Breathing New Life into Old Records:
Analysis of the Muhlbach and Stelzer sites on the Northern Plains

by

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Abstract

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In the early to mid-1960s, two important excavations of major Besant archaeological sites were carried out on the northern Plains. In Alberta, Ruth Gruhn uncovered the Muhlbach site beneath a farmer's yard, revealing a large bison kill site with a lithic assemblage dominated by Knife River Flint projectile points, a material that could only be found in North Dakota. Concurrently, Robert Neuman was completing his excavations of the Stelzer site in South Dakota, an enormous encampment with copious amounts of Knife River Flint, surrounded by contemporary burial mound complexes; he would ultimately use this material to define the Sonota Complex, a regional variant within the Besant phase. These two sites would form a foundation in the archaeological literature, and continue to shape the discussion surrounding the relationship between Besant, Sonota, and the Hopewellian Interaction Sphere.

Since the initial publications and preliminary reports for these sites, little attention has been dedicated to the original source material. Given the importance these two sites have in the Besant/Sonota discussion, it is imperative that we return to further explore these assemblages in order to illuminate broad-scale interactions occurring on the northern Plains. Advances in radiocarbon dating allow us to firmly fix the temporal duration of these sites, to help explore questions regarding length of occupation, and relations to other dated archaeological assemblages. Developments with spatial analytical methods and

technologies also provide further inferences about the Muhlbach and Stelzer occupations.

High frequency Knife River Flint sites on the northwestern Plains are rare, despite their prominence in the literature. Their very uniqueness warrants careful exploration to assess their significance with respect to a broader Hopewell Interaction Sphere. In these terms, I will explore Muhlbach as reflecting a prestige-based acquisition pattern involving both bison products and Knife River Flint, and suggest that Muhlbach may have been linked to the Sonota burial mounds as part of a broader regional interaction focused upon ceremonial life, and mortuary ritual in particular.

Dedication

To B.
Love R.

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Chapter 1 – Introduction

During the mid-1960s, Ruth Gruhn arrived at a small farmyard near Stettler, Alberta, to begin the excavation of a large Besant bison kill site, which would become known as the Muhlbach site. While other bison kill sites had been discovered and excavated on the northern Plains, the Muhlbach site contained a unique lithic assemblage dominated by an exotic caramel-coloured stone called Knife River Flint. This raw material could only be found at quarries in North Dakota and Muhlbach was located over 1 000 km away from the source area. The presence of this rare material was exceptional for Alberta, and intrigued by this phenomenon, Gruhn sought comparisons to explain it.

When Gruhn was at Muhlbach, Robert Neuman and Oscar Mallory were engaged in a large scale operation excavating several Late Precontact sites along the Missouri River valley in North and South Dakota. Their excavations involved an enormous encampment surrounded by contemporary burial mound complexes, complete with numerous projectile points, pottery, scrapers, bone tools, and exotic trade goods like marine shell artefacts and copper. Known as the Stelzer site, this enormous campsite had several characteristics in common with the Muhlbach site: similar projectile points, vertical bone features known as "uprights," and a preference for Knife River Flint in the lithic assemblage.

When Gruhn and Neuman excavated their respective sites, their work was on the boundary of northern Plains archaeological research, as little was known about the A.D. first millennium time period to which Muhlbach and Stelzer dated. These prominent archaeologists both noted the similarities in the shape of their projectile points to the Besant typological form defined by Boyd Wettlaufer in 1955 at the Mortlach site in Saskatchewan. These broadly side-notched projectile points could be found in abundance across the northern Plains and into the parkland region. Unlike most Besant sites, the inhabitants of the Muhlbach and Stelzer sites had an affinity for Knife River Flint, so much so that this toolstone dominated the assemblages, though its sources lay at great distances relative to locally available raw materials. This raw material preference would prove to be a persistent theme in many subsequent Besant and Sonota Phase discussions. As more Besant Phase sites were investigated, a few other episodic occurrences of single occupation bison kill sites with unusual amounts of Knife River Flint came to light, but with few concerted efforts to explain what they reflected, other than rather conventional appeals to migrations emanating from the Middle Missouri region.

In the end, Gruhn published a preliminary report on the Muhlbach site in 1969 and planned to conduct further research into the phenomenon that she observed. Neuman ultimately published "The Sonota Complex and Associated Sites on the northern Great Plains" in 1975, detailing the results of several years of work at Stelzer and related burial mound complexes. In his work, he defined the separate but related Sonota complex in the Dakotas that he felt existed alongside Besant. In the intervening forty years since Muhlbach and Stelzer were excavated, these sites have become central to the debate regarding the relationship between Besant on the northern Plains and the Sonota Complex.

Similar bison kill sites with large amounts of Knife River Flint were discovered, including the Richard's Kill site (Hlady 1967), the Richard's Village Site (Syms 1977), Fitzgerald (Hjermstad 1996), Melhagen (Ramsay 1991), and Fincastle (Bubel 2014; Foreman 2010; Varsakis 2006). Many researchers attempted to fit these datasets into a conceptual framework. Reeves (1983) and Syms (1977) engaged in heated debates over the assignment of Besant and Sonota labels to archaeological sites and regions, while others attempted to smooth over the differences and look at Phase as a whole (cf. Vickers 1994). The debate concerning the desirability of "splitting" or "lumping" continues in recent literature concerning Besant and Sonota (cf. Foreman 2010; Hamza 2013; Peck 2011; Varsakis 2006).

Since both the Muhlbach and Stelzer site were relatively well documented in the earlier literature and had large assemblages suitable for comparisons, they were often included in these debates. However, comparatively little is known about the sites. Research on the Muhlbach site never progressed beyond Gruhn's preliminary report, other than some selected uses of the archaeological assemblage (Foreman 2010; Hamza 2013; Shortt 1993; Varsakis 2006). Neuman's work continued to be widely cited after it was published, but the collections were widely scattered. Some parts of the collection were housed at the Smithsonian Institution in Washington D.C., while others parts reside with the South Dakota State Historical Society and the Nebraska State Historical Society. The dispersal of the collection and the distance from the research area effectively made the assemblage unavailable to researchers working on the northern Plains. Radiocarbon dating remained a relatively new technique at the time of these 1960s investigations, to the extent that a single date for a site or stratum was an important item of information. Gruhn (1969) reported a single radiocarbon date for Muhlbach, while the Stelzer site was not dated by Neuman (1975). No new data was published on the Stelzer site until Thomas Haberman and Marion Travis produced two radiocarbon dates arising from a site visit in 1988 and an impact assessment in 1986 (Sanders *et al.* 1988). The absence of new data and a thorough description of the original materials from both these sites has hampered our understanding of Besant and Sonota expressions.

Given the significance the Muhlbach site and the Stelzer sites hold in northern Plains archaeological literature and the limited amount of work conducted on the source material since the initial publications, it was important to further explore the material culture from these sites. I explore the nature of the Besant occupation at the Muhlbach site using the original field notes, site photographs, and maps of the bone bed. A thorough inventory of the faunal assemblage is used to explore the scale and conditions of the kill through analyses of herd structure, season of occupation, butchery practices, and utility indices comparisons. Spatial analytical techniques are applied to the distribution of artefacts to highlight site formation processes, and are used to explore the relationship between the Muhlbach site and the surrounding landscape. From all of these threads of information, I probe the significance that the Muhlbach site holds in the archaeological record and how it relates to Sonota Complex in the Dakotas. In this respect, I delve into the essence of what is occurring in the Middle Missouri region during the Besant Phase by reviewing the material collected by Neuman in the 1960s, as well as a multitude of surface collections from the Stelzer site in order to evaluate what Sonota is.

The objective is to create a comprehensive picture of the occupation at Muhlbach and illuminate how it relates to Stelzer, the Sonota Complex, and the Besant Phase as a whole. Too much of the literature has been focused on classifying and categorizing sites by projectile points and other typological categories without any consideration of what the material record can tell us about what appear to be unique cultural interactions occurring during this period. The presence of Knife River Flint at the Muhlbach site is a clear sign of long distance connections between groups in the region, and an exploration of these two important sites can further our understanding of the movement of high valued materials and intersocietal relationships on the northern Plains. More than this observation, both collections raise important ethical issues for archaeologists. We tend to place a premium on investigations of newly discovered sites. Yet, precontact archaeological sites are a finite resource, and, even carefully made and documented collections suffer significant curatorial attrition over time, despite our best efforts. Especially where sites are relatively rare in their characteristics, the archaeological community has a moral obligation to make the best possible use of existing collections and records in continuing investigations of important research questions (Barker 2003; Moyer 2006; Voss 2012). A half century will soon have elapsed since Gruhn and Neuman initiated their research: many new analytical measures and techniques can be brought to bear on existing collections, creating important new understandings of the Besant-Sonota phenomenon.

In the following chapters, I will undertake renewed analysis of both the Muhlbach and Stelzer site locations and collections. For Chapter 2, I provide a review of relevant literature focused on Besant and Sonota; an examination of what is Knife River Flint; current distributions of Besant and Sonota sites in the region, with descriptions of important contemporary sites on the northern Plains available in Appendix A. In Chapter 3, I explore the discovery and excavation of the Muhlbach site, with a focus on location, stratigraphy, and the significance of the new population of AMS dates from the site. I also review the features at the site, and the artefact assemblage collected in the 1960's, with descriptions and photographs.

In Chapter 4, I detail the results of the faunal analysis of the Muhlbach site, discussing the current state of the collection and my methods for cataloguing the faunal assemblage. Using this information, I investigate the herd structure present at the kill site by identifying male and female animals, explore the season of occupation for the site, and apply a series of utility indices to determine patterns of exploitation and butchery present at the site. Chapter 5 will combine the data in Chapters 3 and 4 through spatial analytical techniques applied to the distribution of faunal bone across the site. Using Quadrant Analysis, Kernel Density Analysis, and Band Collection Statistics, I will explore how different faunal elements are distributed across the site in relation to butchery patterns and food exploitation. In this chapter, I also use Viewshed Analysis and Least Cost Path analysis in conjunction with environmental data to explore how the bison were driven into the Muhlbach trap, and what implications this information has on locating any ancillary processing areas or camps.

Chapter 6 will explore the Sonota occupation at the Stelzer site, combining data from Neuman (1975), excavation records, site photographs, and original field maps of the site and surrounding area. Using a sample of faunal remains from the site, a large population of AMS dates is produced to fix the Stelzer site into the northern Plains chronology. I also illustrate and describe the material culture recovered from Smithsonian excavations, along with several large surface collections from the site with an objective of exploring what is Sonota. Chapter 7 contains descriptions of the many upright features found at Besant and Sonota sites, as well as possible interpretative models for determining functionality. Chapter 8 draws all of these threads together into interpretations about what high frequency Knife River Flint sites like Muhlbach represent in the archaeological record and what these imply for Besant and Sonota.

Chapter 2 – Besant and Sonota in the Northern Plains Archaeological Record

Muhlbach, Stelzer, and the other key sites dealt with in this research come from a specific time period to which the archaeological rubrics “Besant” and “Sonota” have been applied. The term “Besant” was initially applied by Boyd Wettlaufer in 1955 at the Mortlach site in the Besant River valley of south central Saskatchewan; Wettlaufer (1956) relied significantly upon projectile points in characterizing Besant, which he described as being short and broad with shallow side notches and occasionally a slight basal concavity. Since Wettlaufer’s publication, Besant sites have been identified widely over the northern Plains. They tend to be concentrated in the prairie and parkland regions of Manitoba, Saskatchewan, and Alberta, but also occur in the states of Montana, Wyoming, North Dakota, and South Dakota.

The Besant Phase has been regarded as transitional phase, preceded by the Middle Precontact Pelican Lake Phase and followed by the Late Precontact Avonlea Phase (Vickers 1994). Syms (1977) defined a time range for Besant extending from 1950-1150 years cal BP. Similarly, Reeves (1983) dated the Besant Phase to 2000 to 1000 BP, with the end of the phase varying in different regions of the northern Plains. Most researchers agree that Besant and Sonota, whatever they may represent, date from roughly 2000-1000 BP (e.g., Foreman 2010; Kornfeld, Frison, and Larson 2010; Novecosky 1999; Neuman 1975; Syms 1977; Varsakis 2006).

In this regard, there are earlier instances of Besant or Sonota-like points, findings that have led investigators to create separate phases and complexes to explain their existence. One of these is the Fincastle site in Alberta, a bison kill with large amounts of KRF that has produced a series of radiocarbon dates averaging ca. 2500 radiocarbon years BP (Foreman 2010). Fincastle would therefore fall even earlier than generally accepted dates for the Besant Phase, leading us to consider the issue of Besant and Sonota origins. Because of this earlier date, several scholars have placed the Fincastle site in the Outlook Complex (Foreman 2010; Peck 2011, Varsakis 2006).

This school of thought perceived Fincastle as the first wave of Middle Missouri invaders into the Northwest Plains region, carrying large amounts of Knife River Flint into the area (Peck 2011:247). Under this model, subsequent waves of Middle Missouri incursions into Alberta (as denoted by high proportions of Knife River Flint in lithic assemblages at sites such as Muhlbach) are distinguished as Sonota rather than Besant sites. Within Alberta, Peck (2011) placed the Besant phase from 2100-1500 BP and considered any "Besant" sites that dated from 1500-1350 BP to belong to the Sonota Subphase. In actuality, the material culture assemblages from these particular sites are virtually indistinguishable, the singular difference lying in their ages. Rather than simply dwelling on taxonomic categorization of these extraordinary sites, however, it is helpful to see them as reflecting a phenomenon that is both rare and episodic, and in need of a carefully considered explanation. For simplicity, I will refer to a Besant-Sonota continuum with a specific focus on the unusual economic and material culture aspects revealed at sites extending from Fincastle through to Muhlbach.

It was during the Besant Phase that several new technologies began to appear sporadically in the northern Plains region. One of the most noticeable changes is the appearance of ceramics for the first time. Pottery is present at Sonota sites in North and South Dakota, but is increasingly rare at Besant sites extending northwestward across the northern Plains (Reeves 1983). These uncommon instances are quite similar; vessels are typically elongated and conical in shape, with a cord-roughened exterior and limited lip decoration (Walde *et al.* 1995:18). Decorations are typically either a line of punctates or bosses around the edge of the rim; there are occasional dentate impressions. Sometimes the lips have impressions from cord wrapped objects or sharp edge tool impressions, but otherwise display a limited decoration motif. This pottery style is consistent with the Plains Woodland tradition, and does suggest an eastern origin of ceramics in the Besant complex (Walde *et al.* 1995).

The introduction of pottery on the northern Plains has been seen as a shift in food procurement and storage strategies away from the intensive bison hunting economy seen elsewhere in the Besant Phase (Novecosky 1999). Yet pottery is neither abundant nor common at northern Plains sites, particularly on the northwestern Plains. Recent phytolith and starch grain analysis into the subsequent northern Plains tradition of Avonlea pottery, which was much wider spread compared to Besant, has demonstrated extensive use of maize and beans across a very broad geographical area (Lints 2012). In the period following Besant, these major domesticates were found in almost every Avonlea site sampled in Saskatchewan and Manitoba. No pottery residues from Besant sites have been analyzed as of yet, but it will be interesting to see if these earlier vessels will show a similar pattern of plant use. The limited appearance and use of ceramics in the Besant Phase, and even within the Sonota Complex, may not herald the beginnings of significant food procurement and economic change in the region. Rather, the limited and episodic use of ceramics during the Besant Phase could simply reflect their novel status, or conceivably be indicative of a desire to obtain domesticates for ceremonial or prestige purposes rather than purely food or economic motives.

Another technological innovation proposed for the Besant phase is the more consistent appearance of bow and arrow technology. In the earliest sites in the Besant phase, the atlatl, demonstrated by wide-necked dart projectile points, dominates the material culture. As time progressed, smaller and narrower Besant projectile points began to appear simultaneously with the wider dart points. These miniaturized dart tips are known as Samantha points and are thought by some to reflect use of the bow and arrow (Varsakis 2006:24). Some Besant assemblages therefore have a distinctly bimodal distribution of inter-notch or neck width metrics for smaller and larger projectile points. It is not clear what the cultural implications of this change in weaponry are, and there has not been a systematic study of the adoption of the bow during the Besant Phase. These small Besant projectile points may indeed represent the introduction of the bow and arrow into the toolset. Dawe (1997) nevertheless demonstrated that these smaller projectile points (made from a single trimmed flake) could actually be indicative of toy atlatl projectile points for children learning how to hunt, rather than arrow tips. Whatever the smaller and larger Besant projectile points represent, by Avonlea times, the bow and arrow had replaced the atlatl as the main weapon of choice (Wood and Johnson 1973).

Frison (1978) singled out the Besant Phase as the apex of intensive, pedestrian-era communal bison hunting on the northern Plains. There is an abundance of well-documented bison jump and bison pound sites on the northwestern Plains, like Muhlbach (Gruhn 1969), Fincastle (Bubel 2014), Happy Valley Bison Kill (Shortt 1993), Fitzgerald (Hjermstad 1996), Melhagen (Ramsay 1991), Ruby (Frison 1971), Muddy Creek (Reher 1987), and Richards Kill (Hlady 1967). Nevertheless, Frison's (1978) sentiment that Besant represents the peak of bison hunting is not completely accurate. The practice of communal bison hunting did intensify on the northern Plains during the Besant Phase as compared to earlier Pelican Lake sites, but the use of communal hunting techniques continues afterwards in both the Avonlea and Old Women's Phases (Peck 2011). For example, the Besant occupation at Head-Smashed-In is actually very limited, and it is during the later occupations at the bison jump site that we see that most intense use of the site (Brink and Dawe 1989; Reeves 1990). While communal bison hunting methods do appear more frequently during the Besant Phase, the practice intensified yet more during later time periods (Brink and Dawe 1989; Brumley 1973; Ives 2003; Kehoe 1973).

