Model

Figures 7.9 and 7.10 illustrate the relationship between the Averaged Bone Grease Fat Model (S)MAVGGRE and the frequency of elements recovered from EgPn-440. This model involves the use of caloric value of bone grease fat only.

In terms of the axial elements, figures 7.9 and 7.10 illustrate significantly different patterns from those seen in the total products and protein models, and from the marrow model. Axial elements in the marrow model demonstrated utility values of 0.0 with the exception of the sacrum-pelvis, which also had a very low value. In the protein and total products models, utility values varied a great deal with elements such as the ribs and thoracic vertebrae demonstrating the highest values. In contrast, the bone grease model assigns a very high value to the sacrum-pelvis, but dramatically lower values to the ribs and vertebrae. The lowest values are again elements such as the atlas and axis, and the caudal vertebrae. The axial elements seem to exhibit an unbiased strategy, or a

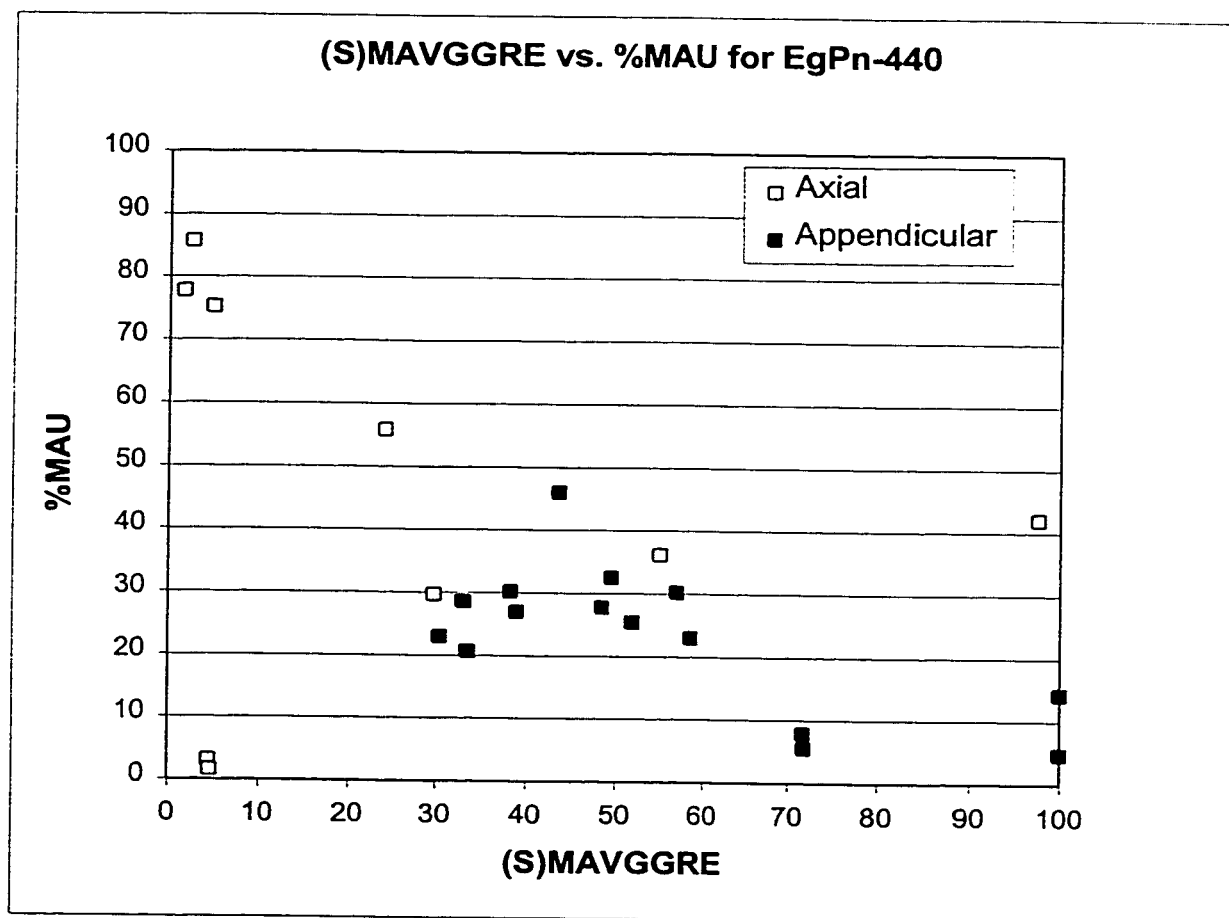


Figure 7.9. Relationship of (S)MAVGGRE and %MAU for EgPn-440. Axial elements exhibit a strongly linear curve indicative of an unbiased strategy. Appendicular elements exhibit a vaguely linear arrangement where all elements are found in low frequencies.

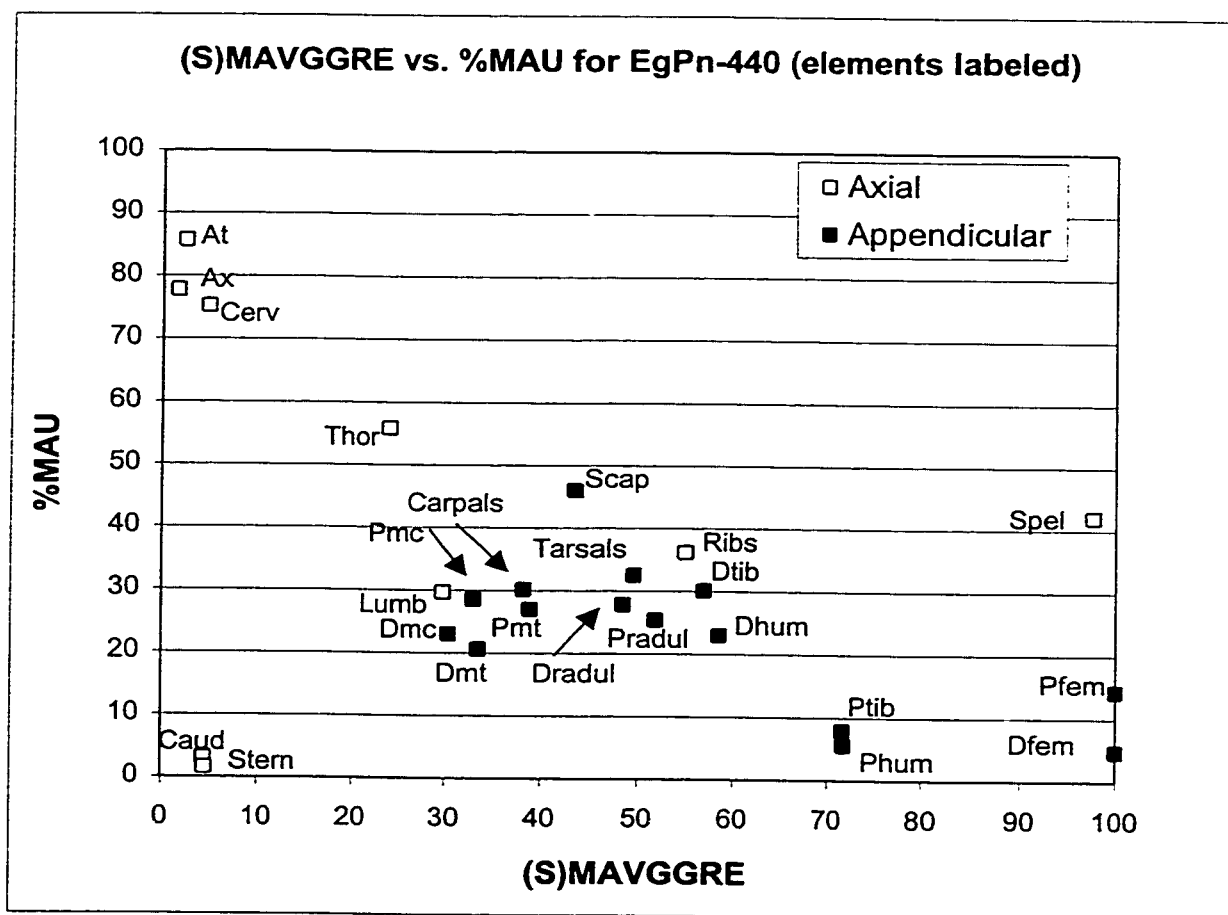


Figure 7.10. Relationship of (S)MAVGGRE and %MAU for EgPn-440 (elements labelled). Axial elements exhibit a roughly linear curve, although the sacrum-pelvis is an outlier when the grease utility index is used. The appendicular elements exhibit very low frequencies for all elements. See Table 7.2 for element abbreviations.

vaguely “bulk” strategy. Outliers include the caudal vertebrae and the sternum, which have extremely low grease utility values and are also found in extremely low frequencies. Explanations for the paucity of caudal vertebrae have already been suggested. The lack of sternebrae has also been suggested to be related to its relatively high utility index value in terms of total products (which relates mainly to a mid-range value in protein and a higher value in total fats, as will be seen in the next section). Preservation may also play a role in the lack of sternebrae found, as this element is not dense and may be vulnerable to taphonomic factors. However, as mentioned previously, preservation is generally very good at EgPn-440.

The sacrum-pelvis is also an outlier that does not conform to the curve formed by the other axial elements. As mentioned, this element has a very high utility value in the grease index, and yet it is found in relatively high frequencies. I suggest that despite the high grease value, this element was probably infrequently removed in its entirety. The %MAU value is derived from the frequencies of the acetabulum; however, Frison describes butchering of the pelvis at the Glenrock site as involving the removal of branches of the element, with the acetabulum being left behind (1970a:16). Thus the frequencies presented here may be elevated by the nature of the calculation of MNI, MNE and MAU. In the quantification section of this thesis (chapter five), the paucity of the blade portions of the ischium and ilium was noted. These parts of the innominate/pelvis were probably removed with muscle tissues, and may have subsequently been subject to bone grease removal at a processing site. The blade portions of the ilium and ischium are the parts of the innominate that contain the majority of the grease in this element.

Unlike all other indices used, no appendicular elements have low utility values in terms of bone grease fat. The lowest value is assigned to the distal metacarpal at around 30. The overall curve is vaguely linear. However, elements at the lower end of the utility index values are present in lower frequencies than would be expected from Emerson's indices. The majority of these appendicular elements are clustered at around the same

frequency even though elements such as the metapodials would be expected to be recovered at a higher frequency due to their lack of bone grease. This suggests that bone grease was not a significant factor affecting the selection of elements, although it does exhibit a slightly stronger correlation than the marrow model. The similar frequencies of the metapodials with the carpals and tarsals could be related to the removal of the feet with the lower limbs, as has been suggested. In addition to these elements being below a threshold level of utility as has already been suggested, the lack of carpals, tarsals and metapodials may also indicate a pattern that makes economic sense in terms of acquiring bone grease. Removing this portion of the limb as a single unit would require little energy in butchering, but would provide a reasonable amount of grease due to the number of elements that can be removed at once. However, the large number of carpals and tarsals noted at the site suggests that these elements are not commonly removed from the site for further processing.

The femur and the proximal tibia and humerus are recovered at approximately the same frequencies although the femur has a significantly higher utility index value. This pattern is seen in the graphs presented for all models in this thesis, and I suggest that the low frequencies are due, in part, to individual/group preferences rather than strictly conforming to utility values of parts.

I suggest that the linear pattern exhibited here indicates that grease content was a factor affecting the selection of anatomical units at this site, particularly when contrasted with the scattered pattern exhibited on the marrow graph. I also suggest that the grease model provides an explanation for the lack of carpals, tarsals and metapodials that other models cannot explain.

Total Fat Model

The final model to be examined is the total fat model. The relationship between the Averaged Total Fat Model (S)MAVGTF and the EgPn-440 assemblage is shown in

figures 7.11 and 7.12. Total fat includes the fat recovered from marrow, bone grease, intramuscular and carcass fat.

The distributions of the axial elements for the total fat utility values most resemble their positions in the protein and total products graphs, and look very dissimilar to the marrow and bone grease models. This suggests that in looking at the total fats of axial elements, intramuscular and carcass fats may have a significant influence on the utility values. Similarly to the total products model, the ribs, thoracic and cervical vertebrae have the highest utility index values of the axial elements, and these values are significantly higher than for any of the appendicular elements. In fact, with the exception of the caudal vertebrae, skull, atlas and axis, all values for axial elements exceed those for the highest elements in terms of total fat. This has implications for the overall selection of elements to be butchered, particularly if fat (including not just skeletal fat, but carcass fat as well) is a consideration for hunters.

The utility curve that results here is linear and slightly resembles the gourmet strategy for the axial elements. Outliers again include the caudal vertebrae and skull, and the sternum. However, the utility value for the sternum is at its highest in the total fat index, and therefore the frequency in which this element occurs approaches more closely the expected frequency for this model, although the frequency is still significantly lower than would be predicted. Assuming a linear "unbiased" curve, the cervical and thoracic vertebrae are present in higher frequencies than would be expected. The thoracic in particular is present at high frequencies considering how high the utility value is (100). This may be explained by butchering techniques. As discussed in chapter five, the spines of the thoracic vertebrae are often removed with the hump meat, leaving the centrum of the vertebrae behind. Since the MNI, MNE and MAU values were calculated from the presence of the centrum, the frequency values may be somewhat elevated.

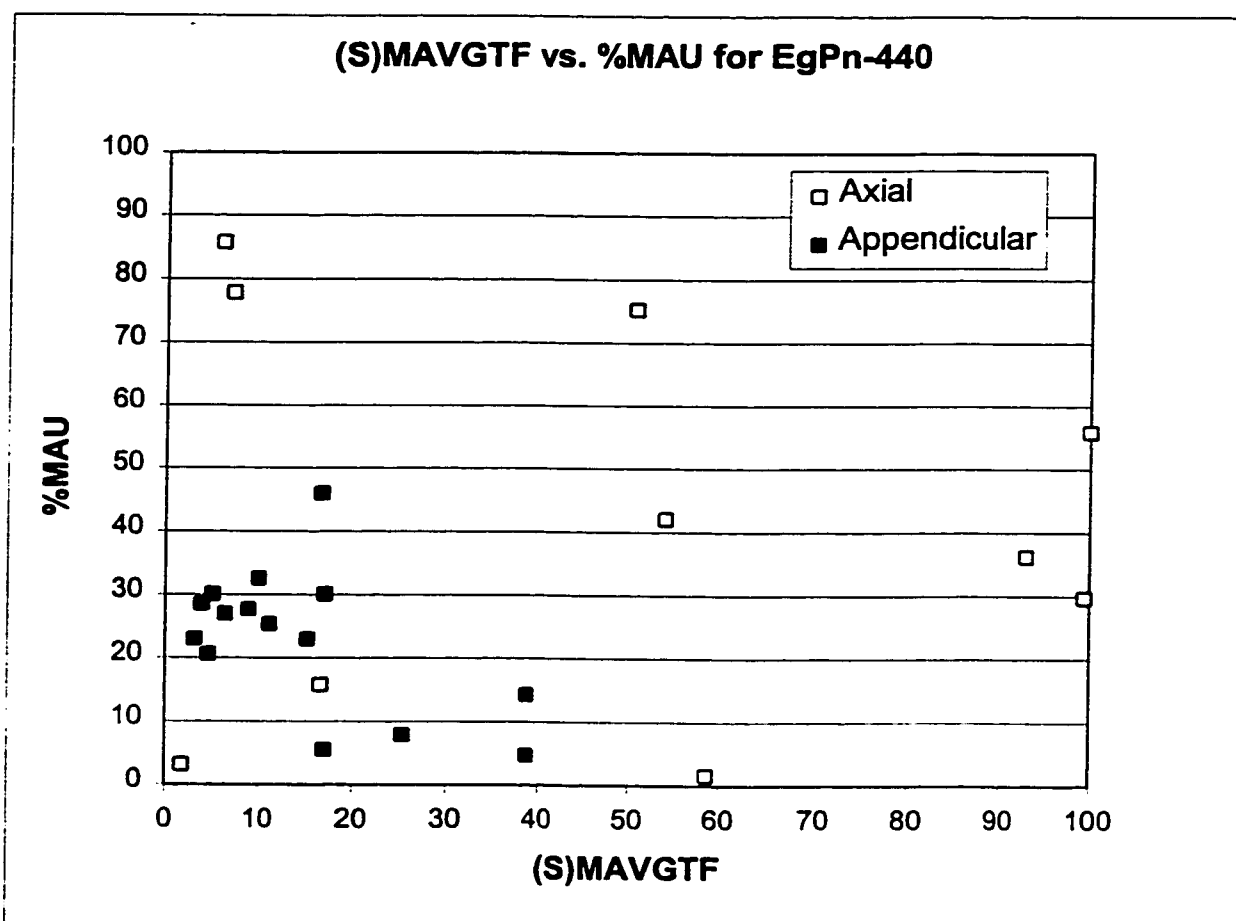


Figure 7.11. Relationship of (S)MAVGTF and %MAU for EgPn-440. The total fats model applied to EgPn-440 data most resembles the total products model (Figures 7.2 to 7.4). Axial elements exhibit a roughly linear unbiased curve, whereas appendicular elements are clustered at the low end, all exhibiting low utility values and low frequencies.

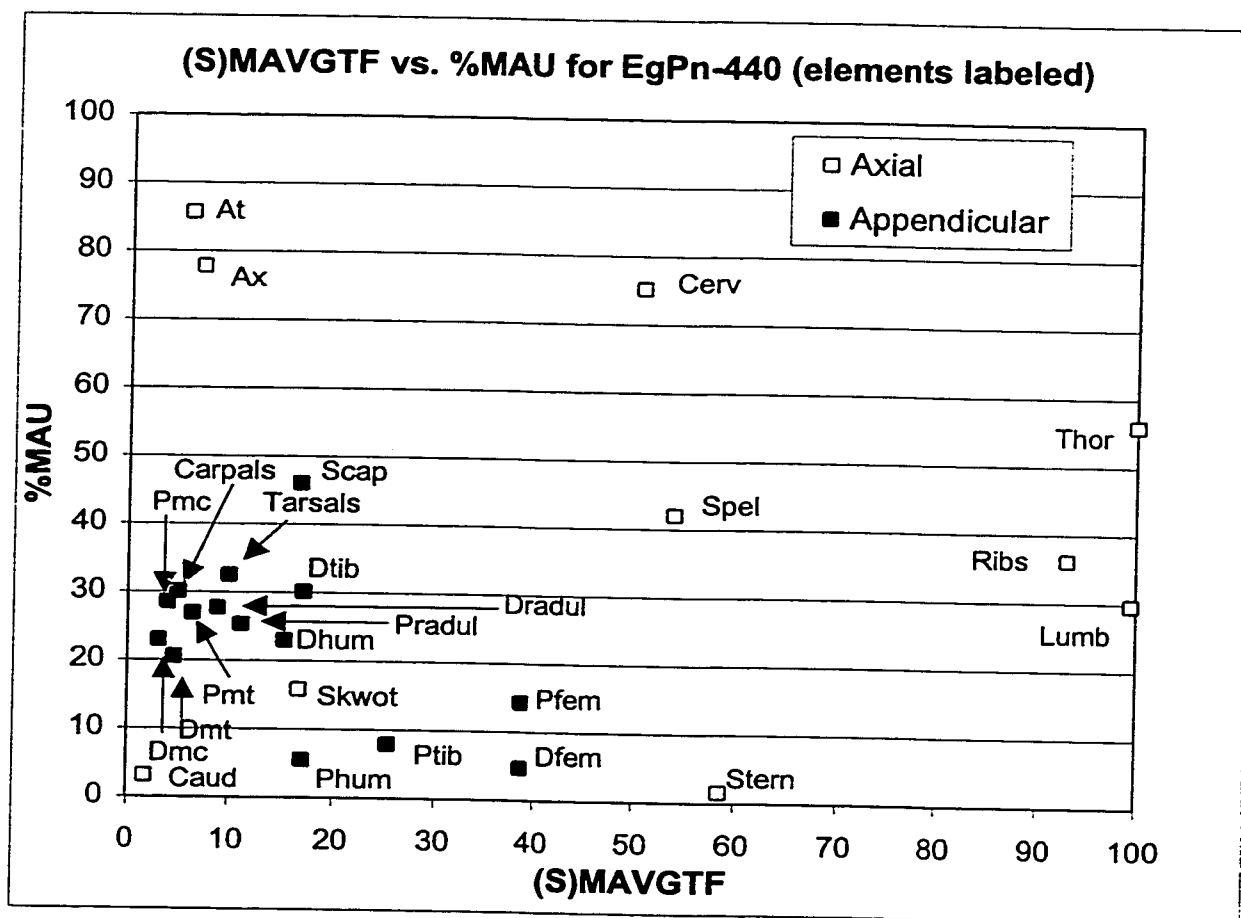


Figure 7.12. Relationship of (S)MAVGTF and %MAU for EgPn-440 (elements labelled). With the exception of the sternum, the axial elements are found in a linear pattern demonstrating that the total fats model may be more applicable than the marrow or bone grease models in explaining frequencies. The appendicular elements are clustered at the low end of the index, although those elements with the highest total fat values are found least frequently, as expected. See Table 7.2 for element abbreviations.

The appendicular elements in the total fat model exhibit a pattern that reflects their significantly lower utility values in terms of total fat when compared with any of the other models used so far. Again, this suggests that the total fat model is strongly affected by other fats besides the marrow and grease fats already discussed. The majority of the appendicular elements are tightly grouped at the far left of the graph. The scapula again looks slightly out of place in relation to the other appendicular elements, although the effect is less obvious on this graph due to the high degree of compression of all the appendicular elements at the left half of the graph. The proximal humerus, proximal tibia and both proximal and distal femur are, as predicted, less frequently found due to their increased utility value. Overall, the appendicular elements represent more of a "cluster" than a curve. Thus, for the total fats model it appears that the threshold level of utility suggested for the foot bones may be operating on the majority of the appendicular elements. In terms of acquiring intramuscular fat from these elements there is little evidence of the selection of certain elements over others, with the possible exception of the femur, the proximal tibia and the proximal humerus. It appears that the low fat levels for appendicular elements are below a utility threshold, and thus no curve indicating the increased selection of certain elements over others is evident.

I suggest that the linear pattern (rather than a scattered pattern) of elements using this model, particularly axial elements, suggests that the total fat content of anatomical units was a factor influencing the selection of elements for butchering. The very different pattern observed in this graph as compared to the marrow and grease models also suggests that carcass and intramuscular fat was important, perhaps even more so than marrow fat, for which little evidence of extraction is present. In addition, this model provides a more solid explanation for the unusual frequencies of some elements. In particular, the sternum, which seems to be present in unexpectedly low frequencies, is assigned its highest utility value in this model, which provides a stronger explanation for the lack of representatives of this element at EgPn-440.

Discussion of Models

From the specific discussions of patterns emerging from each of the five models applied, it seems clear that no one model can be used to explain the distribution of elements in relation to the individual utility indices. The distribution resulting from the total products model most resembles the protein and total fats models; indeed, this is logical since the total products index essentially results from the combination of meat protein and total fat in the animal. However, the marrow and grease indices are included in the total products model, and these indices provide quite different distributions of the EgPn-440 data when examined individually. The total fat model proves to be an interesting check on the types of fat being considered; this model includes the marrow and grease content, but does not resemble either of these indices. This suggests that other types of fat, including intramuscular and carcass fat, are significant factors affecting this model; clearly these types of fat should not be ignored when butchering patterns are interpreted.

A number of outliers consistently appear throughout the application of these models to the EgPn-440 data. I have attempted to explain these in terms of butchering techniques reported from other sites, and in terms of biases that result from my choices in terms of calculating frequencies. Other factors may also be affecting the patterns generated, however. For example, the use of parts does not necessitate their removal from the site. Anatomical parts with high meat utility values may have the meat removed at the kill site due to high energy costs involved in removing the element in its entirety. The scapula has already been suggested as an example of this. Another factor affecting selection and butchering patterns involves sex differences, particularly as they relate to seasonal fluctuations in the quality and quantity of certain products. This was discussed in some detail in relation to variations in marrow quantity and quality in females based on seasonality.

Finally, methodology unrelated to the actual content of the site must be mentioned. As described in chapter three, the entire bone bed was not excavated due to circumstances related to the size of the site. Without the material from the entire extent of the site, any conclusions as to frequencies of elements should be viewed as somewhat tentative. Additionally, preservation of elements should be mentioned. Although overall preservation of the faunal remains was very good, taphonomic factors should always be kept in mind when discussing a sample such as this. Lyman (1992:18) found that when bone density is compared to utility indices, a negative correlation existed for the appendicular skeleton (higher value elements were those with lower bone density), and a positive one existed for the axial skeleton (higher value elements were those with a high bone density) (see also Kreutzer 1992). An examination of bone density and how it relates to preservation has already been presented in chapter five. Results indicated that poor preservation was not an important factor affecting the frequency of elements recovered at this site, but taphonomic factors such as those already discussed (but also other potential factors) should be kept in mind.

The application of Emerson's models clearly provides some insight into choices made in butchering that do not necessarily just indicate a general quantity value. Different components will clearly be selected for or against based on any number of influences as described above. For the EgPn-440 assemblage, I suggest that a combination of factors were involved in the selections that these hunters made. I suggest that selection for protein was indeed a strong influence, but that bone grease was also a consideration that affected the choice of parts removed from the site, particularly influencing elements such as the carpals/tarsals and the metapodials which are usually considered to have little economic use. Marrow appears to have been only a minor consideration, with only the femur, proximal tibia and proximal humerus showing any real evidence of marrow extraction. Finally, the total fat model demonstrates that focusing on only marrow and grease fat (skeletal fat) may be ignoring other types of fat which hunters may have been selecting for. For the EgPn-440 assemblage, the linear

distribution of elements and the ability to explain the positions of certain elements (such as the sternum) with this model over others, suggests that selecting for elements with higher carcass fat content may have been a factor influencing butchering practices at this site.

CHAPTER EIGHT

SPATIAL ANALYSIS

The interpretation of spatial patterns in archaeological data is almost as old as archaeology itself; archaeologists have long tried to interpret the spatial distribution of artifacts uncovered during excavation. However, it is only in the last century that the precise locations of artifacts have been systematically recorded (Kroll and Price 1991:1). According to Hodder and Orton (1976:1), the use of spatial analysis in archaeology has gone through a slow development due to an overwhelming concern with creating chronologies: "Early prehistorians were mainly concerned with establishing chronological sequences and they did not always concern themselves with the geographical extent of the cultures they examined". Recently, however, the focus has shifted to include a number of other aspects of archaeology, including detailed examinations of spatial distributions of sites, activity areas, and artifacts. Middleton (1998) provides a review of the evolution of spatial analysis techniques over the past 300 years.

Spatial analysis has become a more common approach used to understand archaeological remains, particularly with the increasingly widespread availability and use of computers. Geographic Information Systems (GIS) are well suited to the manipulation of archaeological data: "Archaeology is an inherently spatial discipline... GIS offer the potential to integrate database management, analysis and spatial data handling into a single integrated system, simplifying the entire process, and providing us with new ways of looking at the data" (Johnson 1995:2). MapInfo is a readily available GIS system that allows the manipulation of data into layered maps. MapInfo version 4.0 was used in this thesis (MapInfo 1996).

Methodology

MapInfo was used to plot faunal specimens in an attempt to determine if patterns in butchering can be observed by using a spatial analysis of the locations of elements. Data entered into File Maker Pro (Claris 1993) cannot be directly imported into MapInfo. However, the files may be saved as ".dbf" files, which can then be imported for manipulation. Alternatively, File Maker Pro files can first be converted into Excel files (Microsoft 1996), which are easily imported into MapInfo.


A problem was initially encountered with MapInfo due to the methodology involved in the excavation itself. As discussed in chapter three, excavation for the most part involved the removal of archaeological remains in 50 by 50 cm units. Thus, each artifact removed from a given 50 by 50 cm unit received the same provenience designation. As a result, artifacts located in the same unit, when mapped in MapInfo, appeared as a single point on the map whether there was one present or more than one. Determining if any patterns existed based on the density of objects at the site was thus impossible.

The solution to this problem was to assign random proveniences to specimens within each unit. For example, an artifact located in the 50 by 50 cm unit designated as 140.0N and 145.5E was assigned a randomly generated provenience of between 140.00 and 140.49 North, and between 145.50 and 145.99 East. Random numbers were generated by importing the data into Excel and creating a formula using the "rand" function. Files were then exported into MapInfo for manipulation.

For the spatial analysis, only the remains from the bone bed were used to examine the distribution of elements. In the previous sections of the thesis, all bison remains were quantified and analyzed together. However, for the spatial analysis, it was decided to use only those elements that were in the actual bone bed in an attempt to remove from the picture any specimens that may have been moved due to taphonomic processes. Although movement of specimens in a horizontal plane is difficult to correct for, it is

logical to assume that specimens moved to a different vertical plane have potentially also been moved horizontally. Specimens in a different vertical plane than the bone bed were thus removed from the sample to avoid obscuring spatial patterns.

In many examples, the queries involved simply searching for and plotting the location of the element. For example, a query would involve finding and plotting all situations where "element" = "caudal vertebra". However, this type of query often resulted in a mass of points plotted, many of which could have been a number of pieces representing a single element. This affected elements such as the mandible, vertebrae, and long bones. For these elements, further queries were performed using information that was used in calculating MNE. For example, an initial query for "element" = "mandible" resulted in a large number of points which provided very little information on spatial distribution. Further queries were performed to isolate individual parts of the mandible which would indicate the distribution of single elements. For example, the next query was "landmark 19 (the medial half of the condyle)" = "present". This provided a distribution based on one of the criteria for determining MNE. Generally, the criteria used to refine the queries were the same as those used in the calculation of MNI as described in Chapter 4.

Figure 8.1 illustrates the excavation grid as it exists in MapInfo. The "blocks" that will be used to describe patterns in the remainder of this chapter are labelled. Note that the squares do not represent the actual units excavated. Middleton (1998:73) notes the difficulty of making useable grids in MapInfo on which to place point data; no attempt was made in this thesis to impose an actual grid on the points. However, rather than having no reference at all, I chose to use squares () to denote the southwest corner of each 50 cm by 50 cm unit as described in Chapter three. Although this does not provide an actual grid, it provides some frame of reference on which patterns can be observed.

Note also that the "blocks" described are a result only of the excavation itself. Choices on the placement of excavation units in the field resulted in the excavation grid that is shown in Figure 8.1. This does not denote the limits of the site. As discussed in chapter three, the large section that was unexcavated between the north block and the central block contains part of the site that was not excavated due to time constraints and limits on the numbers of units to be excavated. This must be kept in mind when the spatial distributions are examined. Hodder and Orton note:

Any map is, in a sense, an attempt at quantification. It provides the empirical evidence on which some theory can be built. But such a map can be totally misleading due to the uneven way archaeological information survives and is collected. Included on the map, or in the discussion of the map, should be some attempt to assess its reliability (Hodder and Orton 1976:17).

With this in mind, I call the main areas of excavation (as illustrated in Figure 8.1) the "north block", the "central block" and so on, making it clear to which parts of the site I am referring. Note also from Figure 8.1 that a large portion of the site remains unexcavated. This includes a section that largely separates the north and south halves of the excavation area, as well as an area of unknown size to the east of the excavation area which was outside of the pipeline right of way.