Another characteristic commonly associated with the Besant Phase is an increase in the size of tipi rings. Besant stone circles, thought to mark the placement of tipis, showed a marked increase in diameter, indicating an increase in dwelling size (Brumley and Dau 1988; Vickers 1994). An example of this phenomenon can be observed at the Ross Glen site, where Besant tipi rings have an average interior diameter of 6.8 m (Quigg 1986), while rings from other time periods average 4.6 m in diameter (Brumley and Dau 1988). The exact significance of this change is not clear. There is a general agreement that the increased tipi ring size may indicate changes in socio-economic structuring of family units within Besant society (Quigg 1986; Vickers 1994); this trend has not been adequately explored, largely due to the difficultly of associating stone circles with a single time period.

Bone upright features are also linked with Besant and Sonota, although the significance of this association and their function is unclear. These features consist of vertically position bison bone, often into the occupation horizon; where bones are either placed into an existing pit or pushed into the ground. These features are present at a variety of Besant and Sonota sites; Gruhn (1969) and Neuman (1975) had corresponded about the uprights at Muhlbach and Stelzer. Uprights can also be found at later sites like Hokanson (Norris and Hamilton 2004) and Stott (Hamilton *et al.* 1981) in Manitoba. The purpose of these features will be explored in Chapter 7, with descriptions of upright features from a variety of sites on the northern Plains, and possible interpretative frameworks.

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The Sonota Complex/Phase/Subphase

In the Middle Missouri region, Neuman (1975) defined the Sonota complex based on a series of excavations along the Missouri River valley. His report focused upon the Stelzer campsite and a series of associated burial mound structures along the Missouri River in North and South Dakota (Boundary Mounds, Arpan Mound, Grover Hand, and Swift Bird). Neuman perceived Sonota as a complex separate from the Besant Phase, specific to the Middle Missouri region. Neuman (1975:81) noted that Sonota points from his study are decidedly typologically similar to Besant points elsewhere on the northern Plains, although at that time he thought that published descriptions of the Besant point typology were too vague for meaningful comparison. Syms (1977) further differentiated between the two traditions based on the greater length of Sonota projectile points, a distinct corner notching variation not seen in Besant and Samantha points, as well as a preference for Knife River Flint in the lithic assemblage. Other key characteristics of Sonota other than the long well-made side-notched and corner-notched projectile points are conical shaped ceramic vessels with limited decoration, extensive use of Knife River Flint, bone upright features, and small dome-shaped burial mounds containing a subfloor burial chamber with secondary interments (Neuman 1975; Syms 1977; Reeves 1983). Peck (2011) used other characteristics of the Sonota material culture to separate the two traditions, including the preference for endscrapers, utilized flakes, and large bifacial knives. It is unclear to the author how the traits proposed by Peck (2011) could be applied to archaeological assemblages as varied as those of the Besant Phase, given that endscrapers, utilized flakes, and bifaces occur widely in many archaeological assemblages on the northern Plains. Their presence or absence at sites can easily be attributed to site size and type, as well as the size of the sample collected from a site.

The Sonota burial mounds are among the most distinctive features of the complex. These mound sites (Boundary, Swift Bird, Grover Hand, and Arpan) share many unique characteristics that are unusual for a northern Plains setting, and speak to a broad influence stemming from the Eastern Woodlands. Each mound site contains two to five burial mounds, situated on the upper terrace of the Missouri river valley. They range from 16.76 m to 25.91 m in diameter and range from 0.43m to 1.74 m high. In the centre of each of these burials, Neuman (1975) uncovered a subfloor, rectangular burial pit containing several secondary burial locations with numerous individuals. The minimum number of interments in each burial mound ranged from seven to 48 individuals per mound, with most of the burials occurring in the subfloor chamber, and some individuals interred on the mound floor around the pit (Neuman 1975). The demographic profile represented by these burials indicates that it was primarily sub-adults who were interred at the sites with some exceptions; Swift Bird Mound 2 had 30 subadults and 11 adults (Neuman 1975:127), while Grover Hand Mound 2 contained more adults than sub-adults (17 to 8 respectively) (Neuman 1975:110). The largest proportion of individuals for most burial mounds lay in the under-two-years age category (Neuman 1975). The burial chambers were usually covered by a timber superstructure or covering of some type, which in some cases was burned prior to burial.

Aside from the burials, these mounds produced a wide variety of artefacts and offerings that varied significantly between each mound; these are summarized in Appendix A. Among the most significant offerings interred in the mounds were whole, articulated and partially articulated bison skeletons. These carcasses were positioned on the mound floors around the burial chamber, alongside large piles of bison skulls and mandibles (Neuman 1975). Boundary Mound 1 had at least 33 intact bison skulls placed upon the mound floor (Neuman 1975:66). Other artefacts include Besant-style projectile points, other KRF artefacts, atlatl weights, bone and marine shell beads, but the most significant are the artefacts suggestive of the Hopewell Interaction Sphere. Objects like marine shell pendants, atlatl weights carved from conch shells, shell "Thunderbird" effigies, and worked animal and human mandibles and palette bones all speak to the broader regional influences affecting Sonota, emanating from the Hopewell world in the Eastern Woodlands (Clark 1984; Caldwell 1964; DeBoer 2004; Neuman 1975; Reeves 1983; Syms 1977).

Sonota and Knife River Flint

A central element in these debates has been the presence of the tool stone material that is largely found in North Dakota, known as Knife River Flint (KRF). This cryptocrystalline silicified lignite (Gregg 1987) was popular throughout most of the Precontact period, even appearing in Clovis assemblages. By Cody Complex times (circa 8 000 BP), it was the dominant raw material for Alberta, Scottsbluff, and Eden projectile points, even at distances exceeding 1000 km from the North Dakota sources (e.g., Dawe 2013). Later time periods after Cody Complex utilize KRF less frequently, but a resurgence is seen during the Besant Phase, when again, large amounts of the material occur at distances that are in the range of 800-1000 km away from the North Dakota sources.

Cobbles of KRF are found in concentrated deposits in North Dakota, in the Mercer and Dunn counties (Ahler 1977, Figure 2.1). The primary source area is extremely concentrated and spatially restricted; however, it is possible to find cobbles of KRF in limited deposits in eastern Montana, eastern North Dakota, and South Dakota (Gregg 1987), although these sources have not been well-documented. KRF occurs only in secondary deposits in glacial till, as the original source of the cobbles is thought to have been destroyed by glacial activity. Clayton *et al.* (1970:285) proposed that the Golden Valley formation was the original source of the material, as this formation has a hard siliceous bed in the upper member of the rock unit with similar internal bedding as KRF (Figure 2.1).

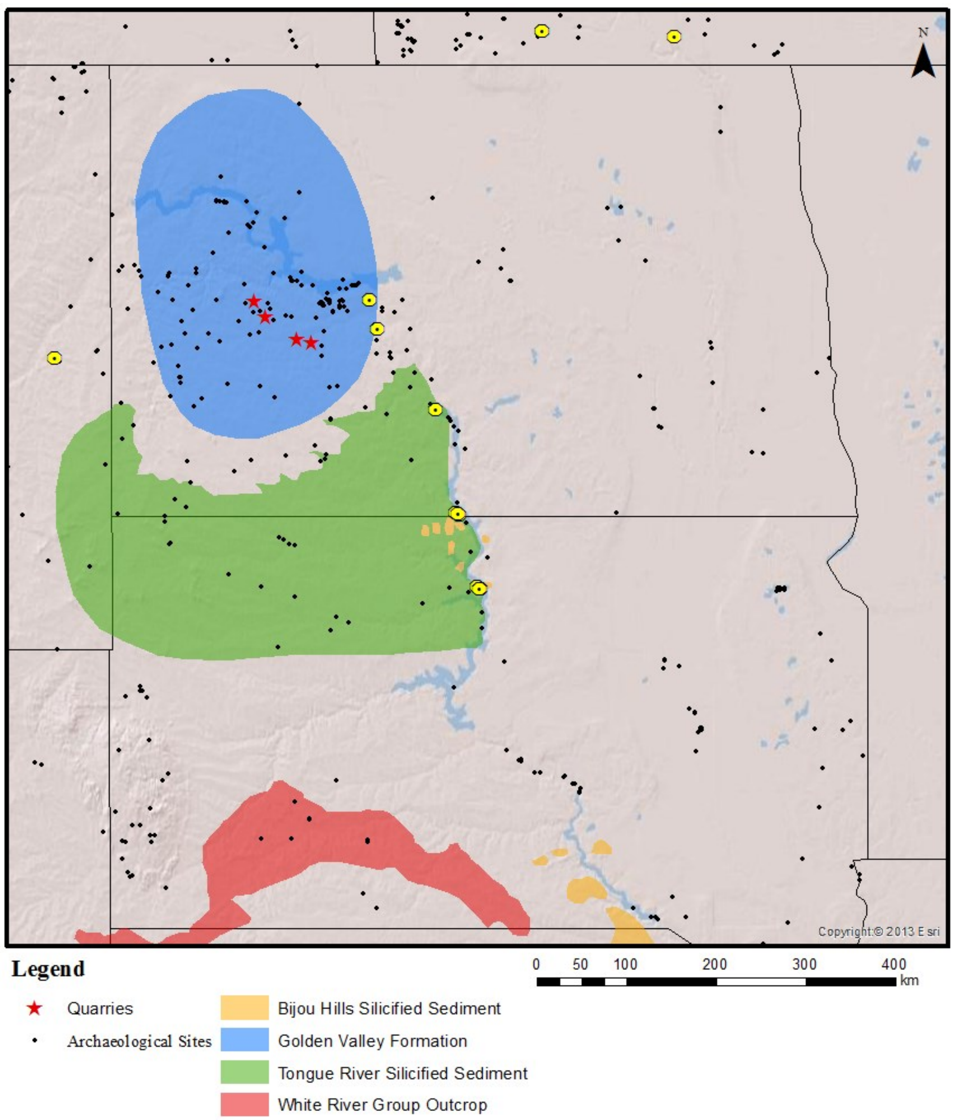

Figure 2.1: Raw material sources for lithics in North and South Dakota adapted from Ahler (1977), along with the location of Besant, Sonota, and other contemporary Late Precontact sites. Yellow dots indicate major sites in region, which are summarized in Appendix A and Figure 2.2.

The archaeological quarries identified in North Dakota have been exploited as early as the Cody Complex period, 8400-8000 BP (Gregg 1987:369) The Lynch quarry, one of the larger quarries known, has 2.8 km^2 area of pits dug into the glacial till to extract the material (Gregg 1987:369). These pits are dug on average 6 m in diameter and about 0.9 m deep, and the fields at these quarries are pockmarked with them. The researchers who identified these quarries estimated that approximately 28 000 cubic meters of KRF had been removed, but only about half of this material would have been useable (Clayton *et al.* 1970).

While KRF is widely recognized on the northern Plains, identifications of the material have been critiqued, as there are a series of similar materials in the region. These look-alike materials are primarily various forms of petrified wood, such as Hand Hills Agate in Alberta, and Antelope Chert and Rainy Butte Silicified Wood in the Dakotas (Ahler 1977; Kirchmeir 2011; Loendorf *et al.* 1984). These materials exhibit a similar colour and luster to KRF, as well as a similar patina, but it is possible to separate KRF from these materials. KRF is typically a translucent brown, but the colours will vary from blonde to near black, and will form white patina as the material chemically weathers (VanNest 1985). The distinct colour and translucency of KRF makes it stand out among other raw materials in lithic assemblages like quartzite or cherts, but it is the flattened plant detritus visible within the material that is the key distinguishing characteristic separating KRF from other similar materials (Clayton *et al.* 1970; Kirchmeir 2011). These plant fossils may not be apparent in every KRF sample, especially small flakes. In a case study separating KRF from similar materials, Kirchmeir (2011:22) found that by using a combination of macroscopic, microscopic, and ultraviolet irradiation, six percent of the similar-looking materials were being falsely attributed to KRF. While this identification issue can bias interpretations, most of the look-a-like materials only occur in small nodules, often too small to form the projectile points and tools seen at most sites. This attribute suggests that the larger formal tools are likely made from KRF cobbles.

Distribution of Besant and Sonota Sites

Archaeologists have identified Besant and Sonota sites across much of western Canada and the adjacent American states. The distribution of these sites is presented in Figure 2.2, showing archaeological sites classified as having Besant, Sonota, or related components. A summary of major sites in the region can found in Appendix A. This site location data was obtained from a variety of government and archaeological agencies that maintain databases of archaeological resources in the region. There were a number of differences in the form of data and attributes provided by the different institutions, limiting what can be deduced from this distribution. The accuracy of locational data also varied widely within the sources, but this error has limited effect at such a broad scale view of the region. The main issue affecting meaningful interpretations of this data set concerned the way the agencies categorized archaeological taxa for each site. Sites in the Alberta and Manitoba databases could be classified as Besant or Sonota, but Saskatchewan classified sites in this general time frame as only Besant. Wyoming and Montana classified sites as Besant, but North and South Dakota designate sites as Besant, Sonota, Early Woodland, Middle Woodland, and Late Woodland during this period. For example, Stelzer and the burial mounds excavated by Neuman are classified as Middle Woodland sites in the South Dakota database rather than Sonota. This variance stems from the variety of typological groupings employed in the region. In the Middle Missouri during this time period, researchers have defined ceramic types like Valley Cord Roughened, Feye Cord Roughened, Ellis Cord Impressed, Scalp Cord-Impressed, Missouri Bluffs Cord-Impressed, and Randall Incised (Hall and Hall 2004). The complexity and uncertainty of identifiable ceramic types in the region means that most sites are wrapped up under the umbrella of Early, Middle, and Late Woodland, to simplify regional and temporal discussions, making the distribution of Besant and Sonota in South Dakota somewhat less precise than other regions of the northern Plains.

Similarly, the designation of Besant on the rest of the northern Plains is problematic. Applying a term like Besant or Sonota is difficult simply because the projectile points used to delineate the Phase are by definition generalized, mid-sized, side-notched points that range from finely crafted to crudely-made. This form is similar to a variety of Middle and Late Precontact point types, like those of the Mummy Cave Complex or some McKean Complex specimens such as Hanna (Walde *et al.*1995:18). This situation can lead to misidentification and overrepresentation of Besant assemblages across the entire region. The classification of Besant components in Plains sites therefore presents challenges. Where further study is intended, assemblages should be vetted as well as radiocarbon dated to assert their placement within the Besant Phase.

For the aforementioned reasons, we need to approach the distribution of Besant and Sonota sites on the northern Plains with some caution. Figure 2.2 shows the locations of all Besant, Sonota, and Middle Woodland sites listed in databases for the region. In total, there are over 2 500 different archaeological sites identified in the northern Plains region for this time period. There are gaps and hotspots within the distribution of sites, but it is difficult to ascertain whether or not these patterns are the result of underlying cultural choices or a reflection of modern disturbance and ability to detect sites in the archaeological record. Besant appears to be concentrated in the Parkland and Prairie regions of the study area, but it also penetrates into the Rocky Mountains and the intermontane basin in Wyoming. In this connection, it is worth noting that broadly side-notched atlatl points that are similar but unrelated to Besant are widely distributed across North America, and can occur in other time periods even on the northern Plains.

This distribution does illustrate several significant facts about the Besant Phase that have come to light since the initial definition of Besant by Wettlaufer (1955). Now, over 50 years since the definition of Besant, it is possible to frame developments within the discipline around the contexts originally provided by Muhlbach and Stelzer. First, the successful communal hunting patterns employed at Muhlbach were in widespread use during the Besant Phase (Bubel 2014; Frison 1971, 1978; Hlady 1967; Hjermstad 1996; Novecosky 1999; Ramsay 1991; Reher

1987; Shortt 1993). While there may be identification issues around Besant projectile points, there can be little doubt that Besant sites are among the most commonly represented in the northern Plains region. This prominence speaks to the broader social-economic changes occurring within this time period, suggested by the abundance of communal bison kills, the noticeable increases in average Besant tipi ring sizes over other time periods (Brumley and Dau 1988; Quigg 1986; Vickers 1994), and the appearance of KRF artefacts at great distances from the source area, in sites like Muhlbach and Fincastle.

Conclusion

The presence of large amounts of KRF at some sites on the northwestern Plains is a characteristic of the Besant Phase, but the magnitude of this phenomenon is often overstated. Given the broad distribution of Besant sites in the region, it is apparent that this high frequency KRF signature is actually quite rare. Of the over 2500 Besant sites identified in the region, only eight sites on the northwestern Plains have this distinctive KRF signature: Muhlbach (Gruhn 1969), Fincastle (Bubel 2014), Fitzgerald (Hjermstad 1996), Melhagen (Ramsay 1991), Smith-Swainson (Foreman 2010), EdOh-23 (Johnson 1983), EgPn-111 (Varsakis 2006), and Pigeon Mountain (Peck 2010). While there may be more sites hidden throughout the "grey" literature, the fact is that high frequency KRF sites are the exception, not the rule. Muhlbach is one of but a handful of western Canadian sites that feature projectile point assemblages dominated by KRF.

This Besant era KRF connection to the northeast Plains parallels the development of Sonota and the appearance of communal burial mounds. During this period, the Hopewellian world exerted its influence far beyond the Eastern Woodlands region in order to obtain exotic, high status goods, like marine shell, copper, obsidian, and KRF (Carr 2006a; Clark 1984; Caldwell 1964; DeBoer 2004; Neuman 1975; Reeves 1983; Syms 1977). The capacity of the Hopewell Interaction Sphere to reach across the northern Plains region is demonstrated by the presence of obsidian from Yellowstone sources in Hopewell sites in Illinois and the appearance of ram effigies in Hopewell burials in Ohio (Caldwell 1964; DeBoer 2002, 2004; Griffin *et al.* 1969). These continental interactions would logically cross the Sonota world and are very likely to be implicated in the amalgam of Plains and Hopewell characteristics revealed in the Sonota burial mounds.