Spatial Distribution of Elements

Overall, there is a greater concentration of specimens in the north block of the excavation grid than in the central or southern blocks. It is assumed that this is likely the area where the greatest number of animals died, although there are certainly a large number of bison also represented in the southern part of the site. Very few elements resulted in obvious distributional patterns. However, a discussion and comparison of the results may provide some insight into butchering procedures that may have been taking place. Maps will be provided for those elements for which patterns of interest are visible.

Axial versus Appendicular Elements

There is a difference in the patterns of distribution of the axial and appendicular elements, although the pattern becomes clearer when the ribs are removed from the assemblage. Figure 8.2 illustrates the distribution of axial elements including ribs. The greatest concentration is evident in the north block of the site, but overall the distribution is quite uniform. Axial elements in this figure are present in all parts of the site. In the north of the site, there are concentrations in the east half of the excavation grid and in the west half. These appear to be separated by a slight gap. This gap may be indicative of a separation between kill and processing areas, or perhaps two different kill events.

Figure 8.3 illustrates the distribution of the axial elements, excluding the ribs. The concentration in this figure clearly shifts to the east half of the north block, and a northeast-southwest linear concentration becomes evident. In contrast, Figure 8.4 illustrates the distribution of the appendicular elements. In this figure, the main concentration is clearly more evident in the western part of the north block, with a relatively scattered distribution apparent in the central and south blocks.

This pattern of distribution may represent different activity areas at the kill site. I suggest that the area where high concentrations of axial elements are present (in the east of the north block and continuing in a somewhat linear fashion toward the southwest) may indicate that this is where the majority of the animals originally fell. Elements such as the atlas and axis (which will be described in more detail below) clearly have their greatest concentrations in this location, and the low utility values of these elements would suggest that they would not likely be moved due to butchering. The appendicular elements, present in higher concentrations in the more westerly part of the north block, were probably moved to the west of their original locations for butchering. The limbs may have been removed from the carcasses and carried to the west part of the site where fewer bison carcasses fell. Butchering of the limbs would have then involved the removal of meat, the smashing of limb bones for marrow, and sometimes the removal of

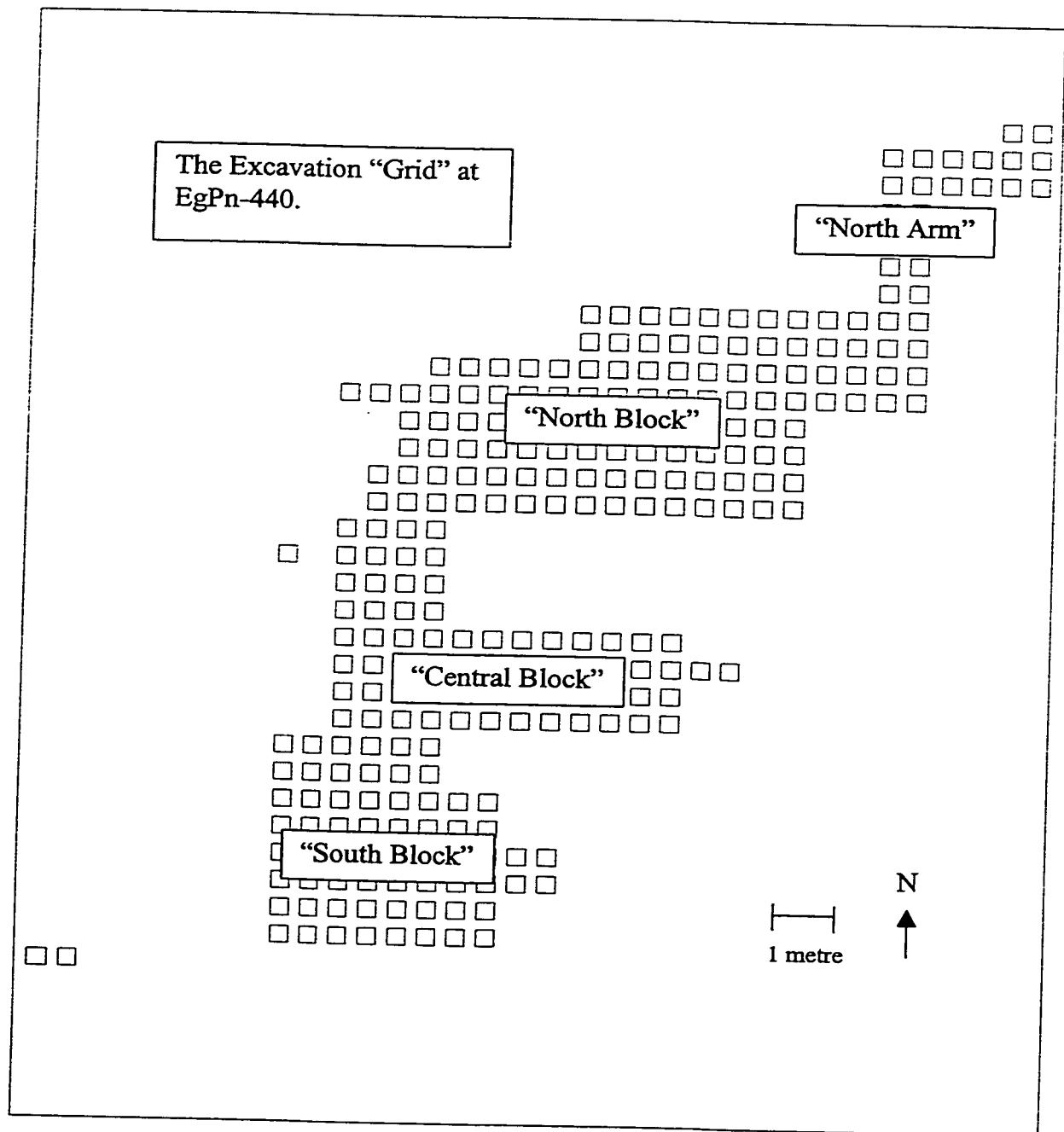


Figure 8.1. The excavation "grid" at EgPn-440, illustrating the locations of areas discussed in Chapter eight.

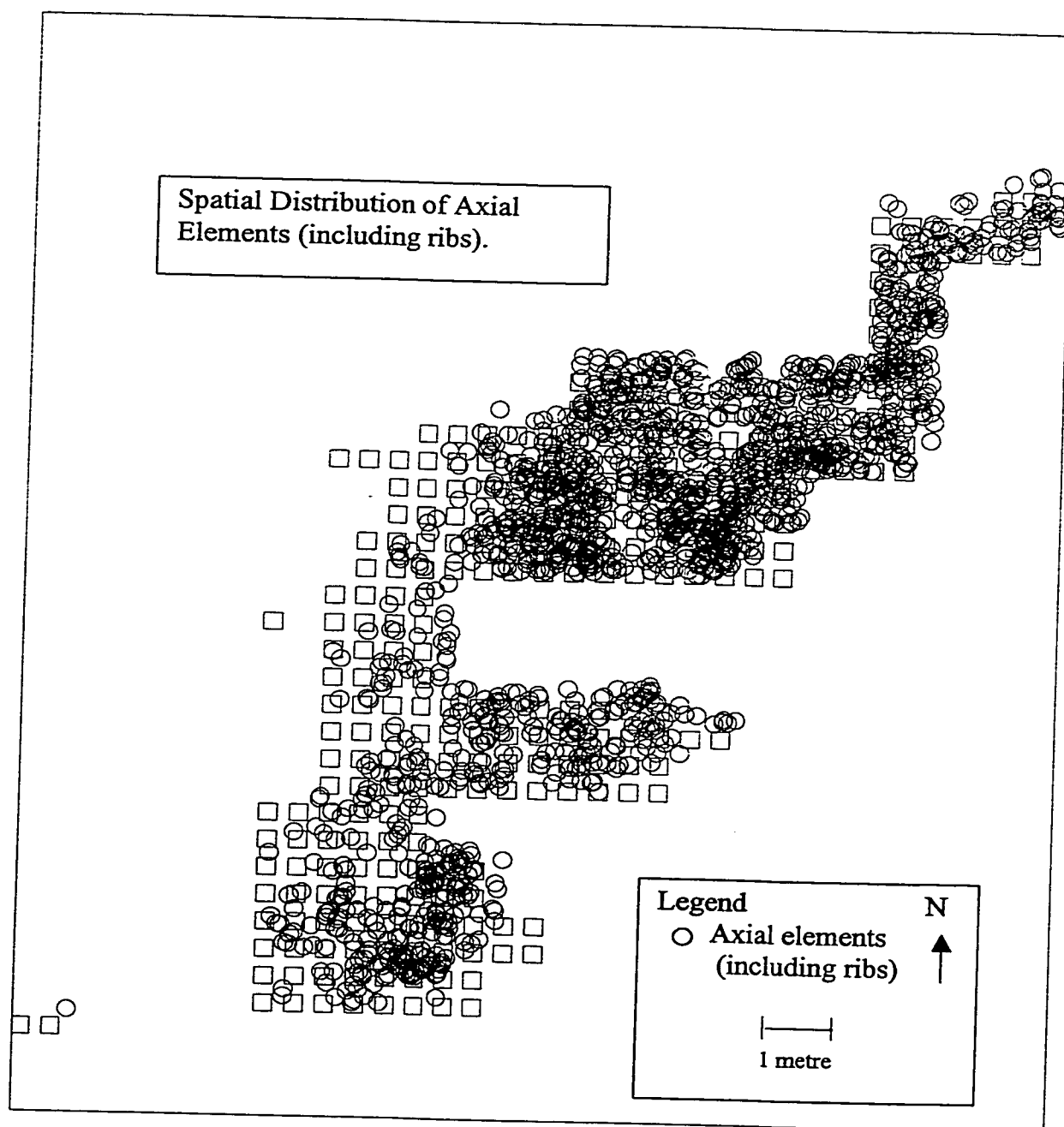


Figure 8.2. Spatial distribution of axial elements (including ribs). Axial elements are found throughout the site with the highest concentration in the north block.

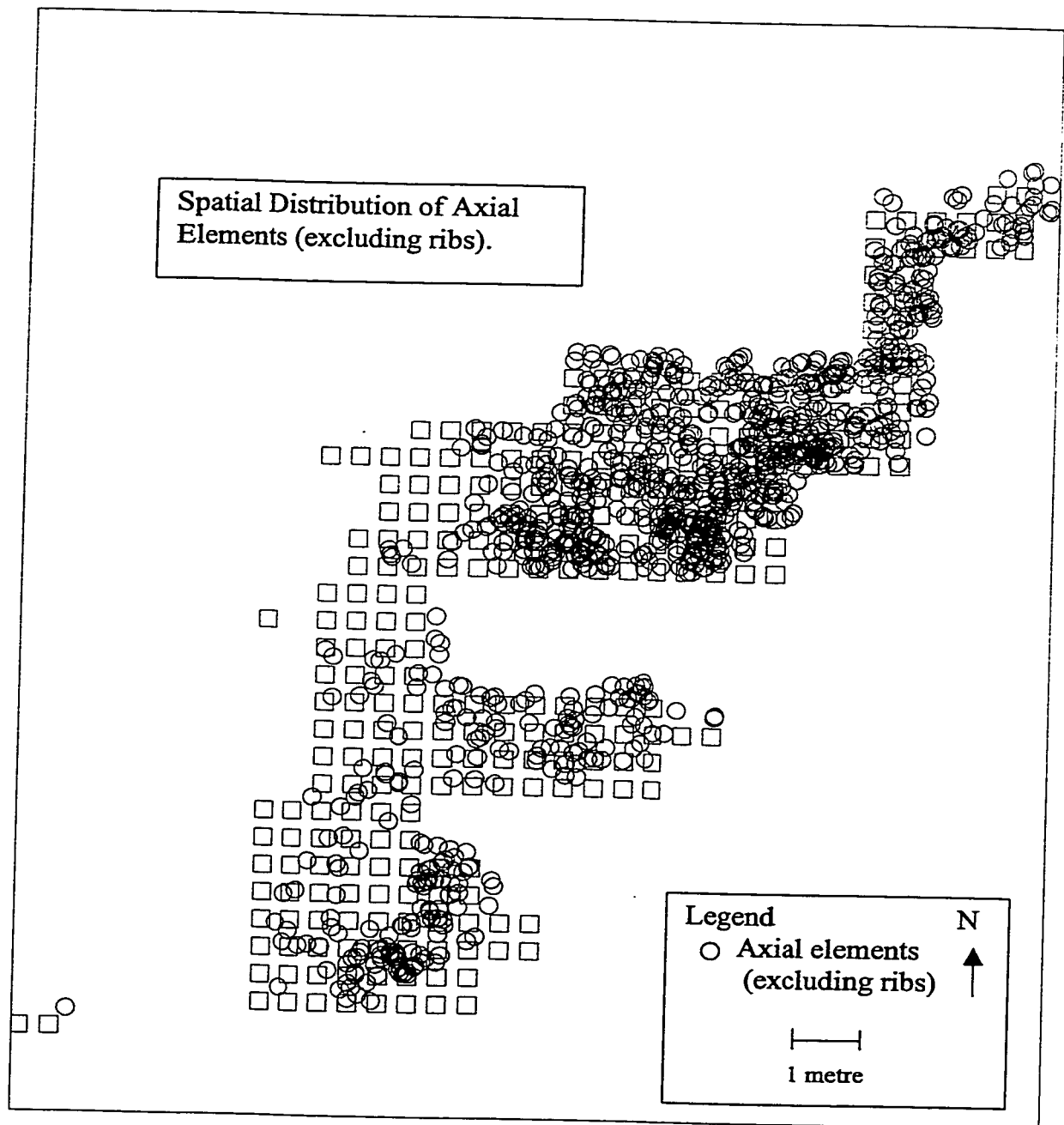


Figure 8.3. Spatial distribution of axial elements (excluding ribs). When ribs are excluded, the axial elements are clearly more concentrated in the east half of the site.