With this framing in place, it becomes possible to probe how Muhlbach and the high frequency KRF sites may have articulated with the Sonota realm. The discoveries of Muhlbach and Stelzer triggered a long-standing taxonomic debate within the discipline, but that debate has been based largely on incomplete knowledge of the assemblages from these foundational sites. We are today able to provide a stronger empirical context through which to examine interaction between the two regions. For Muhlbach, it is critical to establish when and in what season that site was occupied. Were one or more kill episodes involved at Muhlbach, and if more than one kill episode took place, how widely spaced were those episodes likely to be in time? It is equally important to determine how many animals were present at the site, how those animals were processed, and how the kill locus was managed to such great effect.

For Stelzer, we must also determine when that site was occupied, and to what degree it was contemporaneous with nearby burial mounds as well as the unique KRF dominated sites on the Canadian prairies. Stelzer has produced a massive assemblage from an area on the order of 200,000 m^2. Was that assemblage the result of palimpsest occupations by more modest-sized groups over a number of centuries, or could it have been created by very large groups in a condensed period of time? Particularly in the latter alternative, how would the Stelzer inhabitants have supported themselves economically? Renewed analysis of the assemblages from both sites will let us begin answering these questions, and in doing so, can provide us with a more secure footing for understanding the nature of interregional relationships in the Besant-Sonota world, the task to which I now turn.

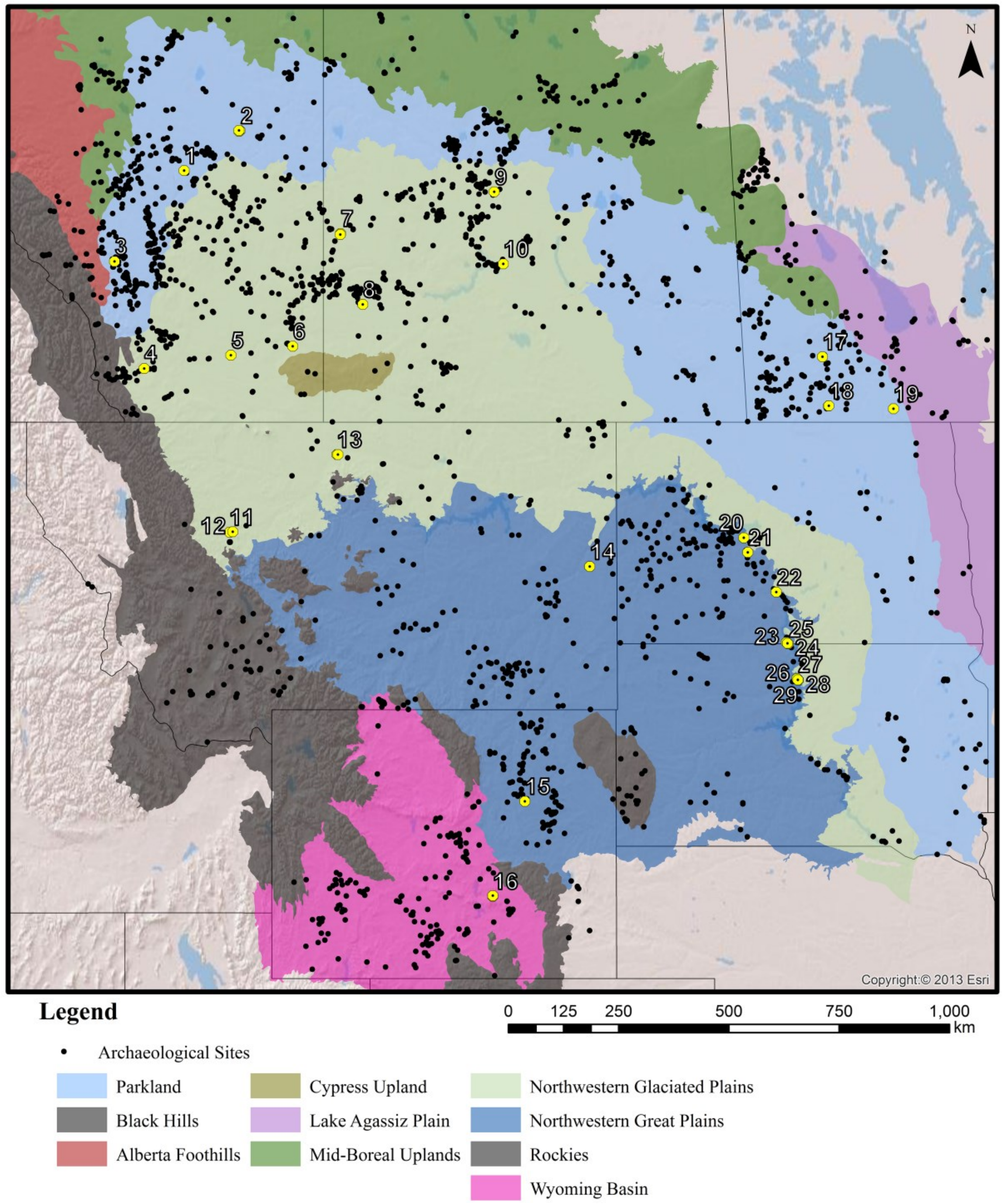

Figure 2.2: Distribution of Besant and Sonota sites in relation to northern Plains ecoregions. Sites discussed in detail are: **1** – Muhlbach; **2** – Smith Swainson Site Complex; **3** – Happy Valley Bison Kill; **4** – Head-Smashed-In Buffalo Jump; **5** – Fincastle; **6** – Ross Glen; **7** – Elma Thompson; **8** – EdOh-23; **9** – Fitzgerald; **10** – Melhagen; **11** – Dago Hill; **12** – Stelling Site; **13** – Wahkpa Chu'gn; **14** – Mini Moon Site; **15** – Ruby; **16** – Muddy Creek Site Complex; **17** – Kain; **18** – Richards Village and Kill Site; **19** – Calf Mountain; **20** – High Butte; **21** Glenharold Mine; **22** – Schmidt Mound; **23** – Porcupine Component; **24** – Alkire Mound; **25** – Boundary Mounds; **26** – Swift Bird Mounds; **27** – Grover Hand Mounds; **28** – Arpan Mounds; **29** – Stelzer.

Chapter 3 – The Muhlbach Site: Excavations, Features, and the Artefact Assemblage

The Setting

The Muhlbach site is located to the southwest of Stettler, Alberta, near Buffalo Lake and the Red Deer River. Situated on the edge of a small, unnamed sand dune complex (Figure 3.2), the site lies on the boundary of the Prairie-Parkland ecoregions. The Parkland is a mosaic ecosystem of aspen forest and short grass prairie located between the open prairie and boreal forest ecoregions. This ecoregion had a strong determining factor for settlement patterns in the historic and Precontact periods (Malainey and Sherriff 1996). This ecological boundary has shifted in the past, with changes in temperature and precipitation affecting the propagation of the aspen groves and the extent of the parkland region (Strong and Hills 2005). Local residents informed Gruhn (1969) that the area around the Muhlbach site was significantly more open within the past century. Historical references and ecological reconstruction of the parkland region suggest that this band between the boreal and prairie ecosystems was further north and significantly narrower within the past 2000 years (Beaudoin 2003; Campbell *et al.* 1994; Malainey and Sherriff 1996). The suppression of fire and the near extinction of the bison have allowed the parkland ecoregion to expand beyond its historical boundaries.

Soil types can provide a certain amount of environmental information about an area and the plant communities established there. The soil zones immediately adjacent to the site are chernozemic soils (Figure 3.1), soils with well-established and thick organic horizons that develop under a prairie ecosystem (Soil Classification Working Group 1998). Nearby the site are patches of luvisolic soil, a soil order that typically forms under well-established forested environments. The nearby Red Deer River valley would have been treed as well, and would have provided riverine and aspen parkland ecosystems and resources for exploitation. The Muhlbach site would likely have been outside or near the southern edge of the parkland ecoregion when the site was occupied, probably in an open environment with a short grass prairie ecosystem, and forested aspen patches nearby.

Surficial geology also would have an effect on the ecosystems near the site. The Muhlbach site lies on the edge of a small eolian deposit that has developed into small sand dunes. Within these sand dunes are pockets of small interdunal wetlands that surround the Muhlbach site (Figure 3.2). These water bodies could have provided drinking water and wetland resources for exploitation, but it is difficult to determine the longevity of these water bodies, as their water levels fluctuate due to climate and seasonal changes. Wolfe *et al.* (2007:186) discussed the ecologically diverse landscapes present in sand dune complexes, providing a wide range of microhabitats and resources to support aboriginal populations.

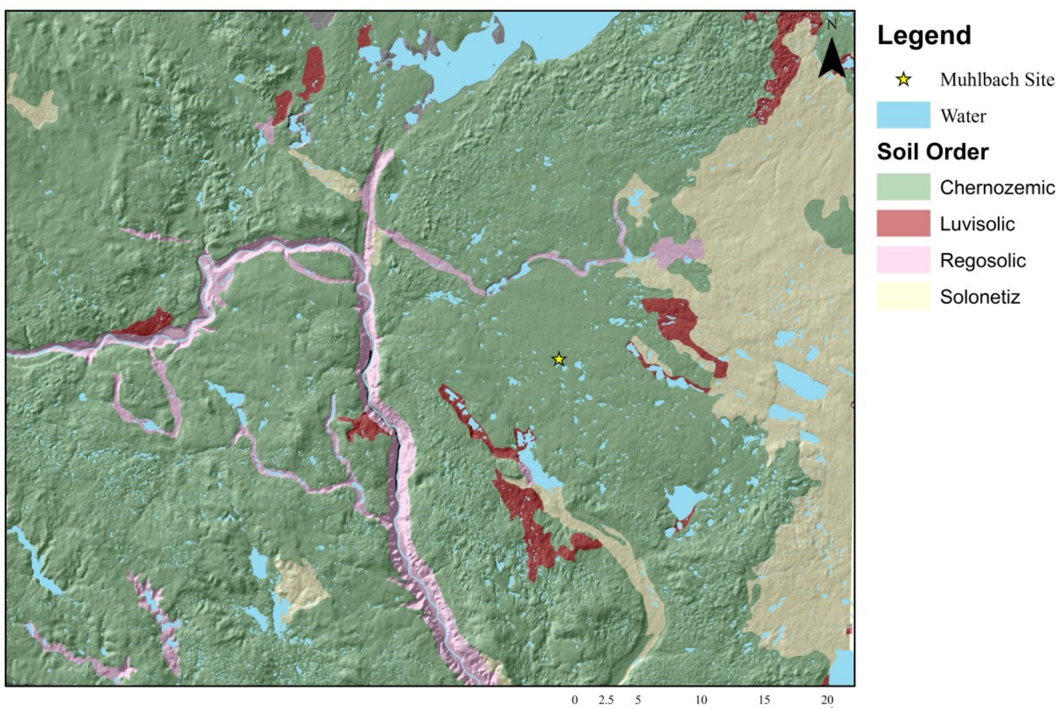

Figure 3.1: Soil order classification around the Muhlbach site locale. Soil order data provided by the Soil Landscapes of Canada v3.2.

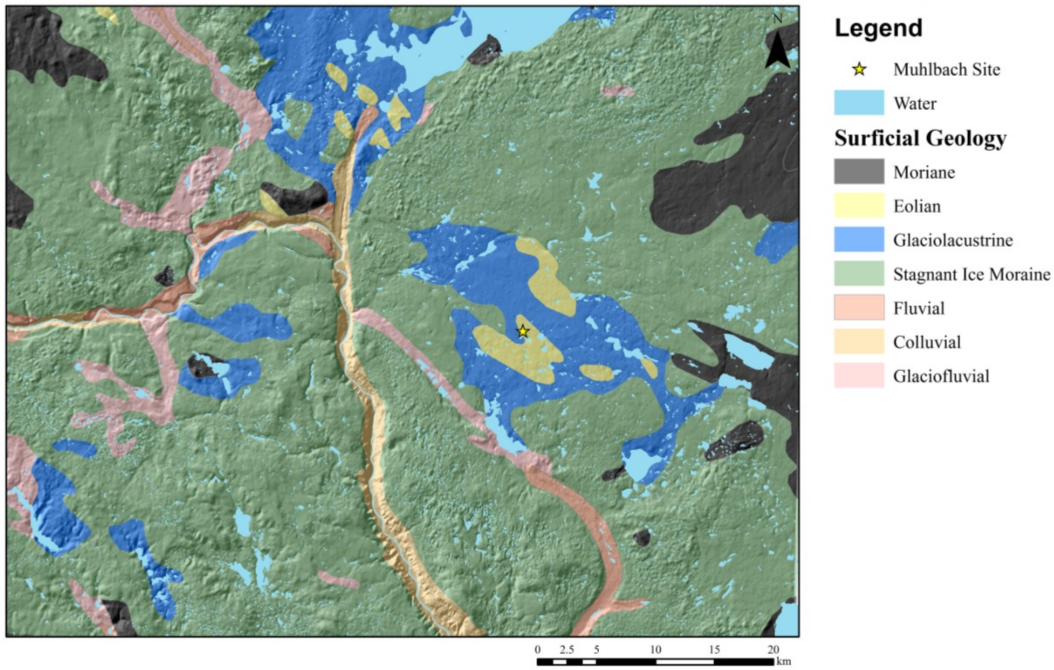

Figure 3.2: Surficial geology around the Muhlbach site locale. Surficial geology classification provided by the Alberta Geological Society.

Initial Discovery and Excavation of the Muhlbach Site

The site was uncovered underneath the farmyard of William and Mary Muhlbach. The family had discovered the site while digging postholes for a new corral, uncovering an extensive layer of bison bone in a dark coarse sand matrix 0.5 m beneath the surface. It is unclear when the Muhlbach family initially discovered the site, but there were no archaeologists at the University of Alberta when they attempted to contact someone about the site. Robert Graham, a local resident, excavated a portion of the site in the corral, and collected several large side notched points made from KRF. The site caught the attention of Alan Bryan and Ruth Gruhn in 1964, while engaged in a survey of archaeological sites in Central and northern Alberta. Gruhn returned in the summer of 1965 to carry out the only excavations at the site to date.

Gruhn (1969) focused on the area within corrals, laying out three excavation blocks in a grid made of two by two meter units oriented on a north-south axis around the disturbed portion of the site where Robert Graham had previously excavated (Figure 3.4). Gruhn assigned a letter to each unit based on the row and a two-digit number based on columns in this grid system: letters began at "A" and increased as units progressed from south to north; numbers started at 10 and increased as units advanced from west to east.

Some errors occurred during the numbering of excavation units that affected records for the site. A miscalculation in the northern trench caused this area to receive the wrong letters, L10 to P10 (See Figure 3.4). In terms of distance north from the datum, these units should have been H10 to L10, and Gruhn (1969) attempted to correct this error by reclassifying these units in her preliminary report on the site. In this analysis, I have reverted to the original L10 to P10 sequence for unit numbers in the northern trench, as all field notes and faunal catalogue numbers reference these numbers. Another issue revolves around Unit A19, as archaeologists excavated this unit, but the faunal remains and records are currently missing. The amount of bone recovered in this unit cannot be determined, and I will exclude this unit from the faunal and spatial analysis.

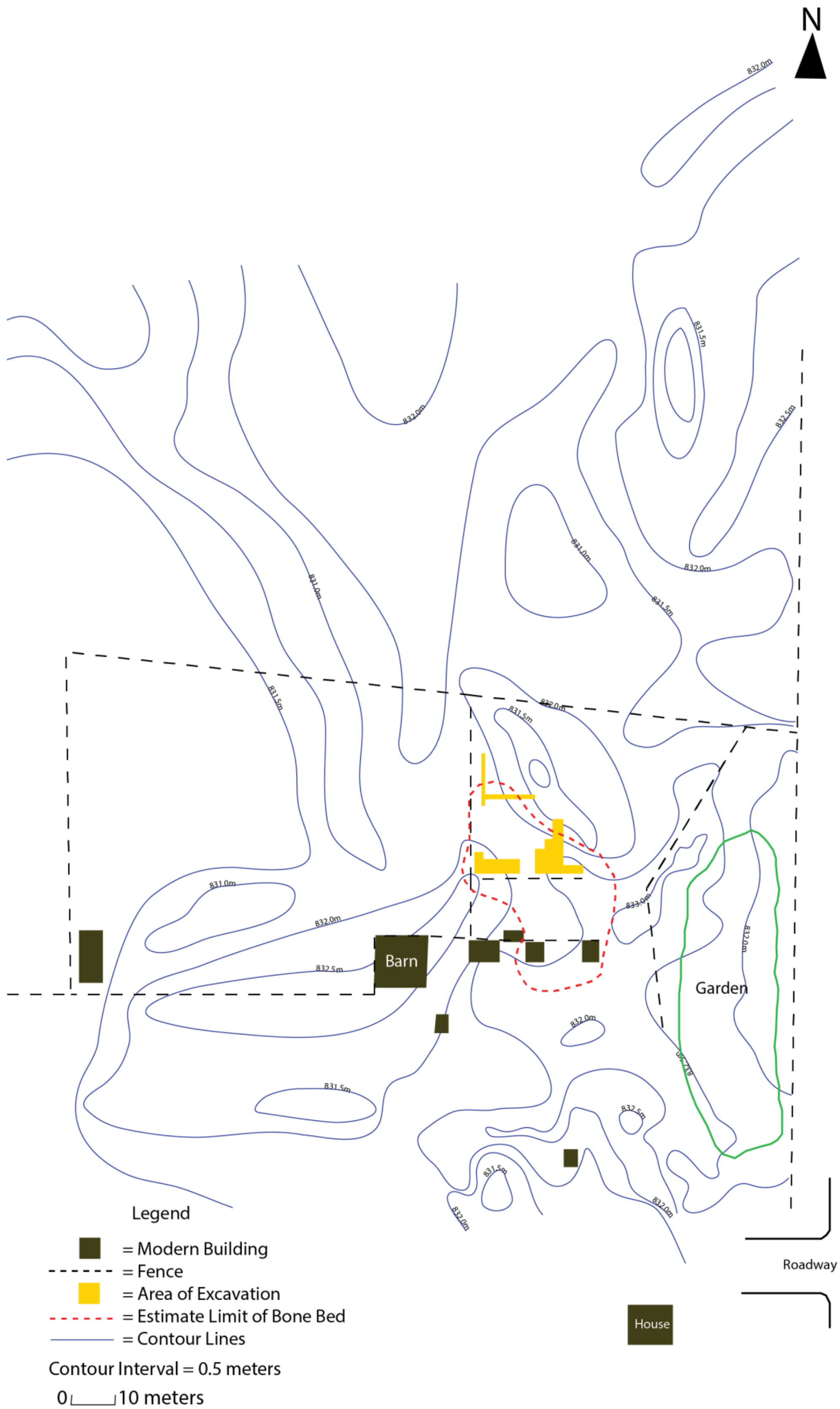

Figure 3.3: Muhlbach site area and excavations adapted from Gruhn (1969:131).