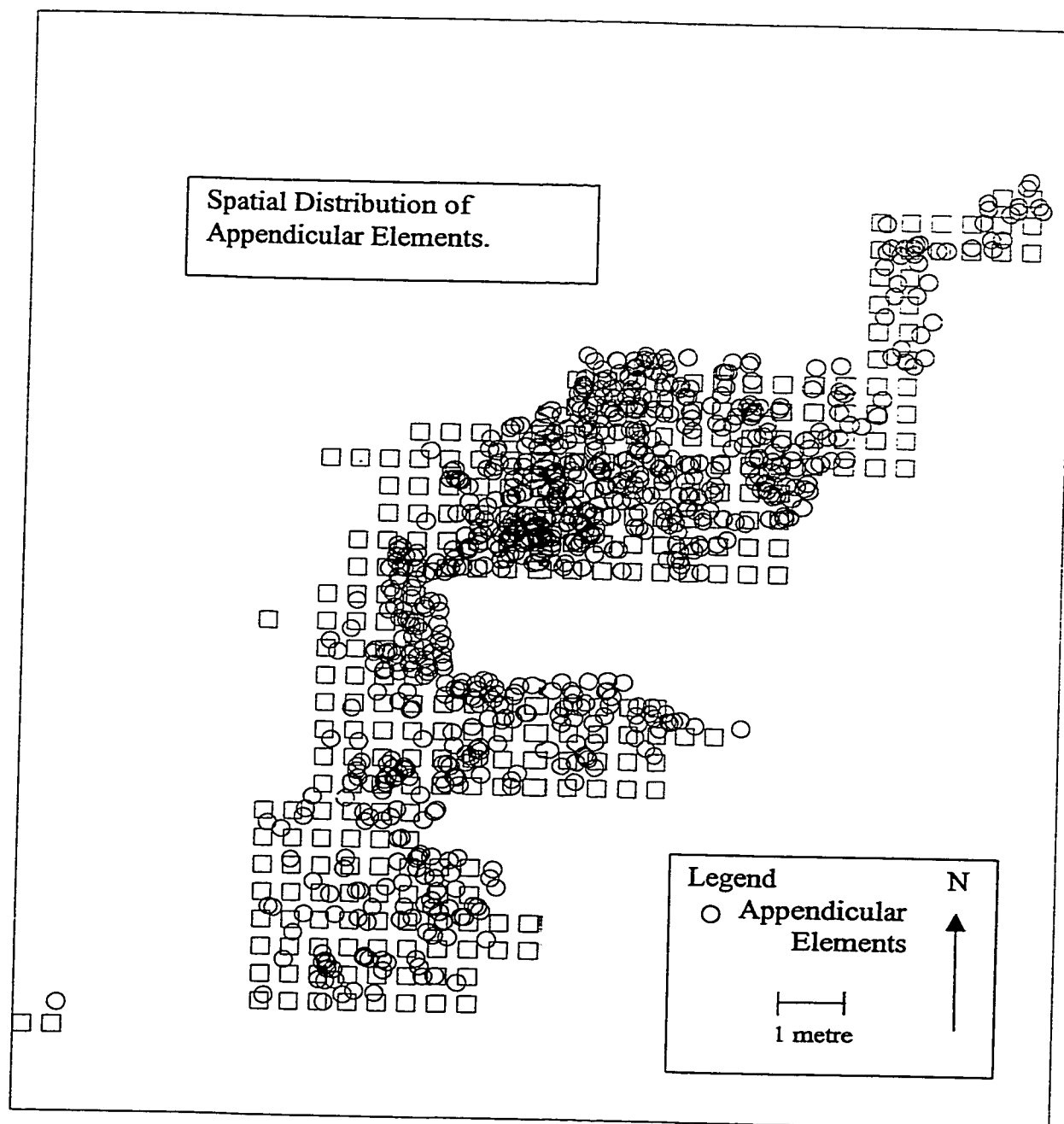


Figure 8.4. Spatial distribution of appendicular elements. Exhibiting the opposite pattern to that noted for the axial elements excluding the ribs above (Figure 8.3), the appendicular elements are more concentrated in the west half of the site.

the feet. Some bones would also have been removed from the site for further processing including marrow and bone grease extraction. This has been discussed in detail in chapter seven.

The distinction between the concentration of axial element to the east and appendicular elements to the west is an overall pattern, but is not common for all elements. A number of elements demonstrate patterns that vary from that described above, and those patterns have implications for the selection of anatomical units, the placement of activity areas, and possibly for distinguishing separate kill events. The remainder of this chapter will deal more specifically with the pattern of distribution of individual elements and anatomical units, and the relationships between them.

Axial Elements

The mandibles provided little evidence of any kind of "stacking" that might be related to activity areas in butchering. Although this element was recovered in all parts of the excavation grid, the greatest concentration was in the east portion of the north block of the excavation. This is a common pattern among the axial elements, as mentioned above. Individual axial elements also overwhelmingly demonstrate this pattern, as will be seen below. Some elements differ from this pattern, and this will be discussed for each element separately.

As with the mandibles, skulls were recovered from all parts of the site, with the highest concentration being found in the eastern half of the north block. Hyoids, found in smaller numbers than the mandible, were distributed in a relatively random pattern, scattered throughout the excavation area. No concentrations of this element were evident, and no evidence of hyoids associated with mandibles was observed.

The patterns exhibited by the atlas and axis paralleled each other. Note that, as mentioned in chapter five, the atlas and axis were generally not noted as being found in articulation at the site. The concentration in the east half of the north block was far more pronounced for these elements as compared with the mandible and skull discussed above. Figure 8.5 illustrates the distribution of atlases and axes at EgPn-440. As discussed in the previous chapter, these elements are among the lowest utility elements and are therefore less likely to be moved from the original location due to butchering. For this reason, I suggest that the heavy concentration of these two elements in the east of the north block indicates the area where many of the animals originally fell. The less concentrated distribution of the mandible and skull may therefore be the result of some degree of butchering of these elements which required them to be moved away from the bulk of the carcasses.

The cervical vertebrae show a similar pattern to the distributions described above. The concentration is in the east half of the north block, although it is not as pronounced a concentration as described for the atlas and axis. The thoracic vertebrae also show a similar distribution. However, unlike the cervical vertebrae, the thoracic elements also show a concentration in the east part of both the middle and south blocks of the site. This may represent the continuation of the main bone bed indicating the original location of most individuals. The concentrations in the central and south blocks is more pronounced for the thoracic vertebrae than for the atlas and axis. This is likely just a reflection of the greater number of thoracics in the skeleton as compared with the atlas or axis.

There is no evidence for the spinous processes of the thoracic vertebrae being removed for further processing. Spines are found in the same areas as the centra of the vertebrae. If thoracic vertebrae are being processed for hump meat, it appears that either the entire element is being removed to other locations (whether at the site or away from it), or that the spines, if they are being removed from the rest of the element, are removed from the site altogether for processing. Lumbar vertebrae show a similar pattern to that

demonstrated by the cervical vertebrae, with a concentration in the east half of the north block and the remainder scattered throughout the excavation grid.

The ribs at EgPn-440 are abundant, and are found in all parts of the site. They are most abundant in the north block, but within this area they exhibit a different pattern of concentration than that observed for the other axial elements. Whereas most other axial units are concentrated in the east half of the block, the ribs appear to be more concentrated in the west half of the north block. An explanation for this pattern is difficult to produce. It is expected that rib heads would be left with the vertebrae in the kill area at the east of the site, and rib shaft fragments would be transported to the periphery of the site or to a processing site. Most accounts of butchering techniques affecting the ribs involve the ribs being cut or broken near the vertebral column, so the heads of the ribs should be found in association with the thoracic vertebrae (Frison 1970a:19; Frison 1970b:15). However, when mapping the ribs, the presence of the head of the rib was used as a landmark, so that single ribs were plotted, not a series of rib fragments. The presence of a larger number of rib heads in the west of the excavation (not associated with the vertebrae in the east, as expected) is thus difficult to explain.

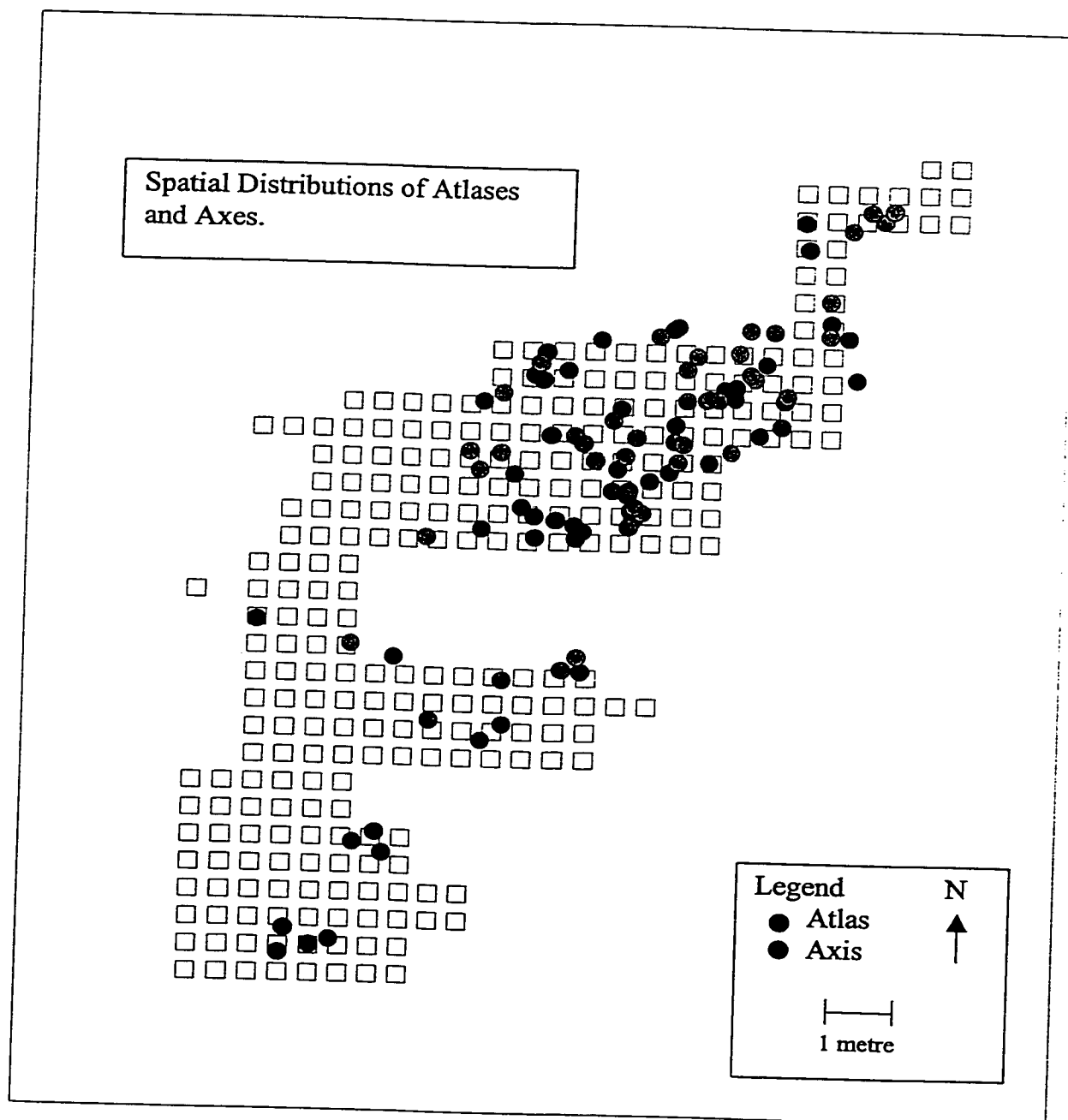


Figure 8.5. Spatial distribution of atlases and axes. The concentration of these elements in the east half of the excavation area probably represents the main kill area, since these elements are unlikely to be moved elsewhere for processing due to their low utility values.

Appendicular Elements

As with the axial skeleton, the appendicular elements are, on the whole, more concentrated in the north block than in the central and south blocks. Overall, the appendicular elements are more common in the west half of the north block, unlike the axial elements that are more prevalent in the east (with the exception of the ribs, as discussed above). The scapula proves to be an exception to this pattern; this element is more commonly recovered from the east half of the north block. The humerus, on the other hand, is more common in the west half. Determining if this apparent difference in distribution is due to butchering practices requires the proximal and distal ends of the humerus to be examined individually. Proximal humerus ends are rare at EgPn-440, and those present are scattered throughout the site. Distal ends are heavily concentrated in the north block. Only two distal humerus ends are present in the central block, and none are found in the south. Distributions of the scapula, proximal humerus and distal humerus are illustrated in Figure 8.6.

Due to the lack of proximal ends, it is difficult to make any conclusions on whether the humerus is being treated in a similar manner to the scapula due to their proximity in the skeleton. The scapulae are found in a somewhat scattered distribution with a slight concentration in the east half of the site. This likely results from the stripping of the meat from the bone at the site and the bone being discarded, as has been described previously. The humerus is treated differently due to the high content of marrow and bone grease. I suggest that the large number of humeri in the north of the excavation relative to the south indicates that the elements remaining in the north had the meat removed and the bones broken to remove the marrow. Any humeri that were more extensively processed were removed from the site altogether. As mentioned, the humeri are generally found more commonly in the western portion of the north block, suggesting that they have been removed from the carcasses in the east for processing at the western periphery of the site, like most of the other appendicular elements.

The almost complete lack of humeri in the central and south portions of the site may require that an alternative suggestion be presented regarding the distribution of the humeri. One possible explanation centres on the differential selection of elements by individuals or by different groups. Consider the suggestion made in chapter six that this site represents several different kill events. If this suggestion is correct, then different groups using the site (or the same group using the site in different seasons) may have processed the animals differently. It was mentioned earlier that the season in which an animal is killed affects the marrow content of the long bones. The north part of the site may therefore represent a kill that took place in a season where the humeri were in poor condition and were therefore ignored and left at the site. The south part of the site may represent a kill at a time of year when the humeri were in good condition, and were preferentially removed from the site. This may suggest that the north part of the kill took place in the winter, when long bones would be in relatively poor condition, whereas the south part of the kill took place in summer, when the good condition of the marrow bones resulted in their being completely removed from the site. However, evidence of butchering is present on several humeri in the north part of the site, which implies that these elements were not being ignored as suggested.

Alternatively, sex differences may also influence this type of selection; for example, the female humerus often has lower marrow levels in the spring calving seasons, and the male humerus may exhibit low marrow content after the fall rut. These differences may cause preferential selection of elements in varying times of the year. If the selection of marrow bones varies with the season, the potential exists to distinguish kill events occurring in different seasons by applying sexing data to spatial information. An attempt was made to determine if sex (as determined in chapter six) could be correlated to different areas of the site. If female marrow bones were recovered from a different location than male marrow bones, this could potentially indicate separate kill events.

Results from such an attempt were unsuccessful in this thesis. This is largely due to the lack of females as indicated by the sexing determination. For example, only one humerus was assigned a conclusive result of female, and this specimen does not occur within the bone bed itself. This lack of specimens identified as female meant that no pattern of distribution of females versus males was apparent. However, the potential does exist for sexing data to be examined spatially, and future studies may find success with this approach.

A similar pattern to that demonstrated by the humeri is observed for the radii. The radius is relatively abundant in the north of the excavation, but is represented by very few elements in the south. A similar explanation may be offered to that of the humerus distribution: the south section may represent a kill taking place at a time when the long bones were in good condition in terms of marrow and grease content and quality, and long bones may have been preferentially removed from the site. The ulna does not show this pattern, however. Instead, the ulna is essentially scattered evenly throughout the site. This pattern may actually support the suggestion that different kill events took place here in different seasons. Although Emerson provided utility values for the radius and ulna together, I suggest that these bones may have actually been separated during the initial stages of butchering; spiral fractures noted on the shafts of eight ulnae may support this, and no fused radii-ulnae were recovered at EgPn-440. If the radius and ulna were separated, the radius may have been preferentially removed from the site for further processing for marrow and grease, but the ulna, which lacks a large marrow cavity, may have been left behind.

When the radius is examined in terms of proximal versus distal ends, however, another pattern becomes clear. Figure 8.7 shows the distribution of proximal radius, distal radius and ulna elements (note that a proximal portion of the ulna is being mapped, not distal fragments). Proximal ends of the radius are present in all parts of the site, as is the ulna. However, the majority of the distal ends of the radius are found only in the north part of the site. I suggest that, like the pattern noted for the humerus above, this

indicates a significant difference between the north block and the south block; this may be the result of separate activities taking place in the north and the south parts of the site, or of separate kill events which produced differing butchering patterns.

The carpals were generally found evenly distributed throughout the site. The metacarpals showed a similar distribution, although this element showed a slightly stronger concentration in the north block of the site, like most of the other element distributions described. If the appendicular elements are being removed from the carcasses and taken to the western periphery of the site, as has been suggested, we would expect to see a stronger concentration of carpals and metacarpals in the west part of the site. The distribution of the left metacarpals and carpals was plotted spatially to determine if groups exist that are indicative of articulated units. This plot is shown in Figure 8.8. This plot indicates that some evidence of articulated metacarpals and carpals can be observed. However, a number of these elements are found scattered throughout the site, with no evidence of articulation. Taphonomic processes may explain this to some degree.