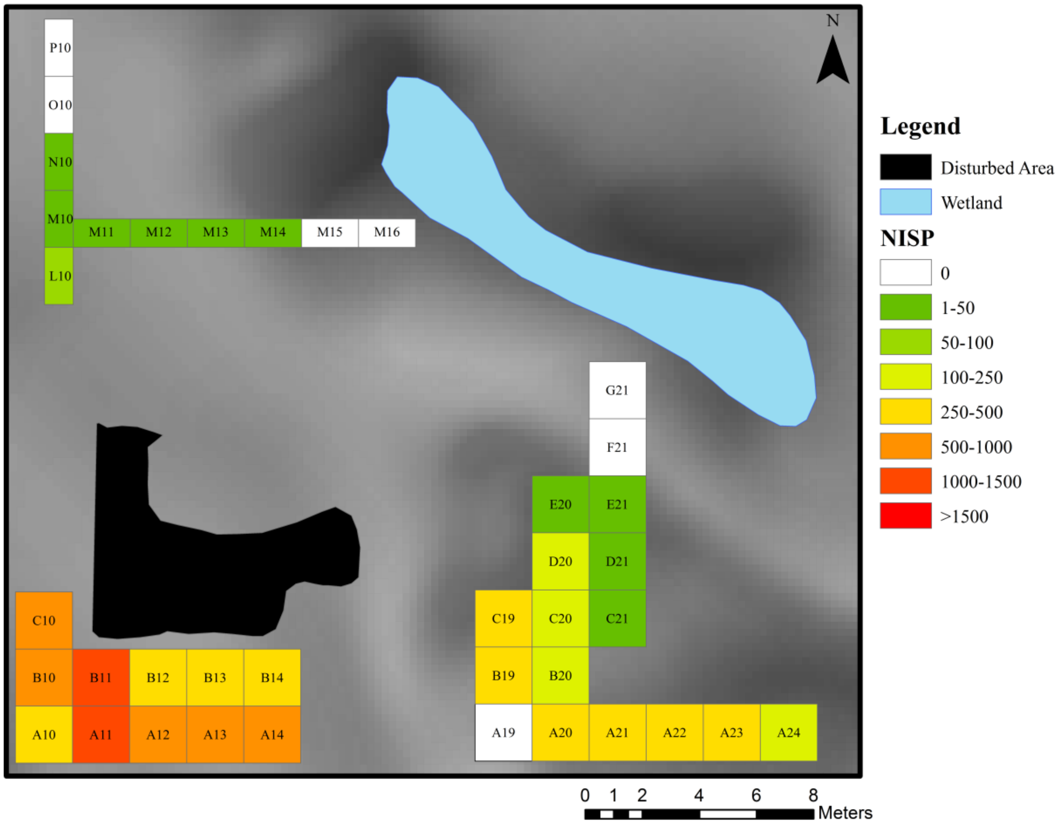

Figure 3.4: Muhlbach excavation units and bison NISP. Note that there is no faunal data for Unit A19.

Gruhn (1969) created a 0.5 m surface contour map with modern structures and landmarks, measuring surface elevations of the surrounding landscape and unit corners with a Cowley Automatic Level. I digitized the contour map of the site and traced the contours in ArcGIS 10.1 with the associated elevation information, then used the Kriging extrapolation tool to fashion a Digital Elevation Model (DEM) of the site. This DEM provides a high-resolution continuous elevation surface for the site, creating the capacity to further our understanding of the Muhlbach site.

Excavations at the site were carried out using baulks, leaving 0.2 m on either side of each unit (Figure 3.5). The archaeologists excavated each unit by shovel until they reached the level of the bone bed, where trowels, dental picks, and spoons were then used to carefully expose each bone, which was then mapped in situ (Figure 3.6). They also mapped artefacts, rocks, and some noteworthy faunal elements, all of these in three dimensions relative to the southwest corner datum of each unit. Excavators used screens to sift through some sediment at the site, but the size of the screen and the consistency of screening at the site is unknown. Artefacts were catalogued based on unit and stratigraphic horizon: primarily above, in, or below the bone bed. Profiles were drawn of each wall after each unit was excavated, then baulks between each unit were removed, and the bone bed within each baulk was mapped.

Figure 3.5: Muhlbach Main excavation area with Ruth Gruhn in the centre. View west. Photograph courtesy of the Royal Alberta Museum.

Figure 3.6: Bone bed in Main excavation area. Photograph courtesy of the Royal Alberta Museum.

Due to time constraints, Gruhn mapped faunal remains only in the main trench area, as this contained the greatest concentration of bone fragments and artefacts. The eastern block of excavation units also contained abundant bison bone fragments, but the density of the faunal remains decreased swiftly towards the north and east, similar to the northern block, which yielded small amounts of bone that also tapered off towards this direction. The aforementioned faunal distribution indicates that the excavation had uncovered the northern edge of the bone bed. To explore south of the excavations, sediment cores were used to determine the extent of the bone bed (Figure 3.7). Based on the appearance of bone fragments at the appropriate depth in the core, it was determined that the bone bed extended 25 m southwards underneath the existing buildings at the yard. In total, 134 m^2 was excavated of the estimated 1 250 m^2 of the bone bed.

The stratigraphy at the site was composed of several paleosols and coarse eolian sand deposits riddled with rodent burrows (Figure 3.8). Gruhn (1969:133-135) designated four stratigraphic zones at the site, Zones A, B, C, and D. The first stratigraphic unit, Zone A, was comprised of the modern Ah horizon and the compressed manure that covered the surface of the site. Zone B was approximately 0.5 m of grey-brown massive coarse sand deposits. A thin paleosol is present in the Zone B stratum, but it is discontinuous across the site. Just underlying Zone A (the Ah Horizon of the modern soil), this paleosol in Zone B suggests that the sand dunes reactivated at some period between the main occupation at the site and the modern surface. Excavations in Unit A24 exposed a buried pig skull in an intrusive pit (A25-A20 Profile Figure 3.8). The significance of this pig skull is unclear, but given presence of a domesticated species of European origin, and that the top of this feature is in line with this paleosol in Zone B, it is likely that the dune activation occurred at some point during the Historic period.

The Besant occupation resided in Zone C, a layer of black, organic rich, medium to coarse sand that adhered to all of the faunal remains, with charred horsetail stems interspersed amongst the bone. This black to dark grey sand was relatively thick and continuous in the Main trench area, as well as towards the eastern excavation block, but the paleosol disappeared as excavations moved northwards (See C21-G21 East profile, Figure 3.8). Furthermore, this black sand was not present in the northern block at the site (see L11-Q11 Profile and M11-M17 Profile, Figure 3.8). Somewhere between the northern and main excavation area the paleosol disappears, but the occupation continued. This distribution is important to note, as the distribution of faunal remains and artefacts in relation to the paleosol could have implications regarding activity and work areas at the site.

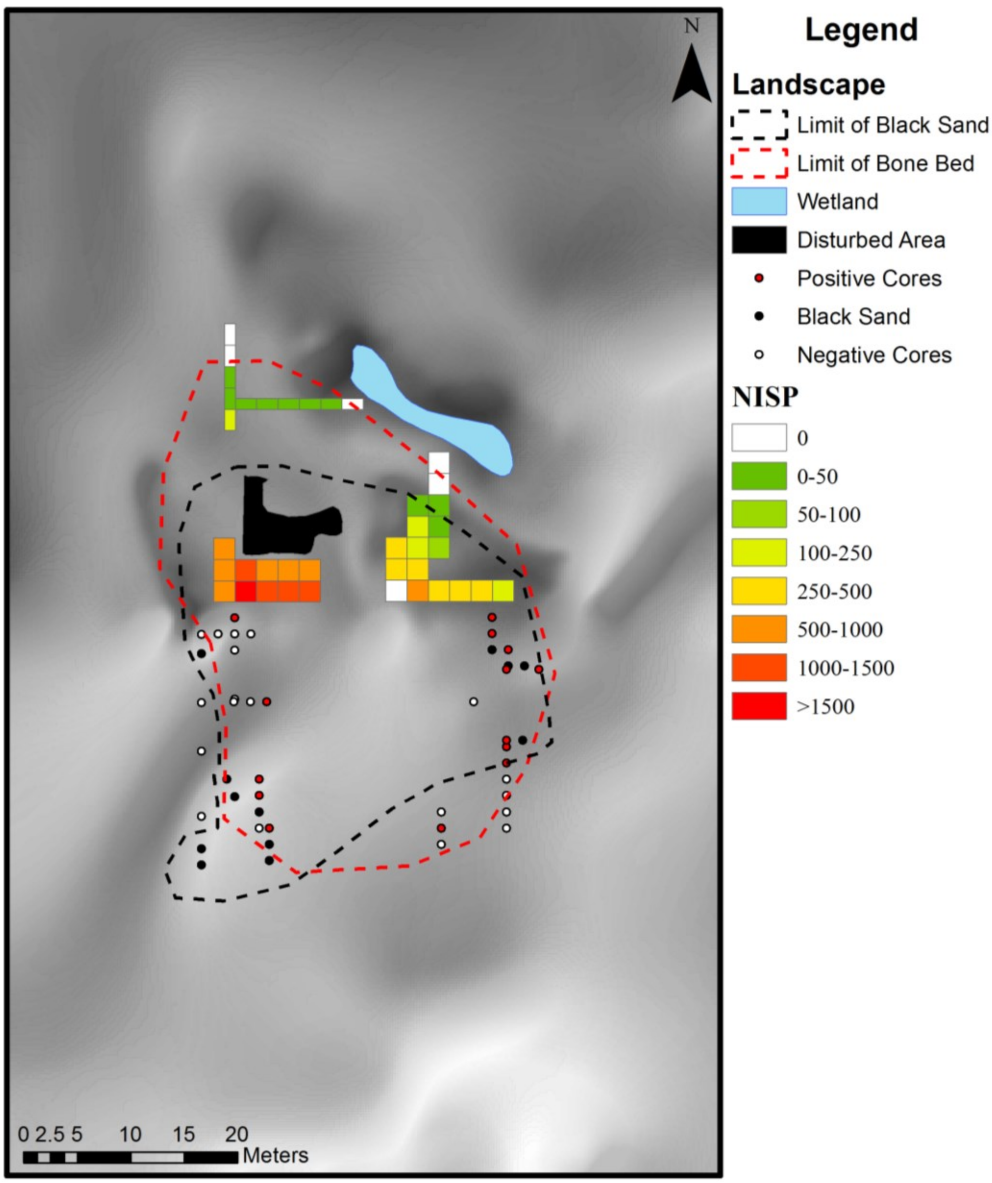

Figure 3.7: Extent of bone bed and black sand stratum based on profiles and core results, with underlying DEM.

Gruhn (1969:133) interpreted the black sand as a paleosol from some type of wetland when the kill occurred. She based this interpretation partially on the burned horsetail stems (*Equisetum sp.)* in the strata, but also on the presence of mottling and irregularly shaped orange concretions in the yellow-grey sand beneath the bone bed. The presence of these soil characteristics is typical of waterlogged soils that lead to gleying of the sediment from the anaerobic environment. The presence of horsetail in the paleosol suggests that the living surface at the site was water saturated because this plant typically grows in wet sandy soils. The pit and upright features from the occupation in Zone C generally penetrate into the lowest stratum, with the black sand conforming around these intrusions into the lower stratum.

As previously mentioned, this wetland paleosol disappears between the northern and main excavation area, but extends towards the east. Gruhn cored the southern region of the site to determine the extent of the bone bed in this direction, and found that the site and black sand stratum continued underneath the extant buildings at the site (Figure 3.7). While the core results indicate that the bone bed spreads farther south, the black paleosol is not continuous. Several core results produced bone at the appropriate depth, but the black sand stratum was not present. This discontinuity of the black sand stratum is visible in the A10-A15 South Profile (Figure 3.8). While the majority of the bone bed lies in this stratum, some areas of the site extend beyond it.

There was no visible stratigraphy within Zone C, suggesting that there was a single occupation event at the site, although Gruhn (1969:140) considered the possibility of multiple kills in quick succession. Portions of the bone bed had been burned, creating concentrated areas of burned bone fragments in Units B12, B13, and B14 (Figure 3.24). These units have the highest concentration of burned bone at the site, with surrounding units having incrementally less burned bone. The burned bone is dispersed amongst the faunal elements at the site, with unburned bison bone overlying burned bone in most units in the Main trench of the site (Figure 3.24). The stratigraphic position of the burned and unburned bone indicates that there were at least two kill events at the site: one kill in which part of the bone bed was burned afterwards and another that covered the existing burned bison bone.

The lowest stratigraphic unit at the site, Zone D, was a yellow-grey massive coarse sand containing orange concretions. The water table appeared in this level, as a deeper layer of lacustrine clay held the water level in place. Gruhn did not encounter the lacustrine clay at the Muhlbach site, as the high water table prevented deeper excavations, but lacustrine clay layer was reportedly common in the general vicinity of the site (Gruhn 1969:130). Furthermore, Gruhn (1969:133) referred to Zone D as linked to the formation of an "AG horizon of a warp anmoor type soil (Weisenboden) in an area with a high water table." She was referring to an early form of soil classification developed by Kubiena (1953:84). This type of soil forms when water periodically covers the sediment and propagates variable peat formation on top of the mineral soil, but the sediment itself is completely waterlogged at all times. This soil type would be referred to as a gleysolic soil today (Soil Classification Working Group 1998) This information indicates that at the time of occupation, the soil at the Muhlbach site was likely waterlogged, but any surface water would be dependent on the season of occupation.

It is important to consider the paleoenvironment of the site occupation, as these factors have a bearing on the mechanics and orientation of the kill and the nature of the occupation. The majority of the bone bed, artefacts, and features lie within the Zone C stratum, but the site does extend outside of it. The grey-black sand stratum visible in the Main and eastern excavation blocks does not appear in the northern area at the site, and likely disappears somewhere between these areas (Figure 3.8). Furthermore, Zone C does not connect to the nearby wetland to the northeast of the site (Figure 3.7). Visible in the east profile of C21-G21 (Figure 3.8), the black sand stratum begins to taper out before the profile slopes downwards toward the modern slough, indicating that the Zone C paleosol at the site was not connected to any modern water body, but formed independently in the past. These characteristics indicate that the Besant occupation occurred in a small interdunal wetland typical of sand dune formations found on the northern

Plains. This wetland was subsequently filled in by eolian sand deposits as the dunes became activated, covering the bone bed. Wolfe *et al.* (2007) postulated that Precontact aboriginal activity in sand dune areas contributed to the destabilization of the eolian deposits, causing the dunes to reactivate, a likely scenario for Muhlbach. If the dunes around the site were activated by human activity, then it could explain why the site was buried after the most intensive portion of the occupation.

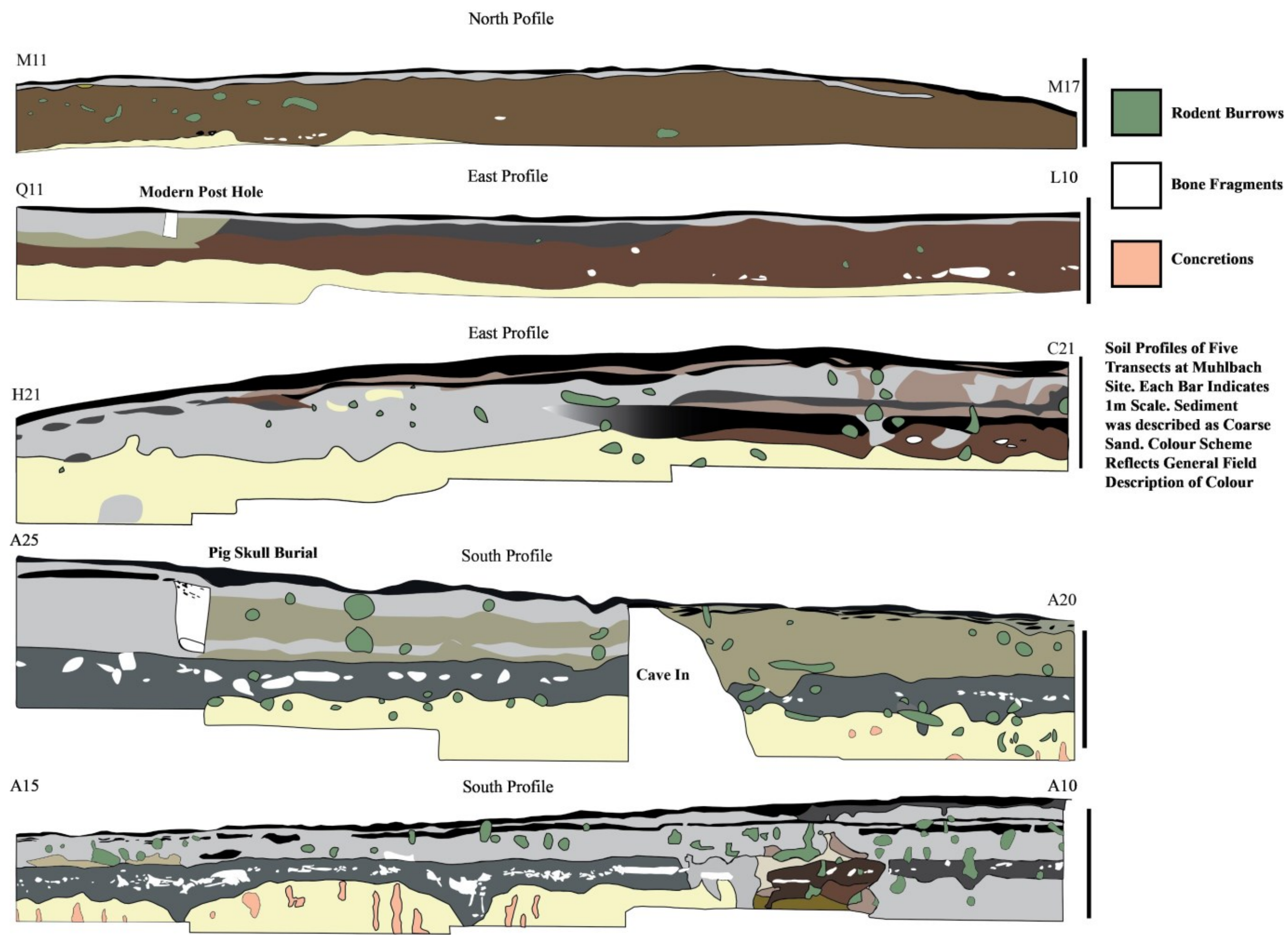

Figure 3.8: Muhlbach soil profiles for the main trench (A15-A10), the eastern trench (A25-A20, H21-C21), and the northern trench (Q11-L11, M11-M17).

Radiocarbon Analysis: Samples and Results

Gruhn (1969:144) obtained a conventional radiocarbon date from a composite sample of burned bones in Unit B12, yielding an age of 1270 ± 150 ^{14}C yrs BP. Since the bone bed at the site demonstrated no visible stratigraphy that would indicate multiple occupations, Gruhn (1969:140) concluded that this kill represented a single occupation event. This initial date was consistent with the ages of other known Besant sites on the northern Plains, although Gruhn had reservations regarding the integrity of the date. The site lay under a modern corral, and there were concerns about contamination from the manure seeping down from the surface. With recent advancements in the precision of dates produced by Accelerator Mass Spectrometry (AMS) and the broad error accompanying this early conventional radiocarbon date, it is necessary to revaluate temporal span of the Muhlbach site.

I selected 15 radiocarbon samples from Stratum C in three rounds of dating from the Muhlbach faunal assemblage, distributed across all three excavation areas in order to assess any variation in the age for the different areas of the site. In addition to the 11 samples from the general faunal assemblage, four expedient bone tools were also dated. With the assistance of Dr. Duane Froese (Earth and Atmospheric Sciences, University of Alberta), I submitted the bone samples to the University of California-Irvine Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory, where the samples were demineralized in order to extract the collagen, then ultrafiltered, combusted, and counted. The results were calibrated using the IntCal13 curve in the OxCal 4.2 Calibration Program (Bronk Ramsey 2009; Reimer *et al.* 2013), and are summarized in Table 3.1 and Figure 3.9. The results in Figure 3.9 are calibrated with two sigma values.

The initial round of dating (UCIAMS 89684 to 89687) produced ages ranging between 1688 and 1410 cal BP, roughly four hundred years earlier than Gruhn's original date of 1522 to 918 cal BP. While the original date from the site fell within ranges given in the literature for the Besant Phase, the initial Muhlbach date fell relatively late in the phase. This preliminary round of dating brought the age of Muhlbach more in line with ages typical for other Besant Phase sites. However, sample UCIAMS 89685 produced an unusually high C/N ratio and the ultrafiltered collagen was a light tan colour rather than a typical white: an attribute that could indicate cross-linking of exogenous carbon contaminants with the bone collagen (John Southon 2013, personal communication). While this date does align with other samples, the possibility of contaminated samples prompted further dating of the site.

Table 3.1: Radiocarbon results from Muhlbach. Yellow indicates samples with tan collagen, that could indicate some type of contamination.

Sample ID	Type	Unit	14C Date (BP)	Sigma	δ13C	C/N	Date CalBP
GSC-696	charred bones	B14	1270	150	N/A	N/A	1522-918
UCIAMS-114940	vertebra	B12	1590	15	-19.25	2.79	1532-1415
UCIAMS-114941	1st phalanx	A22	2335	15	-19.12	2.86	2357-2336
UCIAMS-114942	1st phalanx	A12	2675	20	-19.64	2.94	2844-2750
UCIAMS-114943	1st phalanx	A13	1565	15	-20.26	2.96	1523-1410
UCIAMS-114944	1st phalanx	B10	1555	15	-19.7	2.91	1523-1401
UCIAMS-131378	scapula	A12	1660	20	-19.02	2.97	1609-1529
UCIAMS-131379	long bone	A12	1620	20	-19.52	3.05	1563-1416
UCIAMS-131380	long bone	A12	1645	20	-18.83	2.94	1609-1445
UCIAMS-131381	metapodial	C10	1625	20	-19.58	2.82	1567-1416
UCIAMS-89684	astragalus	A22	1685	25	-17.61	2.80	1688-1543
UCIAMS-89685	astragalus	B10	1585	20	-20.09	3.15	1535-1410
UCIAMS-89686	astragalus	A13	1600	20	-19.36	2.83	1545-1414
UCIAMS-89687	astragalus	C10	1615	20	-19.22	2.81	1559-1415

I selected six samples (UCIAMS 114940-114944) for a second round of dating in order to resolve the contamination issue and to increase the data pool for radiocarbon dates. One sample failed to produced enough collagen for dating, and again three samples yielded higher than normal C/N ratios with tan collagen (UCIAMS 114941, 11493, and 114944). From this round of dating, three dates fell between 1532 and 1401 cal BP, matching the results from the initial radiocarbon dates. Two samples produced dates approximately 1000 years older, at 2357 to 2336 cal BP and 2844 to 2750 cal BP. These results initially appeared noteworthy, as the comparable Fincastle site in southern Alberta had also yielded radiocarbon dates of ca. 2500 cal BP (Bubel 2014).

Upon reviewing the elements that produced these earlier dates, I noted different taphonomic characteristics as compared to the rest of the assemblage. The organic rich, black sand adhering to the bones heavily stained all of the faunal assemblage a dark to light brown. The samples producing early dates came from bison first phalanges that were also stained dark brown, but underneath the top dark layer, the samples had a distinct white colouration. This colouration is typical of sun bleaching observed on bone left exposed on the surface (Tappen and Peske 1970). This underlying white colouration of the bone indicates that these samples had been exposed for some time on the surface before they were buried with the rest of the faunal assemblage. In addition, there were no visible cultural modifications to either phalange, while every other element that was dated demonstrated clear evidence of butchery. It is possible that these elements could have derived from much older bison specimens, as loose animal bone is common upon the northern Plains; if so, these elements that date to a millennia earlier than the bulk of the radiocarbon dated samples might not be related to a major kill event that occurred at the site.

The third round of dating targeted a series of expedient bone tools that had been uncovered in the inventory of the faunal collection (UCIAMS 131378-131381). I selected these bone tools for dating to resolve several issues. Previous rounds of radiocarbon dating had yielded a wider range in dates than previously expected, and increasing our pool of radiocarbon dates would resolve sampling biases. The objective was to further separate the cultural occupation of the site from any natural occurrence of faunal remains at the site, as these expedient bone tools should date close to the cultural occupation of the site. The third set of dates produced a range between 1609 and 1415 cal BP. While slightly older than the bulk of dates from the site, at two sigmas these bone tool ages are indistinguishable from the rest of the faunal assemblage. This situation is due to a flattening of the calibration curve right at the period of occupation for the Muhlbach site (Figure 3.10), meaning that even though there is high precision in the error range for these dates, the calibration of the data “smears” the possible age of the site across a larger time span.

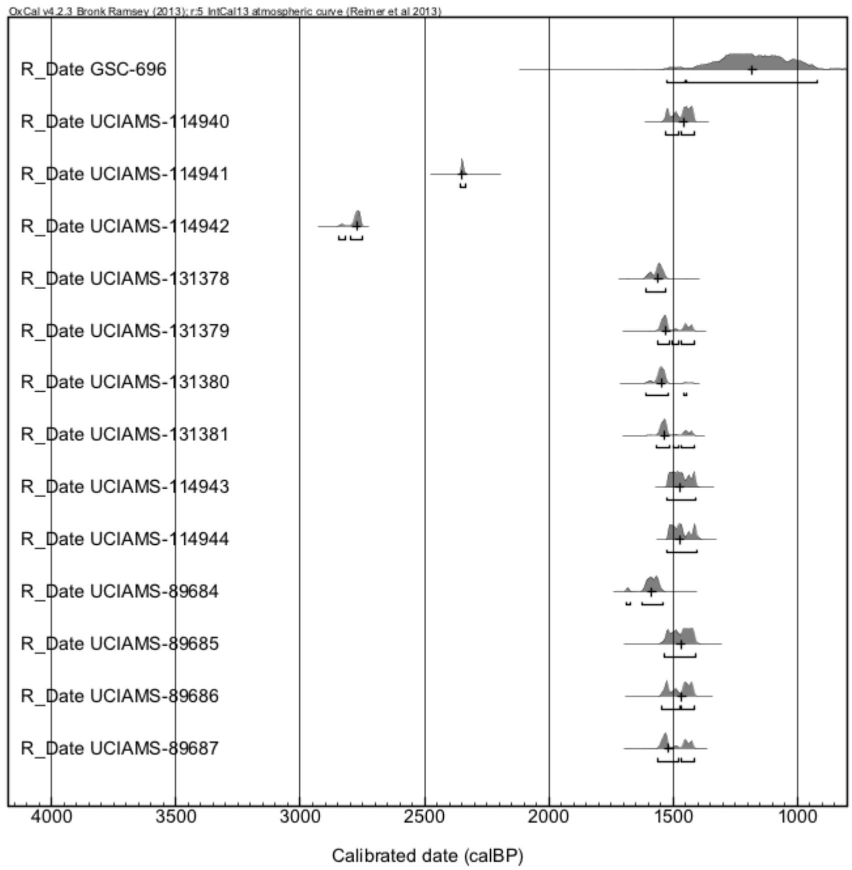

Figure 3.9: Calibrated radiocarbon dates from Muhlbach using OxCal 4.2 and the IntCal13 calibration curve.

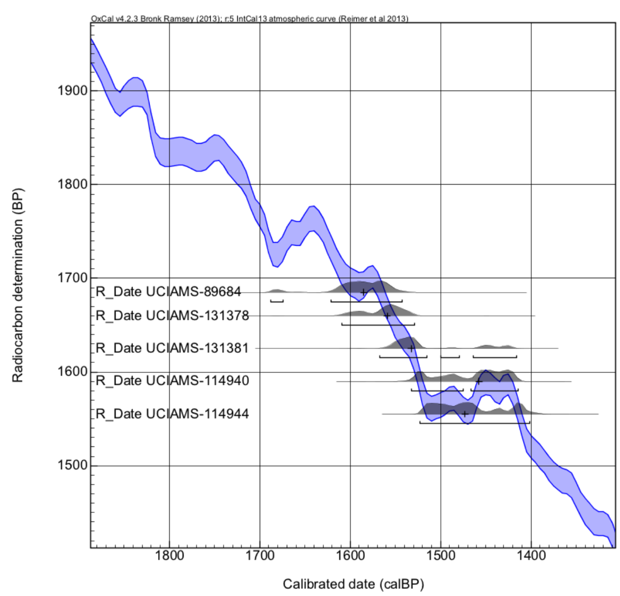

Figure 3.10: Calibration curve for period of Muhlbach occupation with a some of the radiocarbon dates. The flattening of the calibration curve leads to a wider range of possiblilities for the actual age of the radiocarbon samples.

These expedient bone tools were made either during or close to the occupation of the Muhlbach site. This conclusion is certainly a logical possibility, as a quickly crafted bone tool would not have received the same attention as a finely crafted flesher. Interestingly, the $\delta^{13}C$ values from these tools match the values produced by other Muhlbach collagen samples, rather than the values from the Stelzer site (See $\delta^{13}C$ values in Table 6.1). The $\delta^{13}C$ values for bison generally become more negative towards the north and west, as the environment becomes more dominated by C3 pathway plants and grasses (Chisholm *et al.* 1986). These results do suggest that these bone tools were from bison living on the northwestern Plains, rather than the Middle Missouri region.

In summary, these radiocarbon dates indicate a single period of occupation of the Muhlbach site. Excluding the two outlier dates, the new dates cluster between 1688 and 1401 years cal BP, and support Gruhn's notion of a single occupation at the site. The samples that showed evidence of contamination yielded dates in the same range as the uncontaminated dates, suggesting that the results are accurate despite these issues. The intermixing of burned and unburned bone within the bone bed confirms that there were nevertheless multiple kill events at the site, within this single period of occupation.

Features—Uprights, Postholes, Pits, and Hearths

There are 18 different features from the Muhlbach site, including bison bone uprights, pits, hearths, anvils, burned bone concentrations, and modern postholes. I will describe the nature and contents of each feature with as much detail as possible, but there is limited information available from the excavation, partially due to problems during excavations, or omission from the field notes. In addition, night time visitors to the site removed some of the faunal remains from the features, making the inventory incomplete. Profiles of select features are available, courtesy of the Royal Alberta Museum, as well as photographs courtesy of Ruth Gruhn. Descriptions of each feature stem from the individual field notebooks, as well as the Master Site Log prepared by Ruth Gruhn, both housed at the Royal Alberta Museum.

Features in the Main Excavation Trench

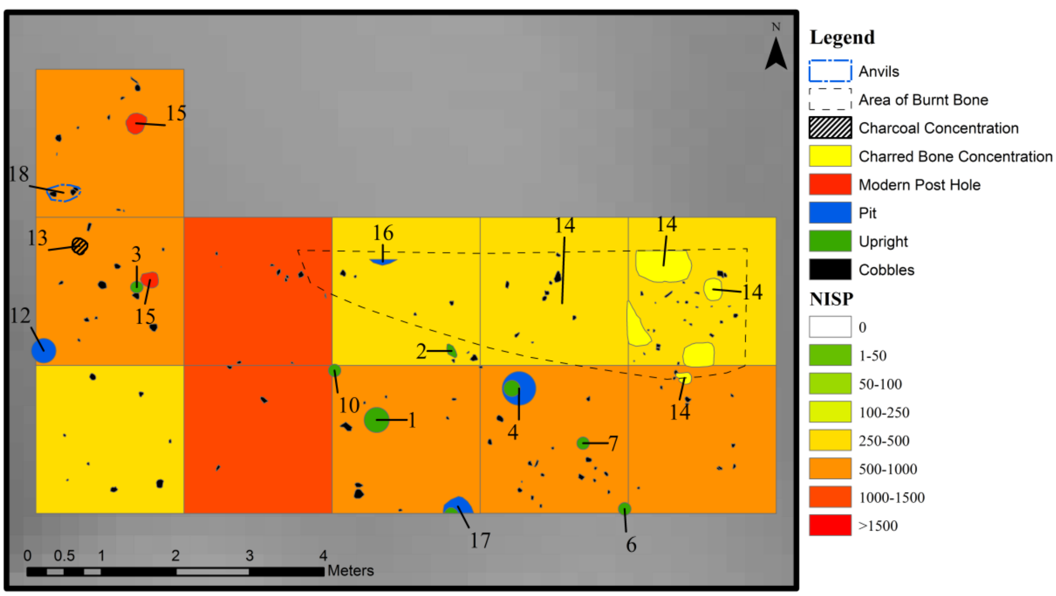

Figure 3.11: Features in main excavation area.

Feature 1

Feature 1 is a bison bone upright in the west central area of Unit A12, with 15 faunal elements positioned vertically in the sediment beneath the bone bed. The upright feature was contained in a 37 cm long by 33 cm wide area, and began at 108 cm beneath the surface. The feature is visible in the west profile of Unit A12 (Figure 3.12), and this profile shows that the dark sand from Zone C continued down around the faunal remains in a pit with steep walls. The steep walls of the pit with an upright are similar to the postholes found at the Ruby site (Frison 1971, also see discussion of Uprights in Chapter 7). The feature contained the blade portion of a scapula, the juvenile diaphysis of a right radius, a right distal metatarsal, a right proximal epiphysis of a tibia, one lumbar vertebra, one cervical vertebra, a patella fragment, a right ilium, an incisor, two mandibles, and four ribs. The ribs were not collected, and the mandibles are missing from the collection.

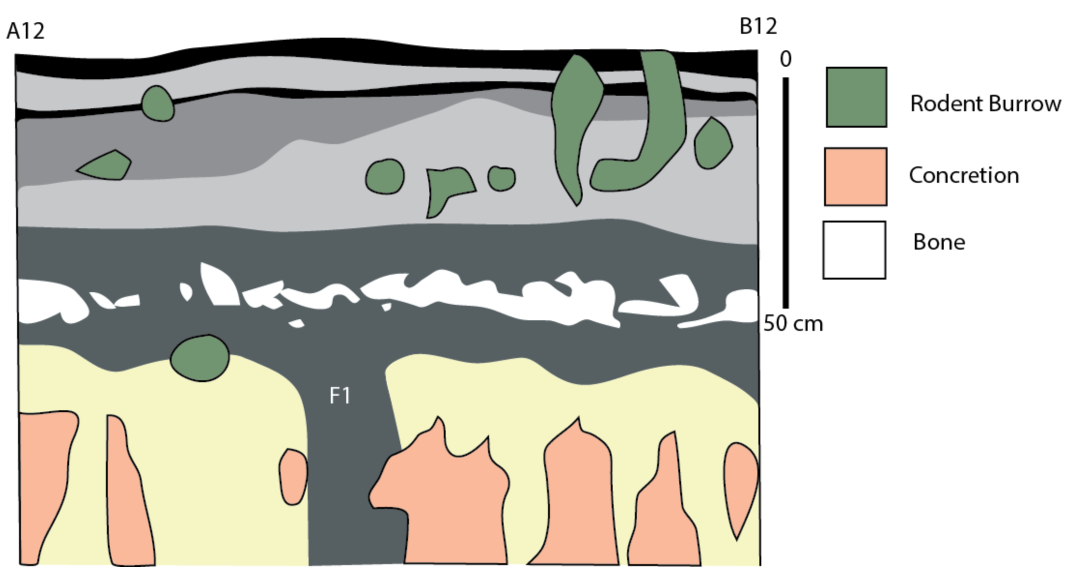

Figure 3.12: West profile of Unit A12 with Feature 1 in wall.