The innominate remains were concentrated mainly in the east part of the north block, although this element was found throughout the site. This distribution is expected; as with the scapula, the butchering pattern affecting the pelvis commonly results in the acetabulum (which is the portion being mapped here) being left behind at the kill. Thus, if the main kill is in the east portion of the north block, the innominate should be most concentrated here, as is the case.

The femur exhibited a very dispersed pattern, although it did follow the typical pattern of exhibiting a more pronounced concentration in the north. In fact, only two elements were represented in the south part of the site. The opposite pattern was observed for the patellae. Only three elements were found in the bone bed, but all three were found in the south part of the site, and none in the north. A map comparing these two elements is presented in Figure 8.9. The distribution of the tibiae at EgPn-440 is also similar to that for the femora, with most elements being found in the north block and few

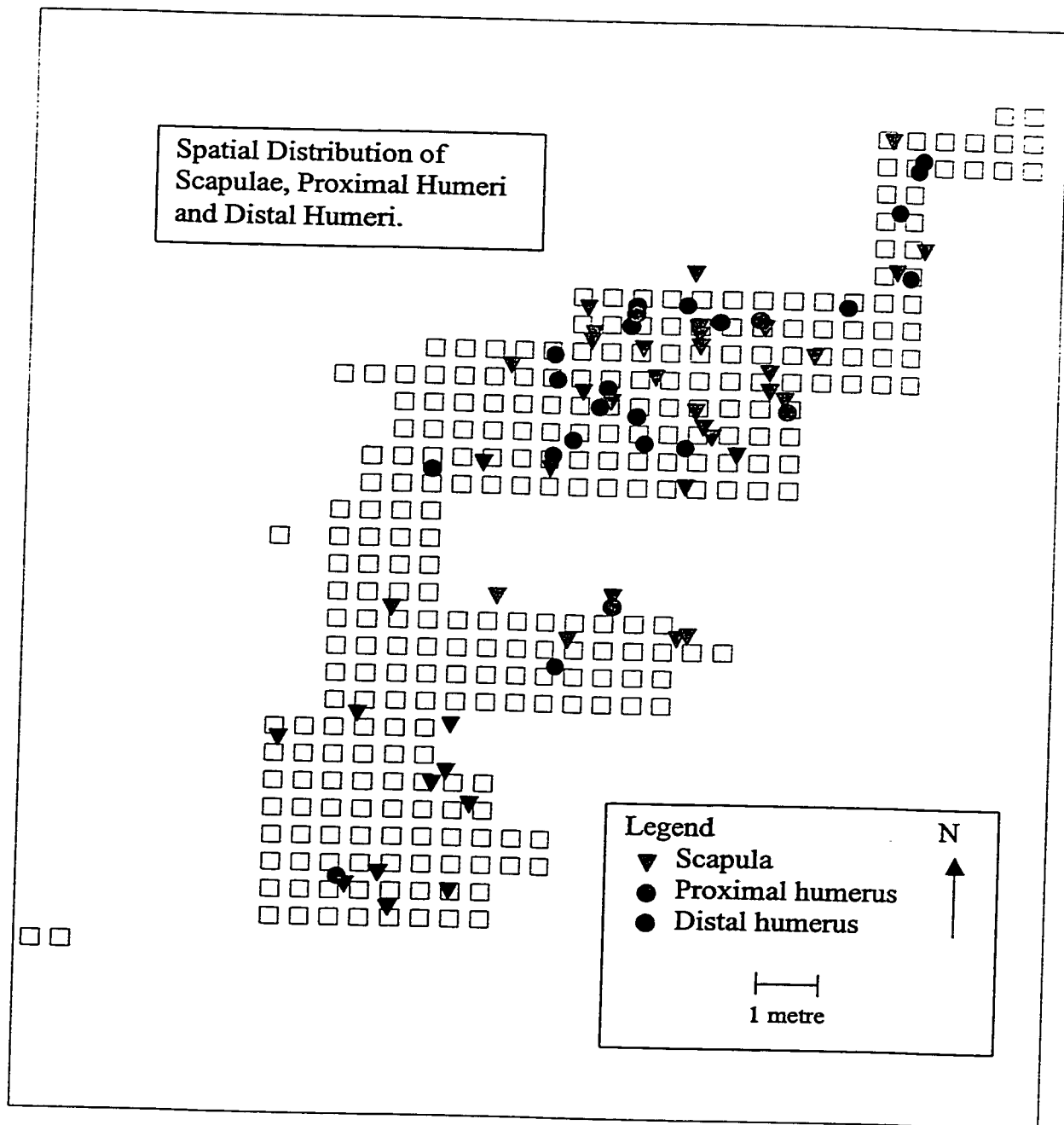


Figure 8.6. Spatial distribution of scapulae, proximal humeri and distal humeri. Proximal ends of the humerus are rare. Scapulae are found throughout the excavation area, whereas distal humeri are found almost exclusively in the north block of the site, particularly in the west.

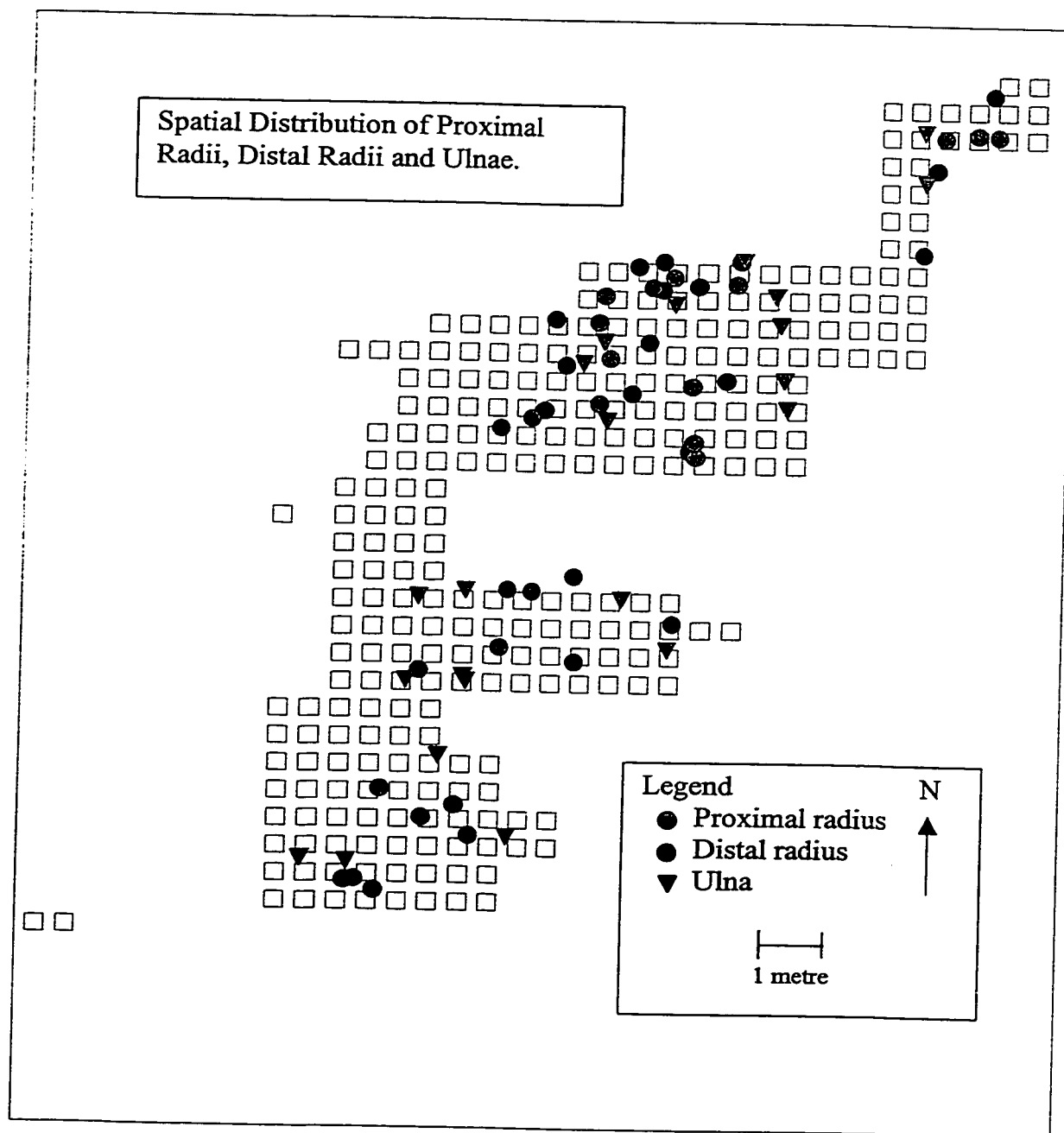


Figure 8.7. Spatial distribution of proximal radii, distal radii and ulnae. Ulnae and proximal radii are found throughout the site, whereas distal radii are found almost exclusively in the west half of the north block of the site.

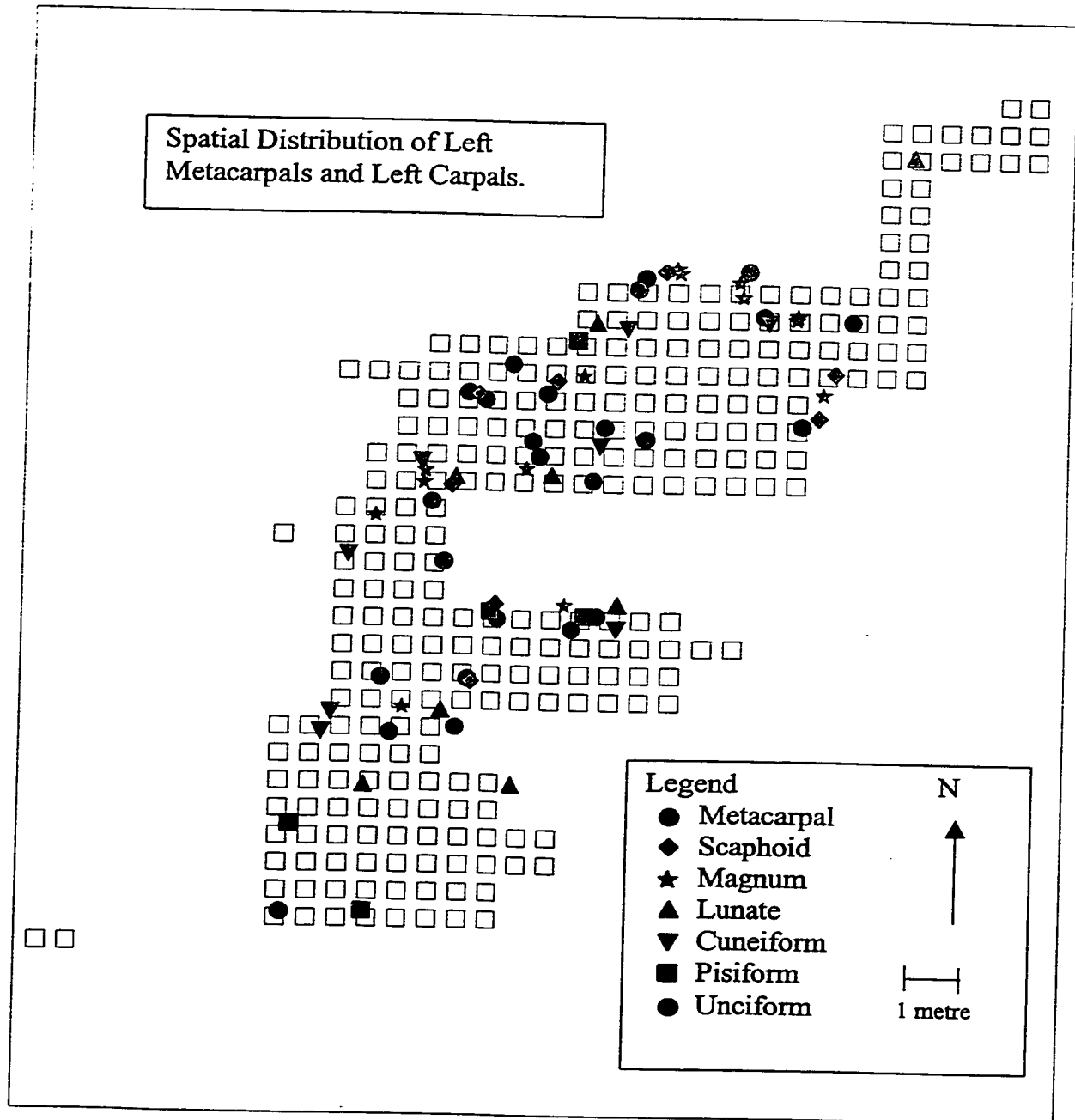


Figure 8.8. Spatial distribution of left metacarpals and left carpals, illustrating some articulated units and some elements dispersed at random. No spatial patterning of articulated units versus dispersed ones is evident.

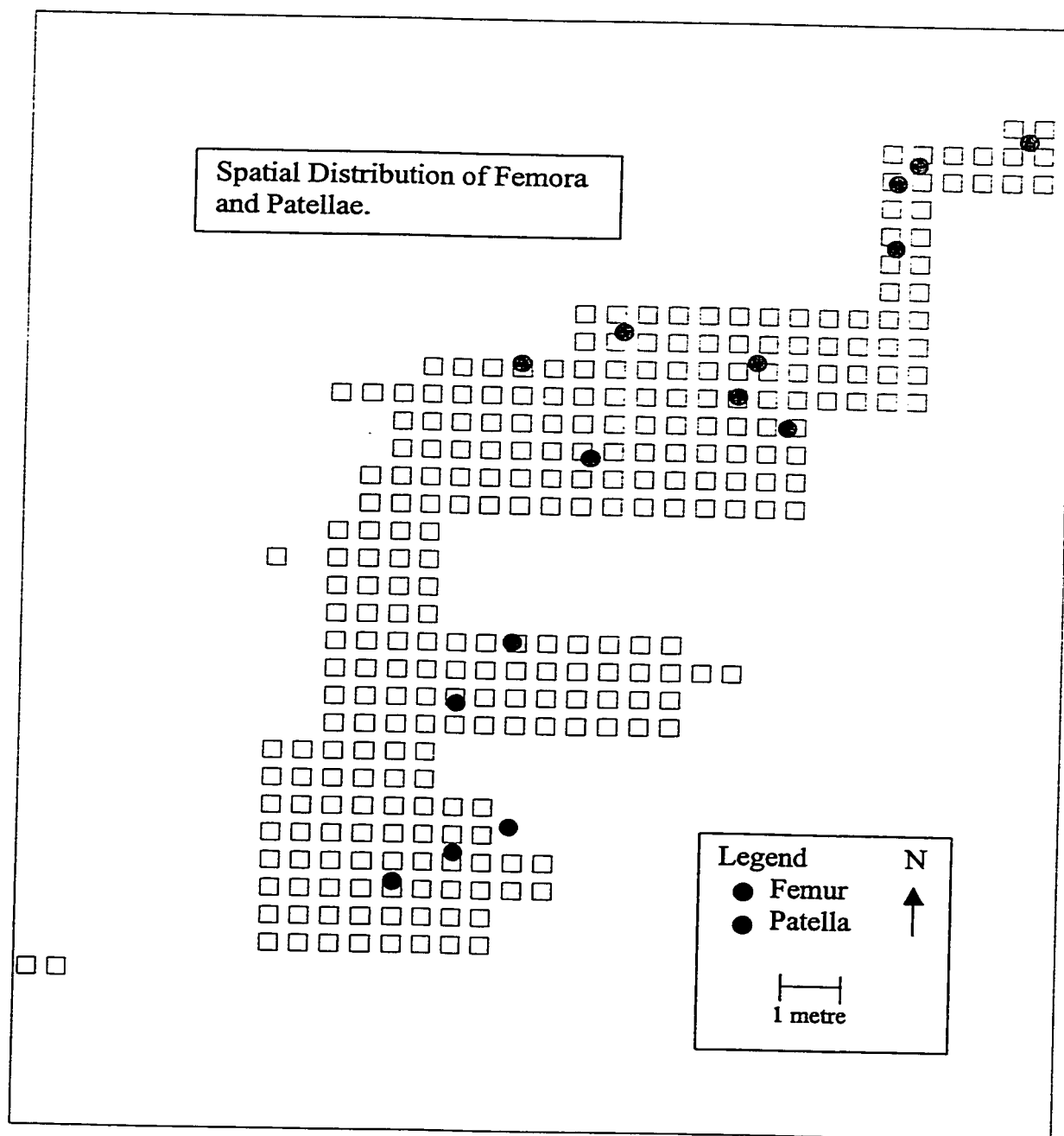


Figure 8.9. Spatial distribution of femora and patellae, showing the presence of patellae only in the south half of the excavation area, whereas most femora are found in the north half of the excavation area.

in the south. This pattern may be explained by butchering techniques already described that involve hacking through to the patella and using it as a hold to remove meat from the hind leg. As already discussed, this technique may explain the paucity of this element at the site overall. The presence of only three specimens suggests that most patellae were likely taken away from the site with the cut of meat. The complete lack of patellae in the north block does, however, seem difficult to explain without assuming that all hind limbs were butchered completely enough to remove all patellae. Other factors such as taphonomic processes may contribute to the lack of this element at the site, although there is little evidence to support this. Preservation is overall very good, and little weathering or carnivore gnawing is evident. Collection techniques also resulted in even extremely small fragments being recovered. Thus it seems unlikely that these factors resulted in the lack of patellae recovered from the site.

The tarsals demonstrate a slightly different pattern than that observed for the carpals, which may suggest that different processes affected the distribution of the forelimb elements and those of the hindlimb. The carpals and metacarpals were found to exhibit some degree of articulation at the site and were distributed throughout the site. The tarsals and metatarsals also exhibit some evidence of articulation. However, these were concentrated in the westerly portion of the north block and the central block, rather than being scattered throughout the site like the carpals. The distribution of the tarsals supports the initial suggestion that the appendicular elements are overall being moved from the carcasses to the western periphery of the site for processing, and the presence of some apparent articulated units also supports this. As with the carpals, taphonomic processes may explain the scattered distribution of some of the elements.

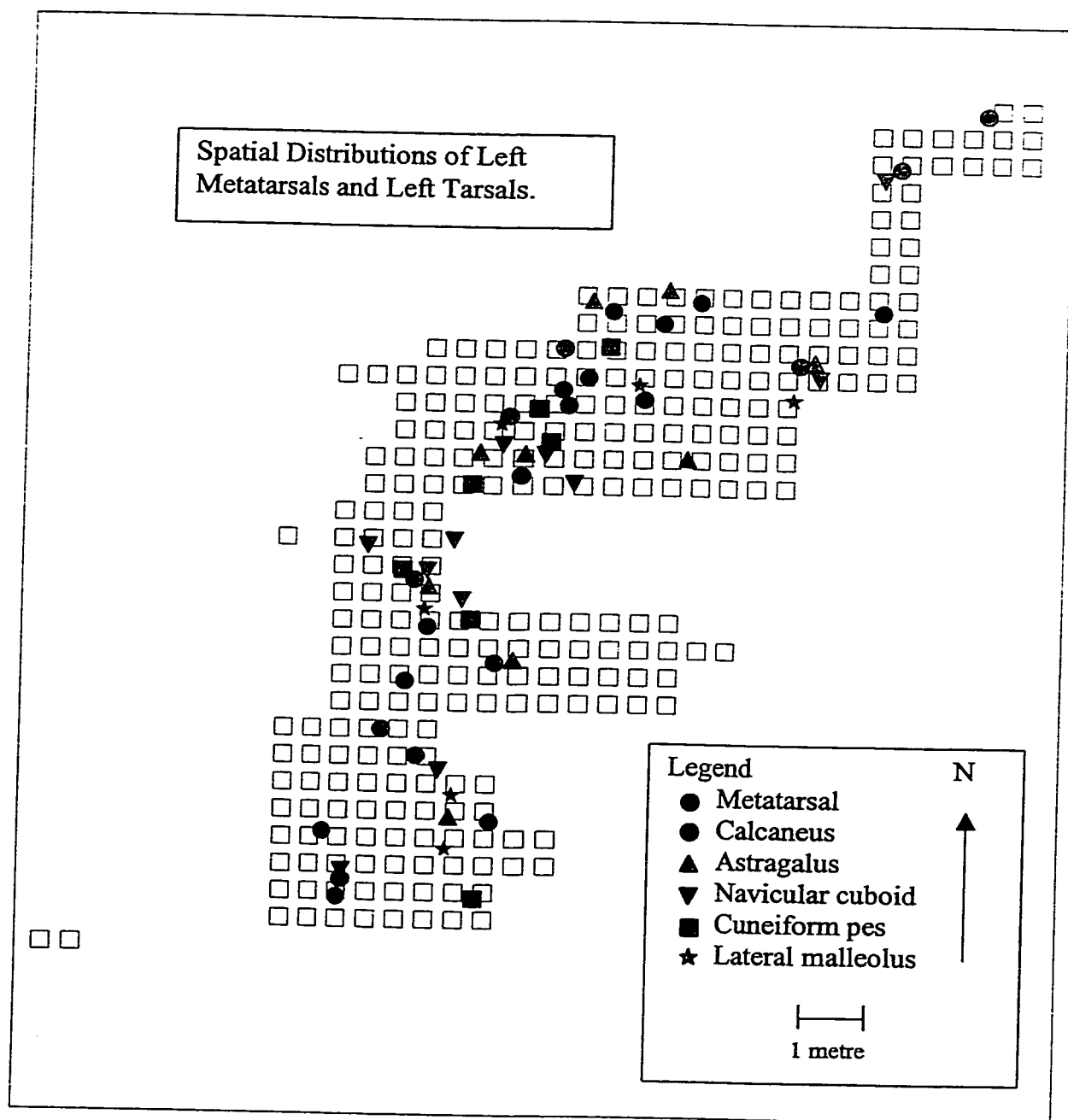


Figure 8.10. Spatial distribution of left metatarsals and left tarsals, exhibiting some evidence of articulations of these elements as a single anatomical unit. The concentration is clearly in the west half of the excavation area.

Summary

Clearly some distinction between the locations of axial and appendicular elements exists in a general sense. As already discussed, this pattern suggests that these areas of concentration (see Figures 8.3 and 8.4) represent a main kill area indicated by the concentration of axial elements excluding ribs, and an area where appendicular elements and ribs were moved to the western periphery of the site for processing. However, the patterns resulting from the examination of individual elements produce some variations to this overall distribution.

The atlas and axis show concentrations in the eastern portion of the north block in particular. This is taken as support for the hypothesis that this is the location of the main kill, since these elements are among the lowest utility elements and would therefore be commonly left behind. The other vertebral elements also exhibit this pattern, although the degree of concentration is less than for the atlas and axis, likely due to some degree of butchering of the cervical, lumbar and especially the thoracic vertebrae. The ribs are the one axial element that proves to be an exception to the axial concentration in the east part of the site based on the presence of the heads of the ribs. Unfortunately, no obvious explanation exists for this distribution.

Appendicular elements are generally concentrated in the western portion of the north block, and I have suggested that these elements are found away from the axial elements as a result of removal of the limbs to the western periphery of the site for processing. There are exceptions to this pattern, as discussed above. Explanations for these exceptions likely stem from butchering practices which affect the distributions of elements differently due to methods of meat removal and the preferential removal of some elements from the site for further processing of marrow and bone grease.

Metapodials and carpals/tarsals exhibit some degree of articulation as a single anatomical unit, which supports the hypothesis that the feet are in some examples being removed from the limb and left at the site. This would reduce the effort of transporting relatively useless and heavy portions of the carcass to processing sites.

As mentioned, a great deal of the bone bed remains unexcavated due to its location outside of the limits of the pipeline right-of-way. Spatial patterns are clearly evident from the portion of the bone bed that has been excavated. However, excavation of the remaining portion of the bone bed would certainly increase our knowledge of the spatial distribution at the site, and may in fact demonstrate clearer indications of activity areas, evidence of multiple kill events, and the extent of the site itself.

CHAPTER NINE

DISCUSSION AND CONCLUSIONS

This thesis has examined a number of different avenues in terms of gaining insight into the use of bison in the Late Prehistoric northwestern plains. Although bison kill sites are common in the plains, the size of the site, the good preservation, and the large excavation area of EgPn-440 provides a great deal of information on one of the more important facets of the lives of prehistoric peoples in southern Alberta and beyond.

In this thesis, the site was placed into context with an examination of the lithic materials, particularly the projectile points. A different approach was taken to this examination than most other studies, based on Peck's (1996) re-evaluation of the Late Prehistoric points in the Saskatchewan and Alberta plains. I suggest that this approach allows the Late Prehistoric lithic tradition to be looked upon in new light, and its use by other researchers may alter the current classification system of points in this region. The lithic data suggest that this site most likely represents use by Early Cayley peoples as defined by Peck (1996). Overall the points suggest a date of between 750 and 1050 BP, although the radiocarbon dates provide an older result of approximately 1250 years BP. This discrepancy between the expected date based on point morphology and the radiocarbon dates does suggest that a somewhat atypical pattern may be represented at this site, and I suggest that further studies into explaining this difference should be undertaken.

A spatial analysis of the lithic material types and of several morphological attributes was also undertaken, with the goal of suggesting that more than one kill event may have taken place at this location. Material type information demonstrated no spatial patterning, but two projectile point attributes (basal edge shape and cross section) do

suggest that there may be some variation in spatial distribution of points between the north and the south portions of the site. This conclusion is tentative, but may provide some evidence that the site was used at least twice.

The faunal analysis from EgPn-440 was described in detail. The locations of cut marks and spiral fractures as they relate to butchering were discussed. Butchering marks are relatively sparse for this assemblage, but it is clear from the existence of spiral fractures and the fragmentation of the long bones, particularly the femora, that butchering took place. In addition, the relative abundance of specific elements clearly indicates that some bones, such as the long bones, were preferentially removed from the site for further processing. Utility of elements was discussed not only in terms of general utility, but also specifically for meat, marrow, bone grease, and total fats. Results suggested that processing for marrow occurred infrequently at the site. The acquisition of meat seems to have been the priority for the groups utilizing the site, but utility of fats (Emerson's (1990) total fats) also appear to have been a major influence on butchering patterns. The clearest correlation of the EgPn-440 assemblage with Emerson's (1990) utility indices came from the total fats index, and this suggests that intramuscular fats were being selected for at EgPn-440 over other types of fats such as marrow and bone grease. This may be taken as support for the suggestion that this site represents a series of falls kills. Intramuscular fat is expected to be highest in late fall when the bulls have regained good conditioning after the rut in preparation for winter, and when males are not found with females or young. This type of analysis, based on more than just general utility, provides insight into the choices being made by past peoples based on seasonal needs as well as individual and group preferences. Future analyses at other sites should include the use of a variety of indices, not just general utility ones, in order to explain selection of elements.

An aging and sexing analysis of the bison remains was undertaken and a somewhat unusual pattern emerged. The aging analysis of the assemblage was difficult due to the small number of socketed mandibular teeth. TEWS data produced results

indicating both late spring and late fall kills. Metaconid height produced data that indicated more animals being killed in the spring, but also a large number being killed at other times of the year. This data is tentative due to the small sample, but it does suggest that more than one kill event occurred at this location in different seasons. The methodology undertaken here would likely provide more definitive results for sites with larger samples than that provided by EgPn-440.

The sexing data produced consistent results for several elements. Carpals and tarsals were measured and plotted according to Morlan (1991). These elements overwhelmingly produced male results, but cow/calf results also occurred in small numbers, ranging from zero for the lunates up to five for the astragalus and calcaneus. The bimodality exhibited by all but one of the elements suggests that Morlan's method of sexing carpals and tarsals has merit, particularly in light of the similar results generated from the long bone sexing analysis. I suggest that this method of sexing elements should be included in other analyses, particularly when large samples can be included. There is need, however, for investigations of modern known sex examples in order to confirm the success of this sexing method.

In a second method of sexing the assemblage, long bones were measured and used in discriminant functions according to Walde (n.d.). Like the carpal/tarsal analysis, these elements also produced a very clear emphasis on males. Although some specimens produced mixed results, most generated the same result for a number of discriminant functions. I suggest therefore that Walde's method of sexing elements is useful, particularly for elements that are recovered in relatively high numbers. For example, the femora provided little information since only two were intact enough to take measurements. I suggest that this method of sexing will be useful for other researchers in sexing bison remains.

The lack of female remains at the site is somewhat unusual. Other bison kill sites for which sexing data has been published have generally resulted in either a split between male and female individuals (for example, the Harder Site (Morlan 1994)), or a majority of females (for example, the Casper site (Frison 1974) and Head-Smashed-In (Brink et al. 1986)). There are sites in which the males outnumber the females recovered (for example, the Happy Valley Site (Shortt 1993)). However, the overwhelming proportion of males at EgPn-440 is uncommon. I have suggested that this site thus represents two or more late fall kills in which all-male groups were slaughtered in the same location. Possible reasons for the presence of almost exclusively male herds at this site may lie in the selective hunting of male groups. Alternatively, it may be indicative of a specific pattern of movement of bison in which male groups were the prevalent herd type in this part of the Bow Valley in late fall. These late fall kills were interspersed with one or more late spring kills which account for the presence of a small number of females and/or calves, as well as accounting for the aging data.

The suggestion that the bone bed at this site may actually represent two or more different kill events separated by a relatively short period of time (on the scale of as much as several hundred years) was tentatively suggested based on the lithic evidence, as mentioned. A spatial examination of the distribution of faunal remains also indicated that separate kill events might be evident in the north and south parts of the site. There appears to be a separation between the western and eastern portions of the site (particularly the north), which I suggest represents the main kill area and a primary processing area respectively. However, there are differences in the spatial distributions of elements between the north and south of the site which may represent two different kill events occurring in these areas. The distribution of elements such as the proximal and distal humerus, for example, are significantly different between the north portion of the site and the south. Distal humeri were recovered almost exclusively from the north part of the site, despite the fact that scapulae were found throughout the site. This suggests

that differential butchering occurred in the north block of the site as compared with the south. This may be related to the kill events occurring in different seasons when elements such as the humerus would be butchered differently due to the condition of the meat or the marrow. Other elements such as the distal radii, femora and patellae also exhibit significantly different patterns in the north part of the site as compared with the south.

Spatial patterns are clearly evident from the distribution of the faunal materials. However, as noted, a great deal of the site remains unexcavated. Based on the concentration of bone at the east of the excavation area and the locations of post holes, it appears that a large portion of the pound itself remains unexcavated. Further excavation of this site would undoubtedly give a clearer impression of what types of activities were occurring at this site. Preservation at the site is excellent, and increased knowledge of the spatial distribution of materials through the remainder of the site would greatly increase our knowledge of bison pounds on the plains. I suggest that, should further development be proposed in this area in the future, the remaining part of the site be investigated.

There are a number of other bison kill sites and campsites along the Paskapoo slopes of Calgary. The Happy Valley kill site has been mentioned throughout the thesis, and other sites such as EgPn-230 have also been mentioned in comparison with EgPn-440. Human occupation of the Bow Valley is evident from almost the time of the retreat of the glaciers. It is clear that the Bow Valley in this area provided an excellent location for both camp and kill sites. The proximity of the Bow River and the diversity of flora and fauna it provided are likely major factors affecting the amount of use this area received in prehistoric times.