7Feature 2

Feature 2 is an upright along the east wall of Unit B12 with two bison bones positioned vertically into the sediment, running down into the yellow sand from the bone bed. Excavators collected a right femur shaft and a left juvenile calcaneus from this feature.

Feature 3

Feature 3 is an upright with four bison bones and a large cobble positioned vertically in the sediment. The feature measures 15 cm in diameter, and begins at 108 cm below the surface. Archaeologists retrieved a cervical vertebra, one first phalanx, one long rib shaft fragment, and one flat bone fragment from this feature. It is not clear what arrangement the faunal remains and the rock were in, but there are similar features found at the Stelzer site (See Appendix C and discussion about upright features in Chapter 7).

Feature 4

Feature 4 is an upright inside of a larger pit underneath the bone bed in Unit B13. The larger pit is 40 cm in diameter, and extends from 108 to 208 cm below the surface. The upper portions of this pit were filled with larger bone fragments and light grey sand. Inside the larger pit was an upright measuring 20 cm in diameter, with nine bison bone elements arrange vertically in the sediment. Collected from this feature are two metapodials, as well as a complete right metatarsal, cranial fragments with a petrous pyramid, an atlas vertebra, the scapular process from a scapula, and fragments from a complete right pelvis. Based on the profile of the feature in the south wall of B13 (Figure 3.13), the walls of the feature are straight, extending deep beneath the Zone C Stratum. The fill is the same as the overlying black sand, indicating that the pit was intrusive into the Zone D yellow sand. The upright is along the west wall of the pit. This arrangement is similar to Feature 1 and the postholes and uprights seen at the Ruby site (Frison 1971). This feature is mostly like a large posthole with bison bone jammed along side to give added support.

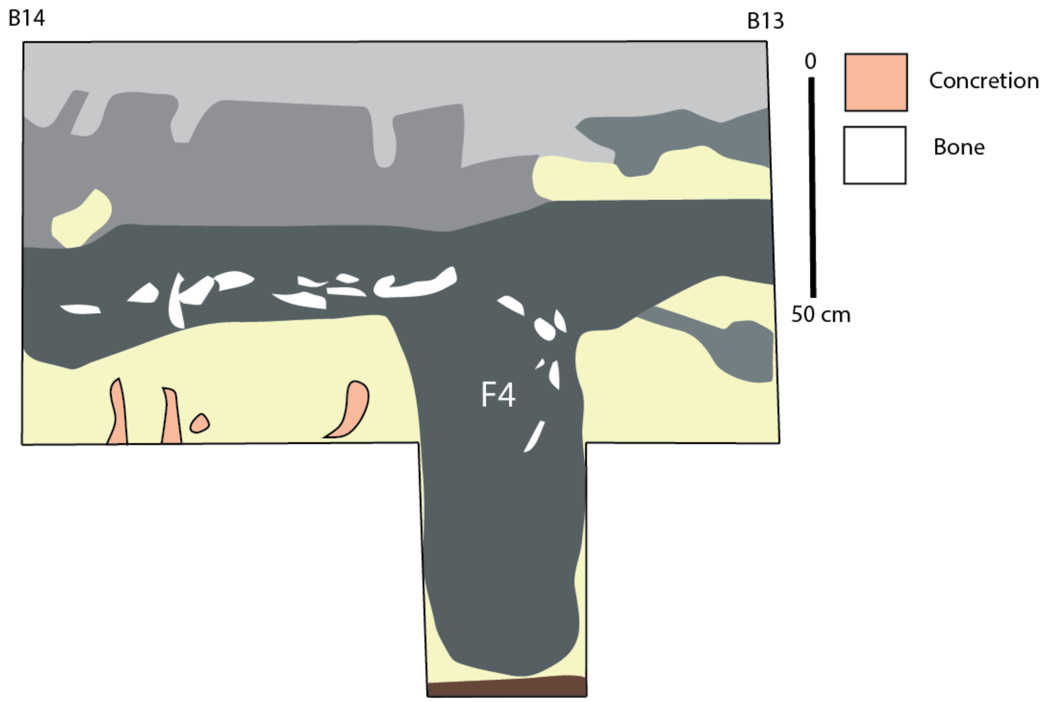

Figure 3.13: South wall profile of Unit B13 with Feature 4 in wall.

Feature 6

Feature 6 is an upright in the southwest corner of Unit A14, where a large number of bones were piled and several positioned vertically into the sediment. This upright and the pile associated with it contained a large maxilla portion, fragments of two mandibles, several cervical and thoracic vertebrae (some in articulation), atlas vertebra, carpals, tarsals, and phalanges. It is not clear which elements were in the upright or in the pile. Visible in the south profile of Unit A14 (Figure 3.20), the black sand of Zone C follows the shape of the feature down through Zone D; this arrangement indicates that the upright bones were positioned in an existing pit.

Feature 7

Feature 7 is an upright found 110 cm below the surface in the northeast area of Unit A13. Gruhn's crew collected fifteen bison bones and an indeterminate number of carpals and tarsals from the pit: I have identified two left distal femora, a right proximal femur, a complete left and right radii, a right distal humerus, a left humerus, an immature right metatarsal, a left scapula head, two left acetabuluae, a molar, a left patella, and two thoracic vertebrae from this feature. The pit contained grey sand, and was intrusive into the Zone D stratum.

Feature 10

Feature 10 is an upright located on the south side of the B11/B12 baulk. The pit contained two complete radii, a first phalanx, a navicular cuboid, one large complete axis, and a carpal.

Figure 3.14: Feature 10 in profile, view southwest. Photograph courtesy of Ruth Gruhn.

Feature 12

Feature 12 is a pit in the southwest corner of Unit B10, extending below the level of the bone bed. The pit had a diameter of 30 cm, and contained several large limb bones, carpals, phalanges, and rib fragments. Based on a photograph of the feature, there are three distal radii and one proximal tibia present, as well as some phalanges and carpals.

Figure 3.15: Feature 12 in profile, view west from Gruhn (1969:150).

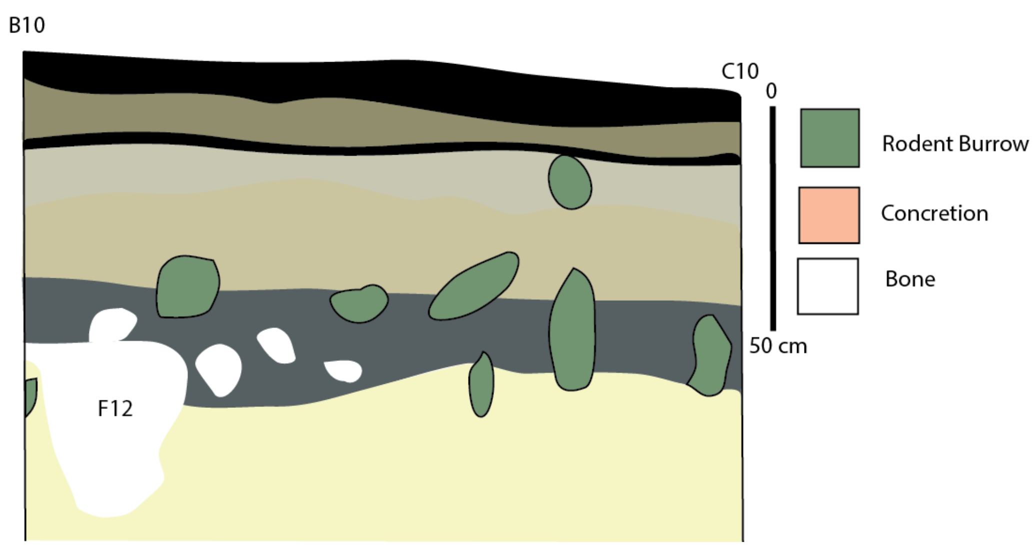

Figure 3.16: West profile of B10 with Feature 12 in wall.

Feature 13

Feature 13 is a small hearth, roughly 20 cm in diameter, found in the northwest corner of Unit B10. This small pit contained darker coloured sand, with small fragments of burned bone and charcoal in the walls of the feature. The hearth was overlain with unburned rib and bone fragments, indicating that the feature must have been created at an earlier stage of occupation at the site, before it was covered up by unburned bone.

Feature 14

Feature 14 is a series of concentrations of burned bone fragments in Unit B14. This unit had the greatest concentration of burned bone from the site, but excavators found the burned bone in a larger area throughout Units B12, B13, and B14. There are five main concentrations of burned bone, although the content of these features is not clear. Gruhn collected samples of burned bone for conventional radiocarbon dating, and these sample bags contained hundreds of small (less than 5 cm long) bone fragments charred completely black. Most of the bone fragments were not identifiable, but I recorded several long bone fragments, small rib fragments, phalanges, and vertebrae within the radiocarbon samples from this area. Uncharred bone fragments overlay these concentrations, indicating that the burn event had occurred during an earlier stage of occupation at the site.

Feature 15

Feature 15 is a series of modern postholes that have affected areas of the bone bed. These modern intrusive features removed portions of the bone bed, presumably from when the Muhlbach family initially discovered the site.

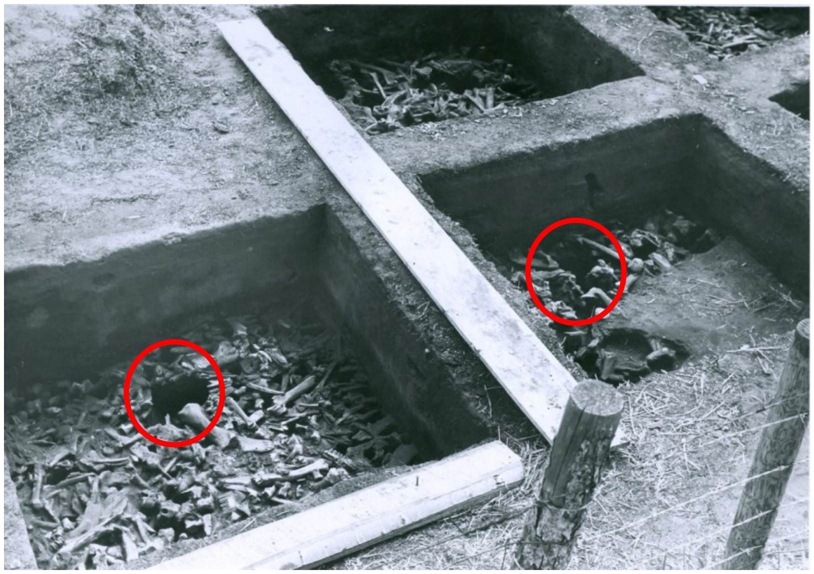

Figure 3.17: Main trench with Unit C10, B10, and B11. Feature 15 circled in red. View southeast. Photograph courtesy of Ruth Gruhn.

Feature 16

Feature 16 is a wedge shaped pit along the north wall of Unit B12. The Zone C stratum in the northwestern corner of the unit started to dip down below the top of Zone D, but the excavator did not record the dimensions of this pit. The profile indicates that the pit was 50 cm wide at the wall. Based on the profile some elements are oriented vertically, although the contents of this pit are unknown.

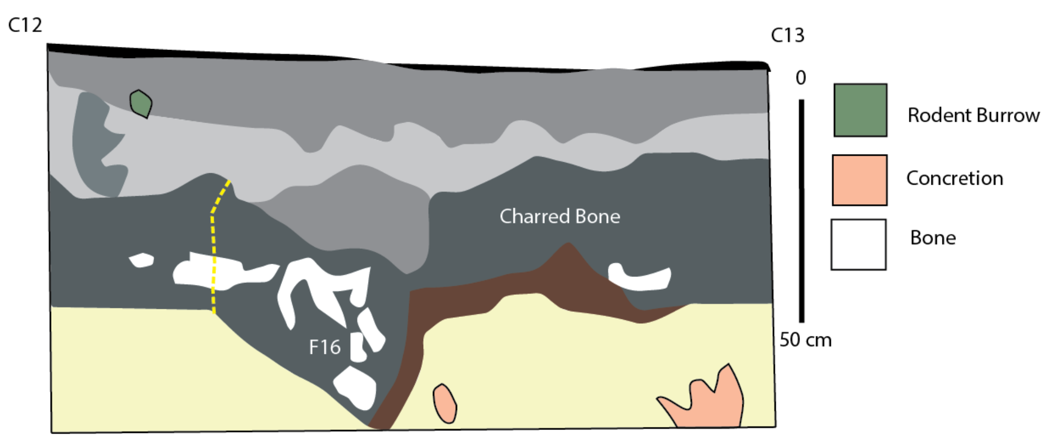

Figure 3.18: North profile of Unit B12 and Feature 16. Yellow line indicates limit of charred bone in profile.

Feature 17

Feature 17 is a wedge shaped pit in the southeast corner of Unit A12. This feature can be seen in the south and east profile of the unit, the south profile shows a wedge shaped pit (Figure 3.20), but the east profile indicates a straight edged pit (Figure 3.19). The pit extends 20 cm north from the south wall and approximately 40 cm on the east-west axis. Based on the south profile of the feature, there appear to be several elements oriented vertically in the sediment, but the exact contents of this feature are unknown.

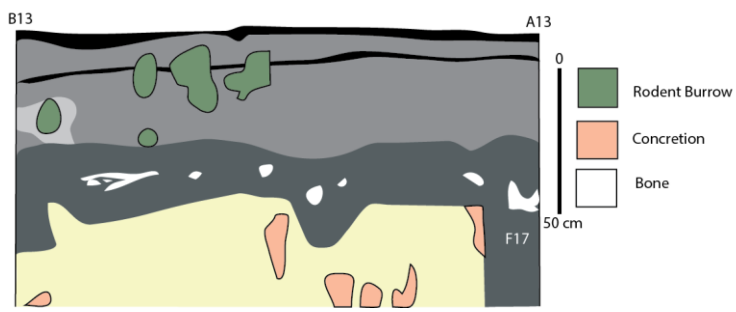

Figure 3.19: East profile of Unit A12 with Feature 17 in wall.

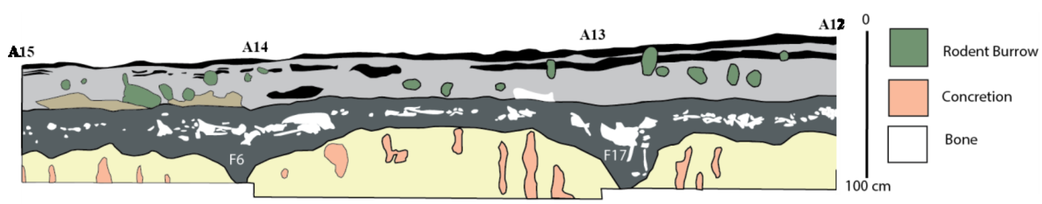

Figure 3.20: South profile of Units A12, A13, and A14 with Features 6 and Feature 17 in wall.

Feature 18

Feature 18 is comprised of several large cobbles surrounded by flakes of bone in the baulk between Units C10 and B10. The bone fragments presumably resulted from smashing bone on the cobbles to extract the marrow, or for grease production. The researchers did not collect the cobbles, and therefore I cannot verify any wear from this activity; the proximity of the bone flakes, as well as the Feature 13 hearth, makes this configuration interesting.

Features in the Eastern Excavation Trench

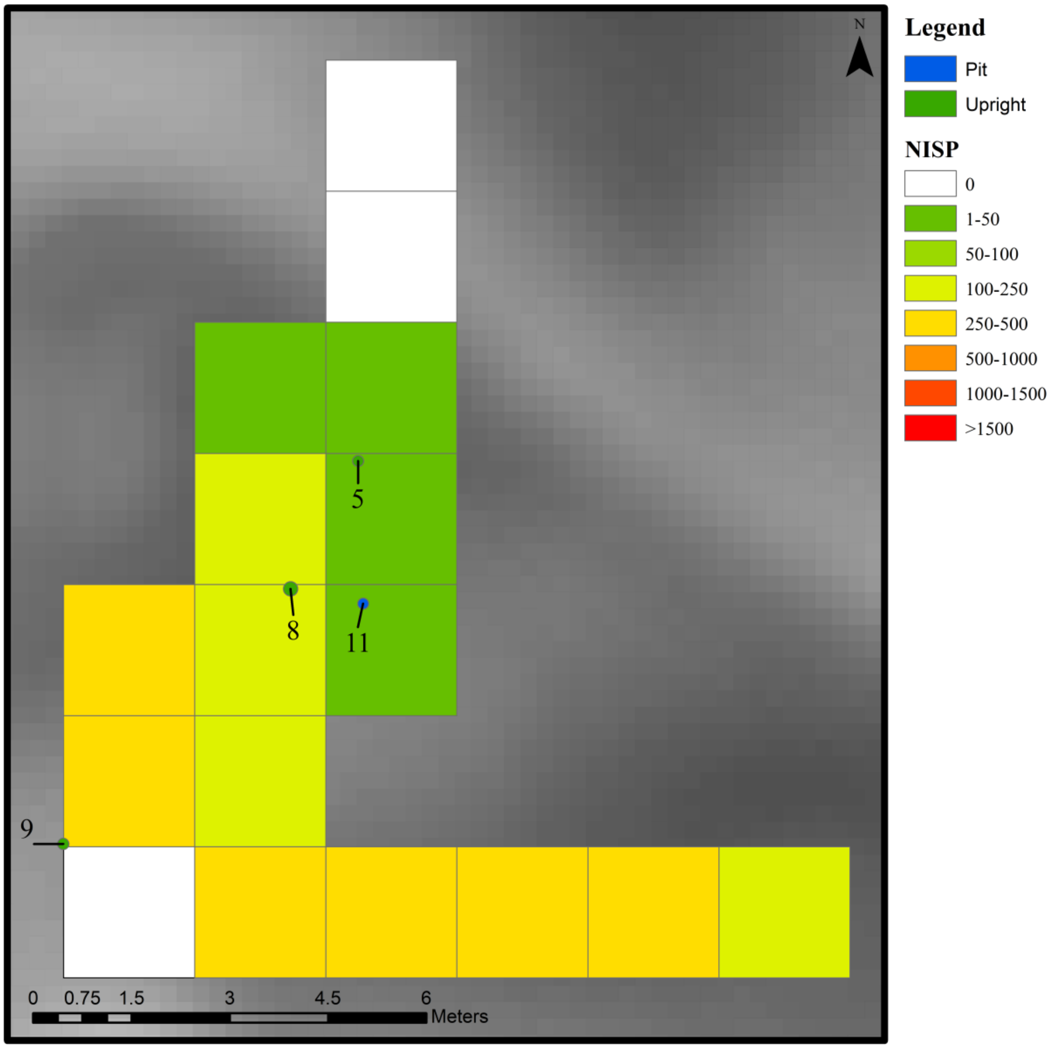

Figure 3.21: Features in eastern excavation trench.

Feature 5

Feature 5 is an upright along the north wall of Unit D21. Researchers recorded little information on the contents of this feature, only that several limb bones were found clustered in a vertical position.

Feature 8

Feature 8 is a bone upright lying on the east side of the baulk between Unit C20 and D20. Bone was positioned vertically in a pit that was 20 cm in diameter, and extended to a depth of 40 cm below the bone bed. Excavators collected 19 elements from the feature, from which I have catalogued a mandible, thoracic, cervical, and unidentified vertebral spinous processes, two scapulae, one humerus, a right distal tibia, a left metatarsal, an ulna, a right calcaneus, long bone fragments, a first phalanx, and four ribs.

Feature 9

Feature 9 is a bone upright with a single mandible positioned vertically in the sediment. The mandible was directly underneath the Unit B19 datum, with the condyles oriented down. The upright starts in the Zone C stratum and pushes through into the Zone D stratum. This is unlike the other upright features in which the Zone C stratum continues around the bones; this feature had been pushed into the underlying sediment, rather than dug and placed in.

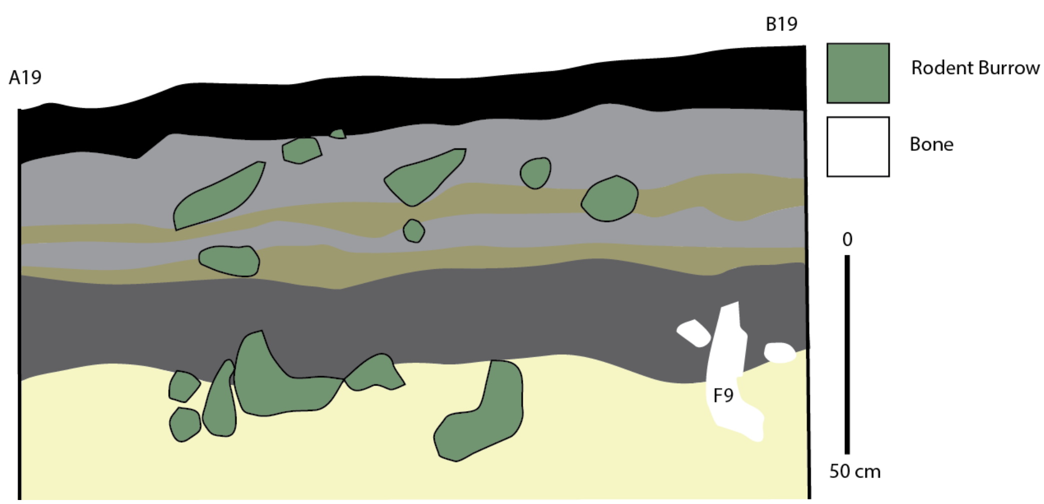

Figure 3.22: Unit A19 west profile with Feature 9 in wall.

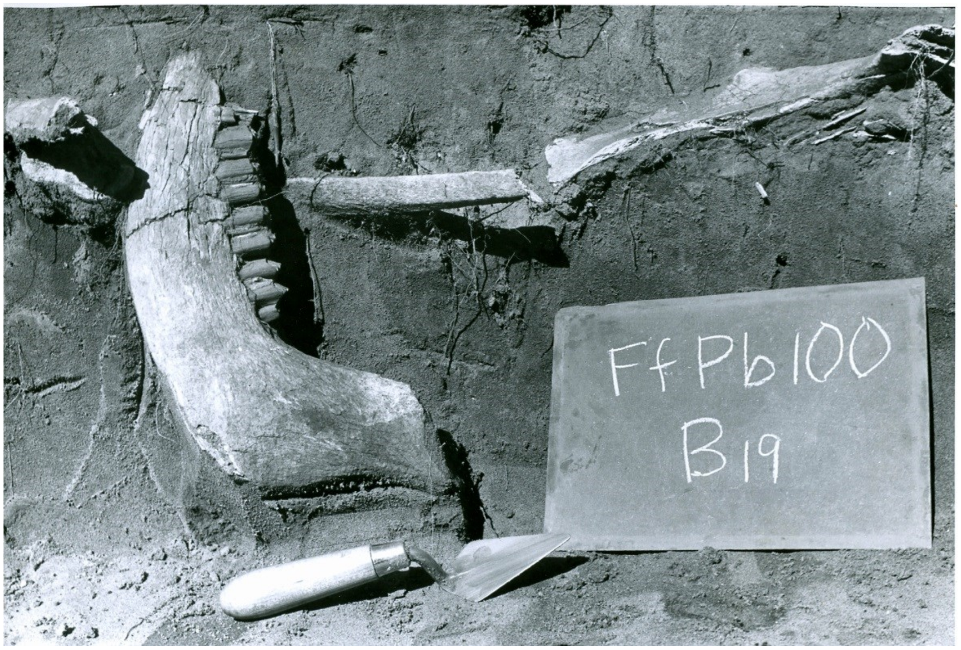

Figure 3.23: Feature 9 in profile, view west. Photograph courtesy of Ruth Gruhn.

Feature 11

Feature 11 is a pit in the northeast corner of Unit C21. Gruhn's team found the circular area of dark sand with a diameter of 15 cm, at 91 cm below the surface, and it extended to a depth of 118 cm. The walls of the feature were completely straight, and the excavators did not collect any bone or artefacts from this feature. This feature was likely a posthole.

Distribution of Burned Bone

One of intriguing characteristics of the Muhlbach bone bed involves the large concentrations of burned bone found throughout the main trench. Depicted in Figure 3.24, these concentrations are located in the main excavation area in Units B14 and over a wider area in Units B12 and B13. In the rest of the site, the burned bone follows the same trend as the overall density of bone, having the highest density in the main trench and incremental lower amounts in the eastern and northern area. This layer of burned bone is interesting, but taphonomic issues and idiosyncrasies around quantification of burned bone (Table 3.2) need to be considered before further inferences can be made.

Table 3.2: Percentages of Burned bone from Muhlbach

Element	Burned	NISP	%	Element	Burned	NISP	%
TTH	13	521	2.5	METC	2	125	1.6
MAND	2	307	0.7	PEL	9	164	5.5
CRA	2	160	1.3	FEM	1	206	0.5
ATL	4	49	8.2	PAT	0	55	0.0
AXIS	0	45	0.0	TIB	2	248	0.8
CER	0	208	0.0	AST	33	261	12.6
THOR	1	303	0.3	CAL	5	259	1.9
LUM	3	115	2.6	LMAL	7	38	18.4
SAC	0	32	0.0	2+3TAR	29	88	33.0
Cau	0	16	0.0	NCUB	3	177	1.7
VRT	26	612	4.2	METT	4	187	2.1
RIB	90	1931	4.7	PHAX	62	1717	3.6
SCAP	7	216	3.2	SES	9	257	3.5
HUM	1	130	0.8	METP	15	64	23.4
RAD	5	229	2.2	FLT	2	34	5.9
ULN	1	123	0.8	LB	25	1045	2.4
CARP	25	786	3.2	UN	1596	2430	65.7
				Total	1984	13138	15.1

As can be observed in Figure 3.24, Unit B13 has significantly lower quantities of burned bone, even though adjacent units yielded an abundance of burned elements. This pattern is a collection bias, chiefly because excavators did not collect or even map all of the burned bone. Rather than map and collect each of these fragments, excavators gathered several general sample bags from each Unit. Gruhn (1969) consumed the Unit B13 sample bags for a conventional radiocarbon date, and thus these sample bags cannot be included in the 2014 inventory. The amount of bone would likely be similar to the neighbouring units. Based on the contents of these sample bags, it appears that the burned bone area (Feature 14) had a high concentration of small (~ less than 5 cm in size) pieces of completely charred black bone underlying the unaltered bone that made up the rest of the faunal assemblage.

The effect heating has on bone has been a subject of interest in archaeology and osteology, specifically for quantifying the effect heat has on structure, chemistry, and size of bone (Lebon 2010; Shipman *et al.* 1984; Stiner *et al.* 1995). It is evident that the burned bone from Muhlbach was exposed to variable degrees of heat, as some elements were charred completely black while others exhibited only limited heat alteration. Calcined bone was not recovered from the site, although the friability of calcined bone may have led to its exclusion from the assemblage. The colour range of burned bone indicates that the burned bone was exposed to a fire ranging between 285° and 440°C, for at least 15 minutes at the higher temperature ranges and at most 120 minutes at the cooler end of the range (Lebon 2010:149; Shipman *et al.* 1984:314), a range similar to reported values for campfires, although the maximum temperature of a campfire is largely dependent on the type of fuel (Shipman *et al.* 1984:308). It seem unlikely that the concentrations of burned bone came from a campfire, as the concentrated burned bone areas (Feature 14) are too large for some type of hearth.

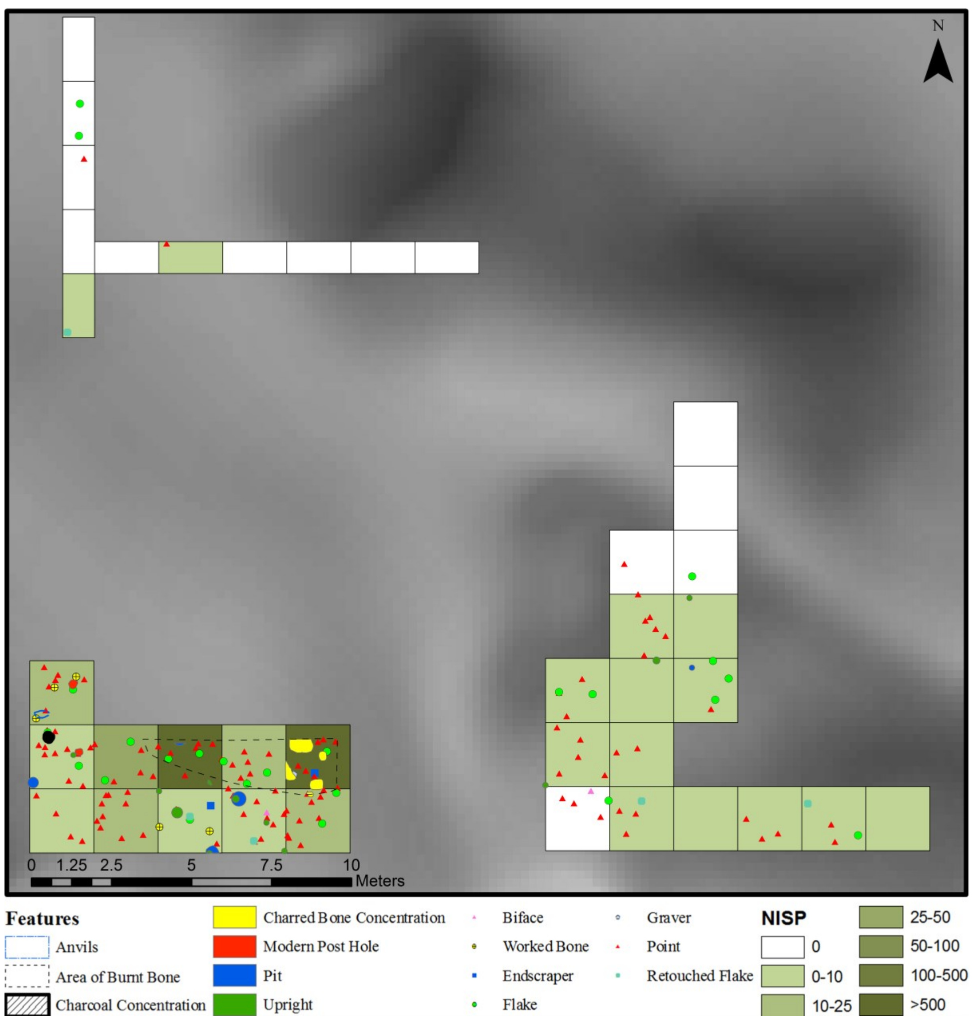

Figure 3.24: NISP of burned bone fragments by unit.

It is possible that wild fires burned part of the bone bed, although it is generally thought that wild prairie fires would not attain the heat to burn bone like this (Brink 2008:164). Wild grass fires on the plains will burn quickly and hot, reaching 682°C at the ground surface, but they lack longevity, only exceeding 65°C for a few minutes (Stinson and Wright 1969:171). If the bone at the Muhlbach site was exposed to a wild grass fire, it is unlikely that there would be sufficient time or heat to char the bones black. Furthermore, once the bone bed was buried, it is even less likely that a natural fire could have altered the bone.

The burned bone concentrations at Muhlbach are similar to the contemporary Besant site, Fitzgerald (Appendix A), where at the east end of the bone bed in Area 1, Hjermstad (1996:38) reported a 20 cm thick deposit of burned bison bone fragments. Comparing MNI, MNE, and MAU of the kill site, processing area, and burned zone at Fitzgerald, Hjermstad (1996:122) concluded that this area was a bone dump from where the hunters burned the bone at a separate location and disposed of it in a pile at the kill site. He based this interpretation on the equal number of high and low utility elements found in the burned zone, indicating that there was no selection of meat, fat, marrow, or grease; rather the hunters used the bone as fuel in fires and deposited them back in the kill site (Hjermstad 1996:214).

It seems more likely that the burned bone layer at Muhlbach was from cleaning up the kill site. The practice of burning a fresh kill site to clean up the smell and rotting carcasses is commonly cited in the archaeological literature, but has not been documented in ethnographic or historical sources. Verbicky-Todd (1984) detailed several dozen European accounts regarding the state of these communal kills; the sheer quantity of rotting meat and flesh often offended the European observers, and on occasion the smell would give cause to move the camp, but nowhere is it recorded that the kill sites were burned to clean them up. Brink (2008:166) postulated that the smell of decomposing bison could drive off future game as well as making camp life unbearable, as shifting wind directions could alert bison herds and drive them away from a gathering basin used for kills.

Despite the lack of comparative examples for the practice, it seems likely that Muhlbach was burned intentionally to clean up the site. A low pile of bison bone with a similar distribution to Muhlbach (Figure 3.17) would burn with some encouragement and produce enough heat to char the bone. In this circumstance, the piles of bone would only calcine if a concerted effort was made to maintain the heat of fire; if the bone bed was lit and left to burn, it would likely not attain sufficient temperatures for long enough to calcine the bone (Lebon 2010:149). Furthermore, superposition of unaltered bone over burned bone suggests that an earlier kill was burned in order to clean up the area, and then a second kill event occurred that distributed fresh bone on top of the existing burned bone.

Projectile Point Assemblage

The Muhlbach site has received a fair amount of attention over the years in the archaeological literature. Wettlaufer (1956) had defined Besant at the Mortlatch site only a decade prior to the excavations at Muhlbach, and in addition to having an unusual KRF signature, Muhlbach was among the first of many Besant sites investigated. The site has been compared to almost every major Besant/Sonota site for typological studies, as the site provided a large sample of points from a radiocarbon-dated single occupation site. Unfortunately, many of the complete projectile points have gone missing from the Muhlbach collections. Gruhn (1969:140) stated that her team recovered 61 projectile points from the site, 35 of which are now missing. This sizeable portion missing from the projectile point assemblage hampers efforts to conduct comparative analysis between sites. Luckily, significantly more points have been identified within the Muhlbach assemblage, as Gruhn did not initially recognize many of the point fragments and flake points in her preliminary report. In her analysis of the site, Varsakis (2006:225) identified a total 112 projectile points from the site, 40 of which were complete. Gruhn also included 34 additional projectile points from the private collection of Robert Graham in the preliminary report (Figure 3.26). There is still a sizeable sample of projectile points available for analysis from the site, and many excellent analyses conducted on the Muhlbach projectile points. I will review the results of these other studies in lieu of conducting my own analysis.

Though there is a general similarity in body shape for all of the points, Gruhn (1969:140) separated the points into bifacially worked points, and flake points. The former category showed a higher degree of workmanship, with even flaking on both sides of the point. The latter category included 25 points made on small flakes, trimmed to form notches and edges, making the flake into a useable point. These flake points were smaller than the bifacial specimens, but shared many of the same physical characteristics. Straight bases were the most common, although a portion of the assemblage had either slightly concave or convex bases

(Gruhn 1969:141). Light to moderate basal grinding was also common on the points. Gruhn (1969:140) conducted only a limited metric analysis on the assemblage, as she expected Reeves (1983; originally 1970) to incorporate the material into his wider investigation on the Late Precontact period.