Reeves (1998:iii) links the groups using the camp and kill sites along the Paskapoo slopes to the kill and processing sites along the Porcupine Hills further south in Alberta. The kill sites on the Paskapoo slopes, which Reeves counts at a minimum of 39

on the east side of Canada Olympic Park alone (see Figure 2.1), are less intensively used than sites in the Porcupine Hills such as the Old Women's Buffalo Jump, but are more numerous and spatially dispersed. Sites such as EgPn-440 are thus not just locally significant, but are significant at a provincial or greater level. The information gained from individual sites such as EgPn-440 can therefore be applied to a larger knowledge base of a significant aspect of prehistoric peoples of the northern plains: the kill and use of bison. It is my hope that some of the techniques used in this analysis, and the results generated, may be useful to future researchers in their examinations of bison kill sites in the northern plains.

REFERENCES CITED

- Adams, G.F.
 1977 *The Estuary Bison Pound Site in Southwestern Saskatchewan*. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper No. 68, Ottawa.
- Albanese, J.P.
 1978 Paleotopography and Bison Traps. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* Memoir 14:58-62.
- Andrefsky Jr., W.
 1994 Raw-Material Availability and the Organization of Technology. *American Antiquity* 59(1):21-34.
- Archibald, J.H., G.D. Klappstein and I.G.W. Corns
 1996 *Field Guide to Ecosites of Southwestern Alberta*. Her Majesty the Queen of Right of Canada, UBC Press, Vancouver.
- Arthur, G.W.
 1978 A Re-Analysis of the Early Historic Plains Indian Bison Drives. In *Bison Procurement and Utilization: A Symposium*, edited by L.B. Davis and M. Wilson. *Plains Anthropologist* Memoir 14:236-242.
- Balkwill, D. McCuaig and S.L. Cumbaa
 1992 *A Guide to the Identification of Postcranial Bone of Bos taurus and Bison bison*. Canadian Museum of Nature Syllogeus No. 71, Ottawa.
- Banfield, A.W.F
 1974 *The Mammals of Canada*. University of Toronto Press, National Museums of Canada, Toronto.
- Bedord, J.N.
 1978 A Technique for Sex Determination of Mature Bison Metapodials. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* Memoir 14:40-43.

- Behrensmeyer, A.K.
 1978 Taphonomic and ecologic information from bone weathering. *Paleobiology* 4(2):150-162.
- Berger, J. and C. Cunningham
 1994 *Bison: Mating and Conservation in Small Populations*. Methods and Cases in Conservation Science Series, edited by Mary C. Pearl, Columbia University Press, New York.
- Binford, L.R.
 1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.
 1981 *Bones: Ancient Men and Modern Myths*. Academic Press, New York.
 1984 *Faunal Remains from Klasies River Mouth*. Academic Press, Orlando.
- Borrero, L.
 1990 Fuego-Patagonian bone assemblages and the problem of communal guanaco hunting. In *Hunters of the Recent Past*, edited by L.B. Davis and B.O.K. Reeves. Unwin Hyman, London, pp.373-399.
- Brain, C.K.
 1967 *Hottentot Food Remains and their Bearing on the Interpretation of Fossil Bone Assemblages*. Scientific Papers of the Namib Desert Research Station No. 32, Transvaal Museum, Pretoria.
- Brink, J.
 1997 Fat Content in Leg Bones of *Bison bison*, and Applications to Archaeology. *Journal of Archaeological Science* 24:259-274.
- Brink, J. and B. Dawe
 1989 *The 1985 and 1986 Field Season at Head-Smashed-In Buffalo Jump, Alberta*. Manuscript Series No. 16, Archaeological Survey of Alberta, Edmonton.
- Brink, J., M. Wright, B. Dawe and D. Glaum
 1986 *Final Report of the 1984 Season at Head-Smashed-In Buffalo Jump, Alberta*. Manuscript Series No. 9, Archaeological Survey of Alberta, Edmonton.

- Brown, C.L. and C.E. Gustafson
 1979 A Key to Postcranial Skeletal Remains of Cattle/Bison, Elk, and Horse. *Reports of Investigations*, No. 57. Laboratory of Anthropology, Washington State University, Pullman.
- Brumley, J.H.
 1976 *Ramillies: A Late Prehistoric Bison Kill and Campsite Located in Southeastern Alberta, Canada*. National Museum of Man Mercury Series. Archaeological Survey of Canada Paper No. 55. National Museums of Canada, Ottawa.
- 1978 McKean Complex Subsistence and Hunting Strategies in the Southern Alberta Plains. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* 14:175-193.
- 1990 *A Procedural Approach for the Description of Bison Mandibles and Dentition*. Manuscript in possession of the author.
- 1991 *Bone Unit Analysis of Ungulate Faunal Remains*. On file with the Archaeological Survey of Alberta.
- Chisholm, B., J. Driver, S. Dube, and H.P. Schwarcz
 1986 Assessment of Prehistoric Bison Foraging and Movement Patterns Via Stable-Carbon Isotopic Analysis. *Plains Anthropologist* 13:193-205.
- Clarix Corporation
 1993 File Maker Pro 2.0, CDv2
- Coupland, R.T. and J.S. Rowe
 1969 Natural Vegetation of Saskatchewan. In *Atlas of Saskatchewan*, edited by Richards and Fung, pp.73-75.
- Driver, J.C
 1976 *Dogs from Archaeological Sites in Alberta*. Unpublished MA by-pass paper. Paper on File. Archaeological Survey of Alberta, Edmonton.
- 1983 Bison Death Assemblages and Communal Hunting. In *Carnivores, Human Scavengers & Predators: A Question of Bone Technology*, edited by G.M. Lemoine and A.S. MacEachern, pp. 141-155. The Archaeological Association of the University of Calgary.

- Duffield, L.F.
 1973 Aging and Sexing the Post-Cranial Skeleton of Bison. *Plains Anthropologist* 18(60):132-139.
- Dyck, I.
 1983 The Prehistory of Southern Saskatchewan. In *Tracking Ancient Hunters: Prehistoric Archaeology in Saskatchewan*, edited by Henry T. Epp and Ian Dyck, pp.63-126. Saskatchewan Archaeological Society, Saskatoon.
- Emerson, A.M.
 1990 *Archaeological Implications of Variability in the Economic Anatomy of Bison bison*. Unpublished PhD Dissertation, Department of Anthropology, Washington State University.
- Forbis, R.G.
 1960 *The Old Women's Buffalo Jump, Alberta*. National Museum of Canada, Bulletin No. 180, Contributions of Anthropology, Part I.
- Frison, G.C.
 1970a The Glenrock Buffalo Jump, 48CO304: Late Prehistoric Period Buffalo Procurement and Butchering on the Northwest Plains. *Plains Anthropologist* Memoir 7.
 1970b The Kobold Site, 24BH406: A Post-Altithermal Record of Buffalo-Jumping for the Northwestern Plains. *Plains Anthropologist* 15(47):1-35.
 1971 The Buffalo Pound in Northwestern Plains Prehistory: Site 48 CA 302, Wyoming. *American Antiquity* 36(1):77-91.
 1974 *The Casper Site: A Hell Gap Bison Kill on the High Plains*. Academic Press, New York.
 1991 *Prehistoric Hunters of the High Plains*, Second Edition. Academic Press, Inc. San Diego.
- Frison, G.C. and C.A. Reher
 1970 Age Determination of Buffalo by Teeth Eruption and Wear. *Plains Anthropologist* Memoir 7.
- Fuller, W. A.
 1959 The Horns and Teeth as Indicators of Age in Bison. *Journal of Wildlife Management* 23(3):342-344.

- Gilbert, B.M.
1990 *Mammalian Osteology*. Missouri Archaeological Society, Columbia.
- Godfrey, W.E.
1966 *The Birds of Canada*. Supply and Services Canada, National Museums of Canada, Ottawa.
- Grant, A.
1978 Variation in Dental Attrition in Mammals and its Relevance to Age Estimations. In *Research Problems in Zooarchaeology*, edited by D.R. Brothwell, K.D. Thomas, and Juliet Clutton-Brock. Occasional Publication No. 3, Institute of Archaeology, London.
- Grayson, D.K.
1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Academic Press Inc., Orlando.
- Hanson, J.R.
1984 Bison Ecology in the Northern Plains and a Reconstruction of Bison Patterns for the North Dakota Region. *Plains Anthropologist* 29(104):93-113.
- Haynes, G.
1983 Frequencies of Spiral Fractures and Green-Bone Fractures on Ungulate Limb Bones in Modern Surface Assemblages. *American Antiquity* 48(1):102-114.
1984 Tooth Wear Rate in Northern Bison. *Journal of Mammology* 65(3):487-491.
- Hesse, B. and P. Wapnish
1985 *Animal Bone Archaeology: From Objectives to Analysis*. Manuals on Archaeology, No. 5. Taraxacum Inc., Washington.
- Hillson, S.
1996 *Mammal Bones and Teeth: An Introductory Guide to Methods of Identification*. Institute of Archaeology, University College, London.
- Hjermstad, B.E.
1996 *The Fitzgerald Site: A Besant Pound and Processing Area on the Northern Plains*. Unpublished MA Thesis, Department of Anthropology and Archaeology, University of Saskatchewan.

- Hodder, I. and C. Orton
 1976 *Spatial Analysis in Archaeology*. Cambridge University Press, Cambridge.
- Johnson, I.
 1995 *Mapping Archaeological Data: A Structured Introduction to MapInfo*. Sydney University Archaeological Methods Series 3, University of Sydney.
- Kehoe, T.F.
 1966 The Small Side-Notched Point System of the Northern Plains. *American Antiquity* 31:827-841.
 1973 *The Gull Lake Site: A Prehistoric Bison Drive Site in Southwestern Saskatchewan*. Milwaukee Public Museum.
- Klein, R.G. and K. Cruz-Urbe
 1984 *The Analysis of Animal Bones from Archaeological Sites*. The University of Chicago Press, Chicago.
- Kooyman, B.P.
 1981 *Metis Faunal Remains and Variables in Archaeological Butchering Pattern Analysis*. Unpublished Masters Thesis, Department of Archaeology, University of Calgary, Calgary.
 1984 Moa Utilization at Owens Ferry, Otago, New Zealand. *New Zealand Journal of Archaeology* 6:47-57.
 1985 *Moa and Moa Hunting: An Archaeological Analysis of Big Game Hunting in New Zealand*. Unpublished PhD dissertation, Department of Anthropology, University of Otago, Dunedin.
- in press Cultural and natural taphonomy at Head-Smashed-In. In *Papers in Zooarchaeology in Honor of Dale Guthrie*, edited by S. Craig Gerlach and D.R. Yesner. British Archaeological Reports International Series
- n.d. Manuscript in possession of the author.

- Kreutzer, L.A.
 1992 Bison and Deer Mineral Densities: Comparisons and Implications for the Interpretation of Archaeological Faunas. *Journal of Archaeological Science* 19:271-294.
- Kroll, E.M. and T.D. Price
 1991 Introduction. In *The Interpretation of Archaeological Spatial Patterning*, edited by Ellen M. Kroll and T. Douglas Price. Plenum Press, New York.
- Krozser, K.
 1991 Canid Remains at Kill Sites: A Case Study from the Oldman River Dam Project. *Archaeology in Alberta 1988 and 1989*. Occasional Paper No. 33, Archaeological Survey of Alberta, Edmonton.
- Lyman, R.L.
 1978 Prehistoric Butchering Techniques in the Lower Granite Reservoir, Southeastern Washington. *Tebiwa*, Miscellaneous Papers of the Idaho State University Museum of Natural History Number 13. Idaho State University, Pocatello.
 1992 Anatomical Considerations of Utility Curves in Zooarchaeology. *Journal of Archaeological Science* 19:7-22.
 1994a Quantitative Units and Terminology in Zooarchaeology. *American Antiquity* 59(1):36-71.
 1994b *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.
- Malainey, M.E. and B.L. Sherriff
 1996 Adjusting Our Perceptions: Historical and Archaeological Evidence of Winter on the Plains of Western Canada. *Plains Anthropologist* 41(158):333-357.
- Mandelbaum, D.G.
 1979 *The Plains Cree: An Ethnographic, Historical, and Comparative Study*. Canadian Plains Research Centre, Regina.
- MapInfo Corporation
 1996 MapInfo Professional Version 4.0.2

- Metcalf, D. and K.T. Jones
1988 A Reconsideration of Animal Body-Part Utility Indices. *American Antiquity* 53(3):486-504.
- Meyer, D. and H.T. Epp
1990 North-South Interaction in the Late Prehistory of Central Saskatchewan. *Plains Anthropologist* 35(132):321-342.
- Microsoft Corporation
1996 Excel 97
- Middleton, H.K.
1998 *The Utility of Geographic Information Systems for the Intrasite Spatial Analysis of Complex Archaeological Sites*. Unpublished Masters Thesis, Department of Archaeology, University of Calgary.
- Moodie, D.W. and A.J. Ray
1976 Buffalo Migrations in the Canadian Plains. *Plains Anthropologist* 21(71):45-52.
- Morgan, R.G.
1980 Bison Movement Patterns on the Canadian Plains: An Ecological Analysis. *Plains Anthropologist* 25(88):143-160.
- Morlan, R.E.
1991 Bison Carpal and Tarsal Measurements: Bulls Versus Cows and Calves. *Plains Anthropologist* 36(136):215-227.
1994 Oxbow Bison Procurement As Seen from the Harder Site, Saskatchewan. *Journal of Archaeological Science* 21:757-777.
- Mulloy, W.
1958 A Preliminary Historical Outline for the Northwestern Plains. *University of Wyoming Publications* 22(1), Laramie.
- North, M.E.A.
1976 *A Plant Geography of Alberta*. University of Alberta Studies in Geography, Monograph 2. Edmonton.
- O'Connell, J.F., K. Hawkes and N.B. Jones
1990 Reanalysis of large mammal body part transport among the Hadza. *Journal of Archaeological Science* 17:301-316.

- Olsen, S.J.
 1964 *Mammal Remains from Archaeological Sites. Part 1 – Southeastern and Southwestern United States.* Peabody Museum of Archaeology and Ethnology, Cambridge, Massachusetts.
- Peck, T.R.
 1996 *Late Side-Notched Projectile Points on the Northwestern Plains.* Unpublished Masters Thesis, Department of Anthropology, University of Alberta.
- Peck, T.R. and J.W. Ives
 n.d. Late Side-notched Projectile Points on the Northern Plains. *Plains Anthropologist* (in press).
- Peck, T.R. and L. Sinkey
 n.d. *An Unprecedented Projectile Point Assemblage Associated with the Col d'Arse Cave Burial (EaPk-1a).* Unpublished manuscript in possession of the author.
- Peterson Jr, R.R. and S.S. Hughes
 1980 Continuing Research in Bison Morphology and Herd Composition Using Chronological Variation in Metapodials. In *The Vore Site.* Edited by C.A. Reher and G.C. Frison. *Plains Anthropologist* Memoir 16.
- Quigg, J.M.
 1978 Winter Bison Procurement in Southwestern Alberta. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* Memoir 14:53-57.
- Reeves, B.O.K.
 1969 The Southern Alberta Paleo-Cultural – Paleo-Environmental Sequence. In *Post-Pleistocene Man and His Environment on the Northern Plains.* Edited by R.G. Forbis, L.B. Davis, O.A. Christensen, and G. Fedirchuk, pp. 6-46. The University of Calgary Archaeological Association, The Students' Press, Calgary.
- 1978 Head-Smashed-In: 5500 Years of Bison Jumping in the Alberta Plains. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* Memoir 14:151-174.

- 1980 *DsPl-10: Awinger Base Campsite in Waterton Lakes National Park*. Report on file, Parks Canada, Waterton Park.
- 1983 *Culture Change in the Northern Plains: 1000BC – AD 1000*. Occasional Paper No. 20, Archaeological Survey of Alberta, Edmonton.
- 1998 *Historical Resources Inventory and Assessment, East Paskapoo Slopes (Permit 98-038)*. Consultants Report, Lifeways of Canada, prepared for The City of Calgary. Copy on file, Archaeological Survey of Alberta, Edmonton.
- Reher, C.A.
 1970 *Population Dynamics of the Glenrock Bison bison Population*. *Plains Anthropologist* Memoir 7.
- Reher, C.A. and G.C. Frison
 1980 *The Vore Site, 48CK302, A Stratified Buffalo Jump in the Wyoming Black Hills*. *Plains Anthropologist* Memoir 16.
- Roberts, L.J.
 1982 *The Formulation and Application of a Technique, Based on Phalanges, for Discriminating the Sex of Plains Bison*. Unpublished Masters Thesis, University of Manitoba, Winnipeg.
- Roe, F.G.
 1972 *The North American Buffalo: A critical study of the species in its wild state*. University of Toronto Press, Toronto.
- Schaeffer, C.E.
 1978 *The Bison Drive of the Blackfeet Indians*. In *Bison Procurement and Utilization: A Symposium*, edited by Leslie B. Davis and Michael Wilson. *Plains Anthropologist* Memoir 14:40-43.
- Schmid, E.
 1972 *Animal Bones*. Elsevier Publishing Company, Amsterdam.
- Shortt, M.
 1993 *The Happy Valley Bison Kill*. Unpublished MA thesis, Department of Archaeology, University of Calgary.

- Speth, J.D.
 1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters*. The University of Chicago Press, Chicago.
- Speth, J.D. and K.A. Spielmann
 1983 Energy Source, Protein Metabolism, and Hunter-Gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2:1-31.
- Schwartz, M.
 1997 *A History of Dogs in the Early Americas*. Yale University Press, New Haven.
- Todd, L.C.
 1986 Determination of Sex of Bison Upper Forelimb Bones: The Humerus and Radius. *The Wyoming Archaeologist* 29(1-2):109-123.
 1987 Taphonomy of the Horner II Bone Bed. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by George C. Frison and Lawrence C. Todd, pp. 107-198. Academic Press, New York.
- Todd, L.C. and J.L. Hofman
 1987 Bison Mandibles from the Horner and Finley Sites. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by George C. Frison and Lawrence C. Todd, pp. 493-539. Academic Press, New York.
- Verbicky-Todd, E.
 1984 *Communal Buffalo Hunting Among the Plains Indians*. Occasional Paper No. 24, Archaeological Survey of Alberta, Edmonton.
- Vickers, J.R.
 1986 *Alberta Plains Prehistory: A Review*. Occasional Paper No. 27, Archaeological Survey of Alberta.
 1991 Seasonal Round Problems on the Alberta Plains. *Canadian Journal of Archaeology* 15:55-71.
- Vivian B.C., K. Bosch and B.O.K. Reeves
 1998 *Historical Resource Conservation Excavations EgPn-230, Final Report (Permit 97-83)*. Consultants Report, Lifeways of Canada, prepared for The City of Calgary. Copy on file, Archaeological Survey of Alberta, Edmonton.

- Walde, D.
- 1985 *On Assigning Gender to Post-Cranial Bison Bones*. Unpublished Masters Thesis. Department of Anthropology, University of Victoria, Victoria.
 - 1996 *An Overview Study of Heritage Resource Potentials in the Development Area of the Cochrane-Calgary Wastewater Pipeline Project*. Unpublished Manuscript on file with author.
 - 1997a *A Heritage Resource Impact Assessment Study of the Cochrane South Wastewater Pipeline Routes Interim Report on Permit 96-086*. Unpublished Manuscript on file with author.
 - 1997b *A Heritage Resource Impact Assessment Study of the Cochrane South Wastewater Pipeline Routes Preliminary Report on Permit 97-038*. Unpublished Manuscript on file with author.
 - 1997c *A Heritage Resource Impact Assessment Study of the Cochrane South Wastewater Pipeline Route: Preliminary Report on Stage 2 Mitigative Excavations Conducted under Permit 97-038*. Unpublished Manuscript on file with author.
 - n.d *Distinguishing Sex of Bison Using Measurements of Postcranial Elements*. Unpublished Manuscript on file with author.
- Walde, D., D. Meyer and W. Unfreed
- 1995 The Late Period on the Canadian and Adjacent Plains. *Revista de Arqueologia Americana* 9:7-66.
- Walker, D.
- 1975 Non-Bison Remains from the Vore Bison Jump, Crook County, Wyoming. *Plains Anthropologist* 20(69):217-223.
- Watson, J.P.N.
- 1978 The Interpretation of Epiphyseal Fusion Data. In *Research Problems in Zooarchaeology*, edited by D.R. Brothwell, K.D. Thomas, and Juliet Clutton-Brock. Occasional Publication No. 3, Institute of Archaeology, London.
- Wegrzyn, M. and S. Serwatka
- 1984 Teeth Eruption in European Bison. *Acta Therologica* 29(9):111-121.

White, T.E.

- 1952 Observations on the Butchering Technique of Some Aboriginal Peoples: I. *American Antiquity* 17:337-338.
- 1953 A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal Peoples. *American Antiquity* 18:396-398.
- 1955 Observations on the Butchering Technics of Some Aboriginal Peoples, Numbers 7, 8, and 9. *American Antiquity* 21:170-178.

Wilson, M.

- 1969 Problems in the Speciation of American Fossil Bison. In *Post-Pleistocene Man and His Environment on the Northern Plains*. Edited by R.G. Forbis, L.B. Davis, O.A. Christensen, and G. Fedirchuk, pp. 178-200. The University of Calgary Archaeological Association, The Students' Press, Calgary.
- 1983 *Once Upon a River: Archaeology and Geology of the Bow River Valley at Calgary, Alberta, Canada*. National Museum of Man Mercury Series. Archaeological Survey of Canada Paper No. 114. National Museums of Canada, Ottawa.
- 1988 Bison Dentitions from the Henry Smith Site, Montana: Evidence for Seasonality and Paleoenvironments at an Avonlea Bison Kill. In *Avonlea Yesterday and Today: Archaeology and Prehistory*, edited by Leslie B. Davis, Saskatchewan Archaeological Society, Saskatoon.

Wormington, H.M. and R.G. Forbis

- 1965 *An Introduction to the Archaeology of Alberta, Canada*. Denver Museum of Natural History, Denver.

PLATES

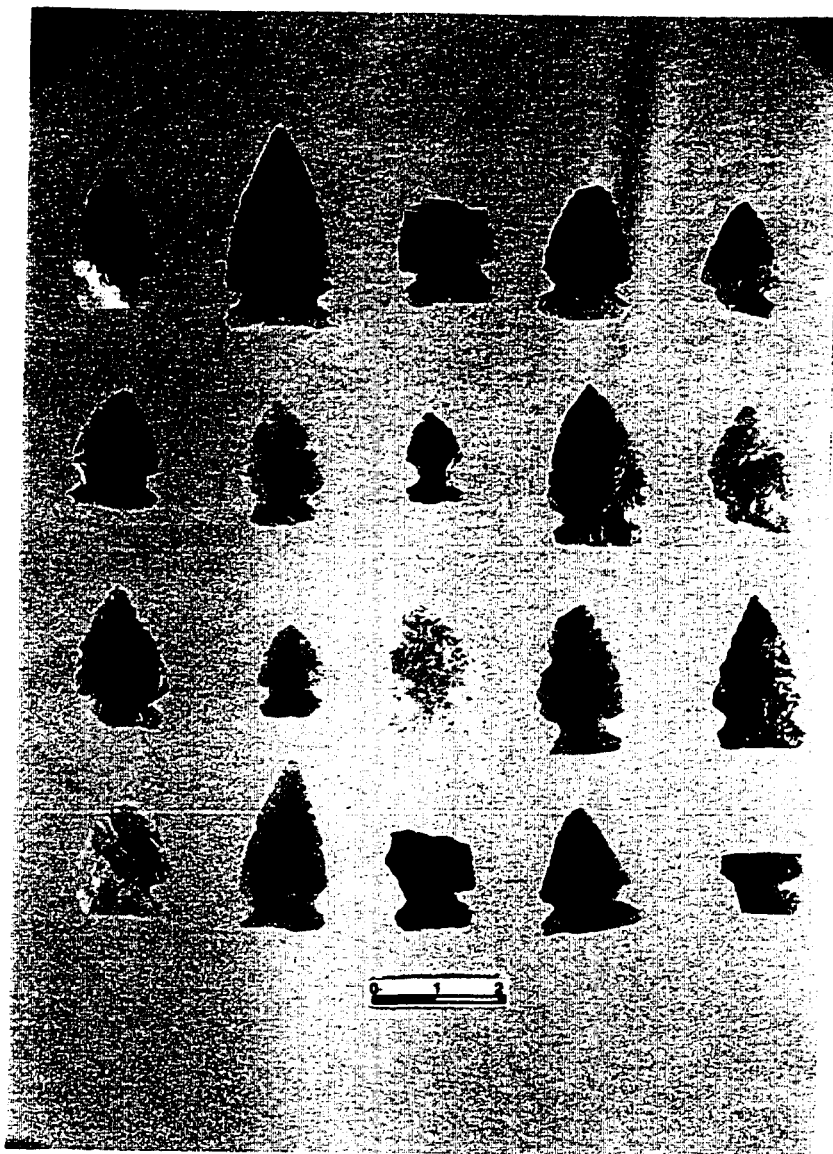


Plate 1. Projectile points from EgPn-440.

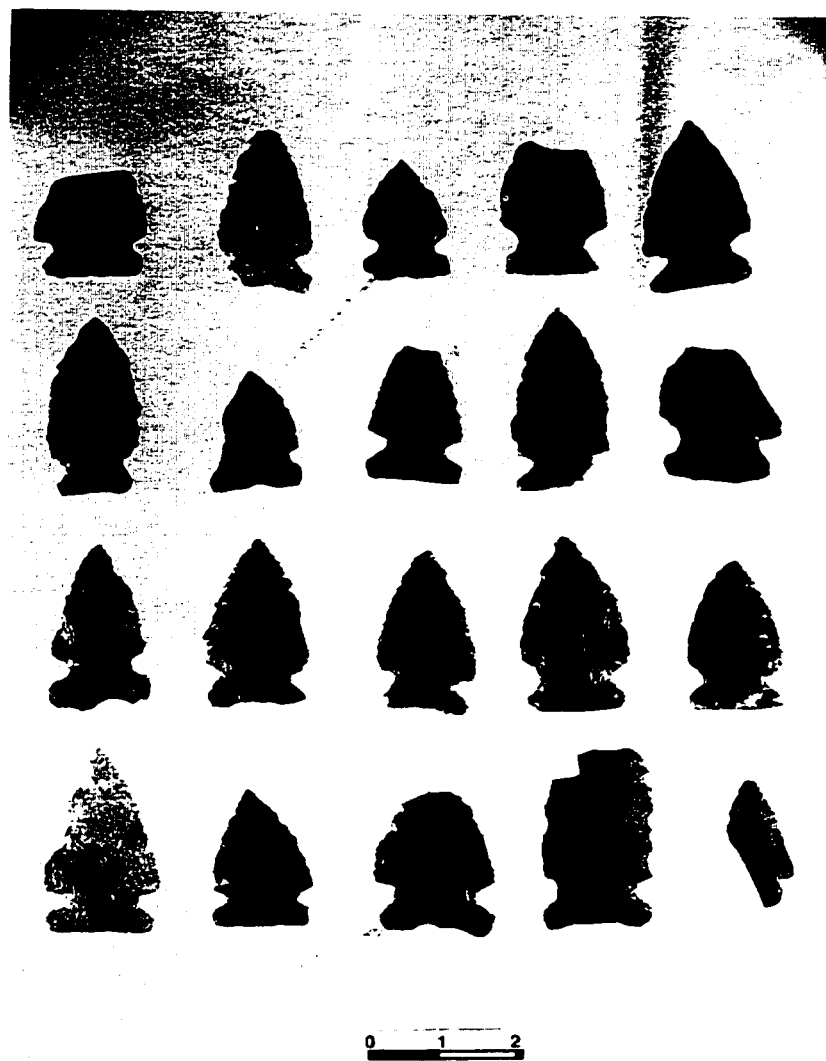


Plate 2. Projectile points from EgPn-440.

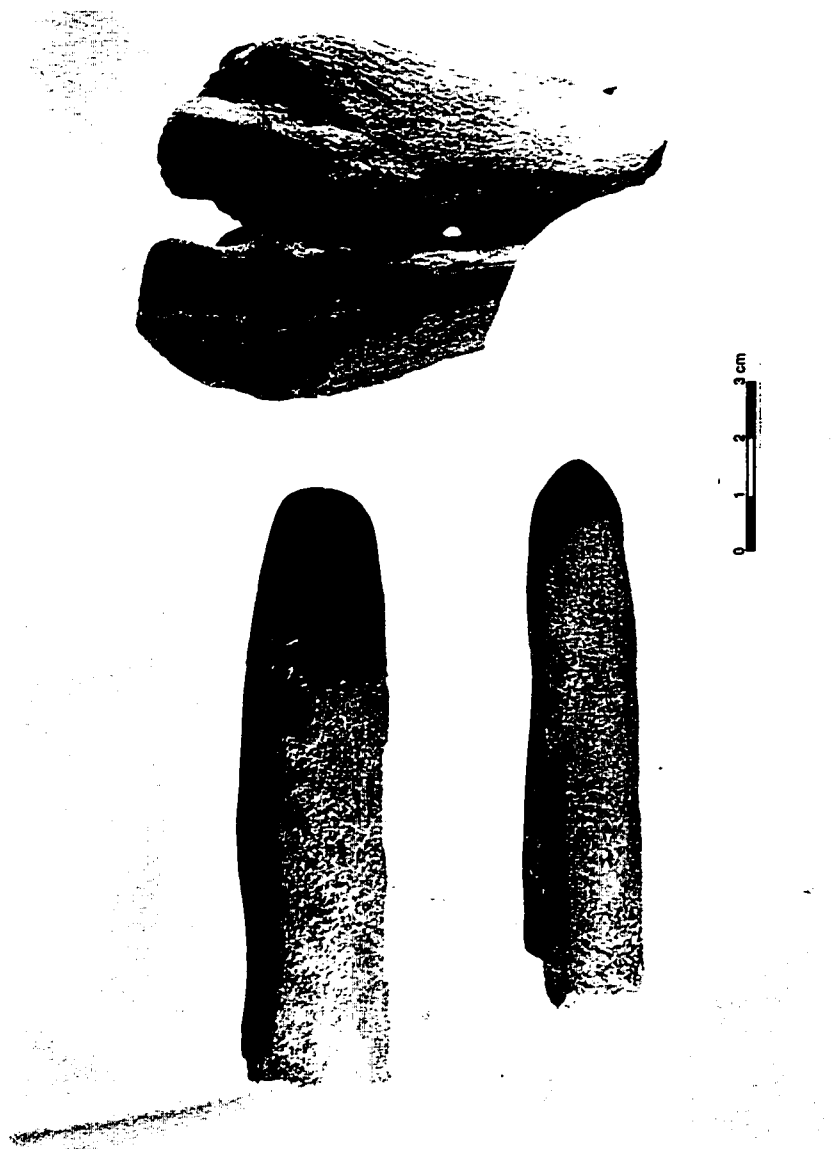


Plate 3. Bone tools from EgPn-440. Top: modified distal metatarsal; bottom left: modified rib shaft fragment; bottom right: modified mandible (ventral border).