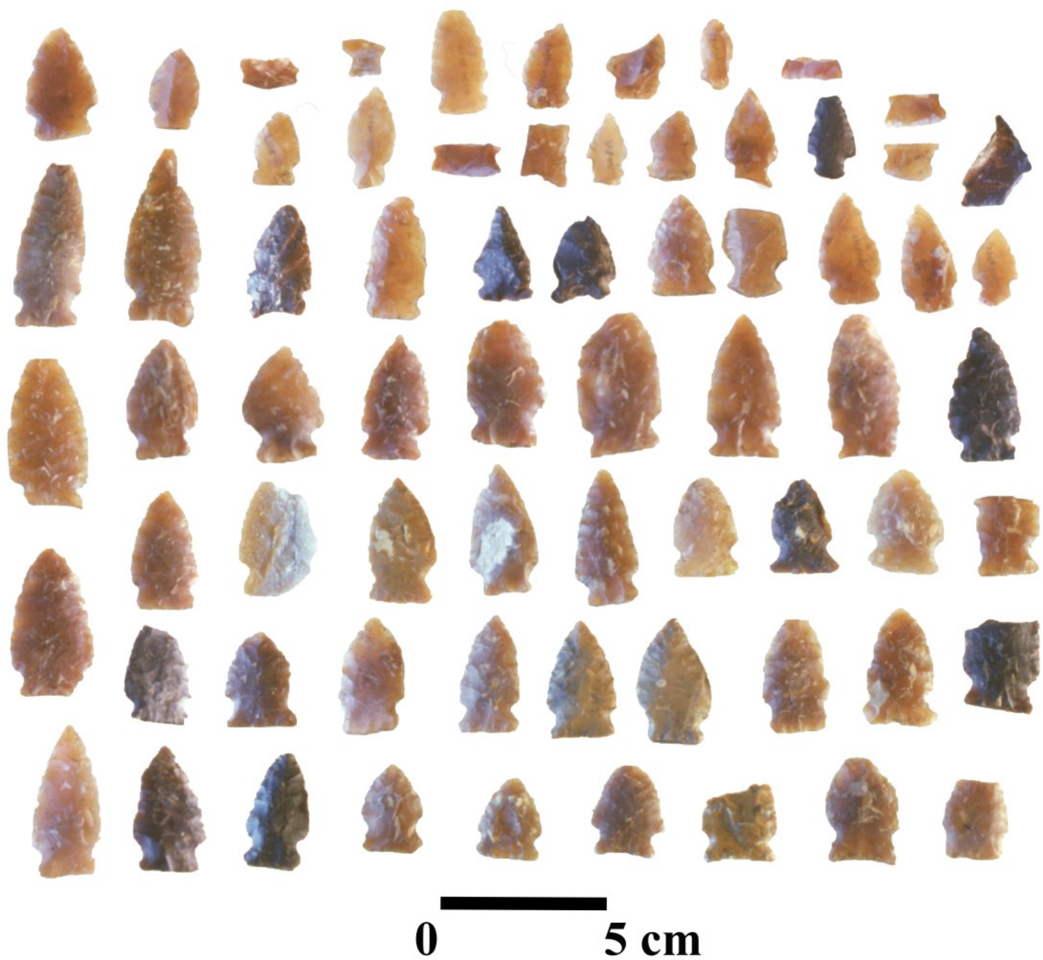

Figure 3.25: Muhlbach projectile points (N=68) as identified by Gruhn (1969). This figure includes many of the missing points, as well as flake points originally not identified by Gruhn. It is a composite image from photographs provided by the Royal Alberta Museum.

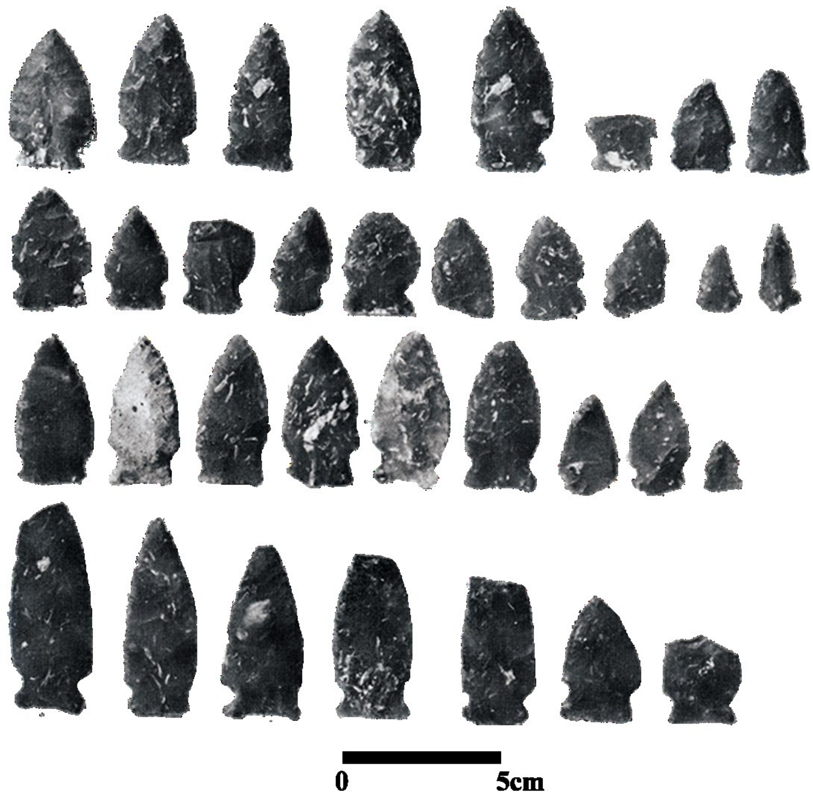

Figure 3.26: Projectile points (N=34) from Robert Graham's personal collection. Adapted from Gruhn (1969:155).

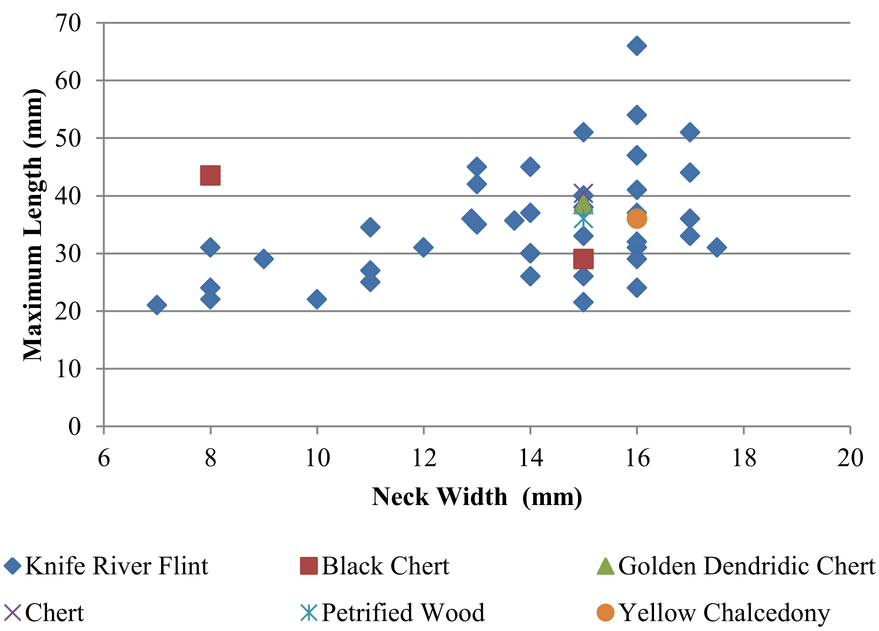

Figure 3.27: Muhlbach point maximum length and neck width compared against raw material types. Metrics and raw material data adapted from Varsakis (2006:229-259).

Varsakis (2006) identified 112 projectile points from the site, and undertook a metric analysis of point morphology for her comparative investigation of Besant, Outlook, and Sonota point forms. Based on her analysis of the material; the Muhlbach points tended to have elongated bodies, with ovate blades, obtuse shoulders, and straight bases (Varsakis 2006:226). Varsakis also identified raw material types of the points (Figure 3.28); KRF was the prevailing material, but there were also minor amounts of chert, chalcedony, quartzite, and petrified wood. Six points are made from a golden dendritic chert, an exotic raw material that is found in Montana (Roll *et al.* 2005:65). Metric and nonmetric analysis of Besant points separated Muhlbach from other contemporary sites based on well-made, long projectile points and heavy reliance on KRF (Figure 3.27) (Varsakis 2006:366). The point assemblage from Muhlbach clustered with the samples from Fincastle, Smith Swainson, Fitzgerald, and the Melhagen site, a pattern interpreted as Sonota hunters coming to trade with Kenny subphase Besant people on the northwestern Plains (Varsakis 2006:368).

Hamza (2013) also conducted a metric analysis of the Muhlbach projectile points, alongside several other similar sites in Alberta, Saskatchewan, and Wyoming. Using a sample of 45 points from the Muhlbach site, she outlined several patterns within the projectile point variability. The Muhlbach points scored low Relative Standard Deviation (RSD) values for maximum width, shoulder width, neck width, and haft length, meaning that these physical attributes of the points exhibited little relative variation within the assemblage (Hamza 2013:111). This is a curious result, as there are several examples of extremely small flake points in the assemblage, which should skew the relative variation for neck width and shoulder width. This may be a sample issue, as Hamza used only 45 points out of the 112 from the site. Among the sampled sites in her study, the length of the projectile points exhibited higher variability within the Muhlbach site. Fincastle, Muhlbach, and Fitzgerald all had longer than average points, as well as greater maximum lengths, than sites that relied on local raw materials (Hamza 2013:112).

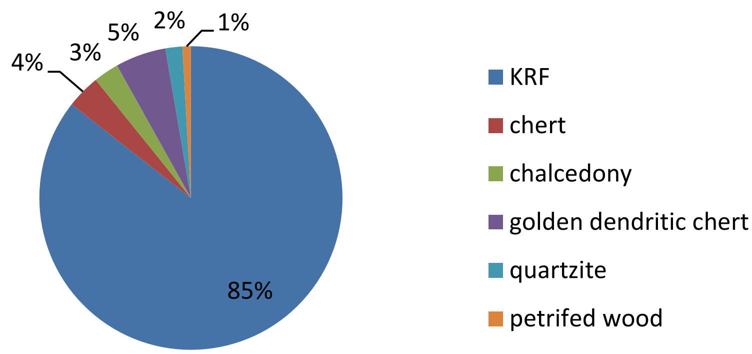

Figure 3.28: Projectile point raw material count from Muhlbach from Varsakis (2006:229-259).

Hamza (2013:174) also calculated the Hafted Biface Retouch Index (HRI) values for her sample. Developed by Andrefsky (2006), this index gives a relative evaluation of the amount of reworking a biface has undergone, in relation to the maximum length. Flake scars that extend to the midline or all the way across the surface of a point are from original tool shaping and assigned a value of zero. Flake scars that do not reach the midline or do not meet with flake scars that extend over the midline are the result of retouch and assigned a value of one (Andrefsky 2006:746). Hamza calculated HRI for a sample of ten points from Muhlbach, revealing a pattern of limited resharpening (Hamza 2013:176). The restricted sample makes meaningful interpretation of point retouch at Muhlbach difficult. In the general pattern for the entire sample of sites, Hamza (2013:174) found that there was more intensive resharpening of points made from KRF as compared to other materials. This observation suggests there was an emphasis on maximizing the utility of this material at these sites.

Hamza's (2013:179) objective was to assess the amount of variability among sites classified as Besant, Outlook, and Sonota, expecting to see the variability within the assemblages correlating with the typological grouping. She found that despite an exhaustive battery of statistical analyses, the overall level of variability among all the sites in the study was negligible. Hamza (2013:169) found that the attributes that had statistically significant variation within each site occurred consistently across all the typological groupings sampled. The attributes that demonstrated the most variability revolved around the blade, characteristics that Hamza (2013:171) considered poor indicators of typological grouping. Furthermore, raw material type had more influence on final point length than cultural choice among the Besant, Outlook, and Sonota typological groupings (Hamza 2013:172).

Further inferences can be made from the neck width of Muhlbach projectile points, as a wide range of neck widths is observed among the points. This feature might arise because both arrow and dart points are present in the assemblage. The bow may have been present during the Besant Phase, although its adoption into the tool kits was variable across space and time. A common technique for separating the two point types uses neck width, as it is thought that this measurement is related to the diameter of the shaft to which it is hafted (Hamza 2013:46; Pyszczk 2003:59). Generally, the dividing line between arrow and dart points is a neck width of 11 mm; this division is tied to the flexibility of the shaft and the weight of the point. For the Muhlbach site, points with incredibly wide and small necks can be observed, but the majority of sampled projectile points lie above the 11 mm boundary (Figure 3.29). While arrow points may be present at the Muhlbach site, the atlatl still dominates the tool kit.

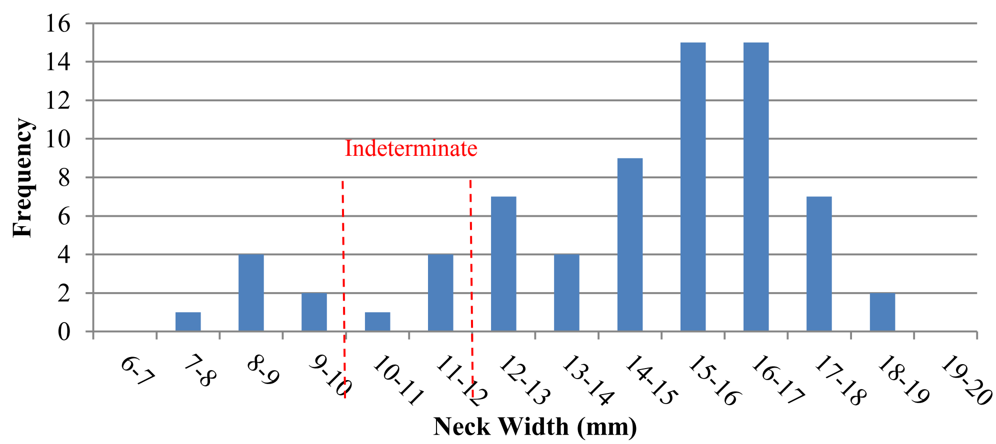

Figure 3.29: Frequency of neck widths at Muhlbach (N=71) with dart/arrow division. Neck width measurements from Varsakis (2006:229- 259).

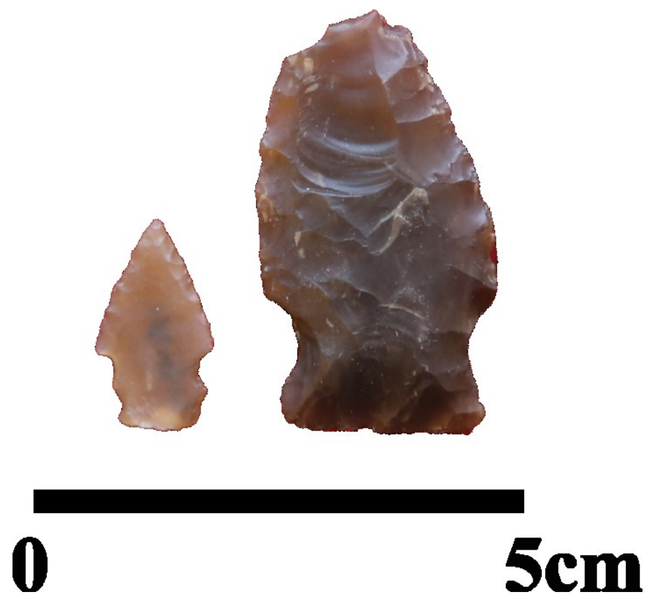

Figure 3.30: Example of bifacial and flake points from Muhlbach.

Dawe (1997) proposed an alternative interpretation of the Muhlbach point assemblage with his analysis of the numerous small, poorly made flake points found at Head-Smashed-In and other northern Plains sites. Researchers have proposed several different interpretations for these small marginally retouched and notched flakes: boring tools, points used to ward off scavengers, hunting of smaller game, and varying skill levels of flintknappers (Dawe 1997:305). Dawe proposed that these small flake points were toys for young First Nations boys. In many northern Plains societies, children received a small bow and arrows to begin practicing archery at an early age. The dimensions of these bows and arrows would be proportional to the age and size of the child, meaning that there should be a size continuum for bow shape and arrow length (Dawe 1997:307).

The expectation is that the point size for children would conform to this continuum. The proportional limitations between the point and shaft of the arrow and the strength of the bow mean that there are specific ranges in which weight and shape will function (Dawe 1997:305-306). If an arrow is too light for the strength of the bow, the projectile will not fly straight, and if the arrow is too heavy, the bow will not properly propel the shaft. These are extremely important variables to ensure projectile accuracy. Looking at ethnographic and archaeological examples of shaft diameter, Dawe (1997:307-309) determined that the neck width threshold between a functional adult arrow point and a toy point fell around eight millimetres. A similar pattern should emerge for dart points, with a higher threshold between dart points and toy versions. When Dawe (1997:311) compared neck widths of flake points and bifacial points for Head-Smashed-In, he found a bimodal distribution, in which the majority of flake points fell below the 8 mm threshold and the bifacial points fell above 8 mm.

Expanding his dataset, Dawe also looked at the flake points from Muhlbach assemblage. While initial calculations determined that there was a bimodal distribution representing use of arrow and dart points, Dawe demonstrated that this bimodality is between the neck widths of flake and bifacial points (Figure 3.30). Dawe (1997:313) argued that if arrows were present at Muhlbach, there should be a bimodal distribution within the bifacial points. Instead, there is a tight unimodal distribution of bifacial points, with flake points occupying the lower portion of the dataset. This result suggests that only atlatl technology was present at Muhlbach, and that the flake points are not arrow points, but representative of toy dart points in the assemblage.

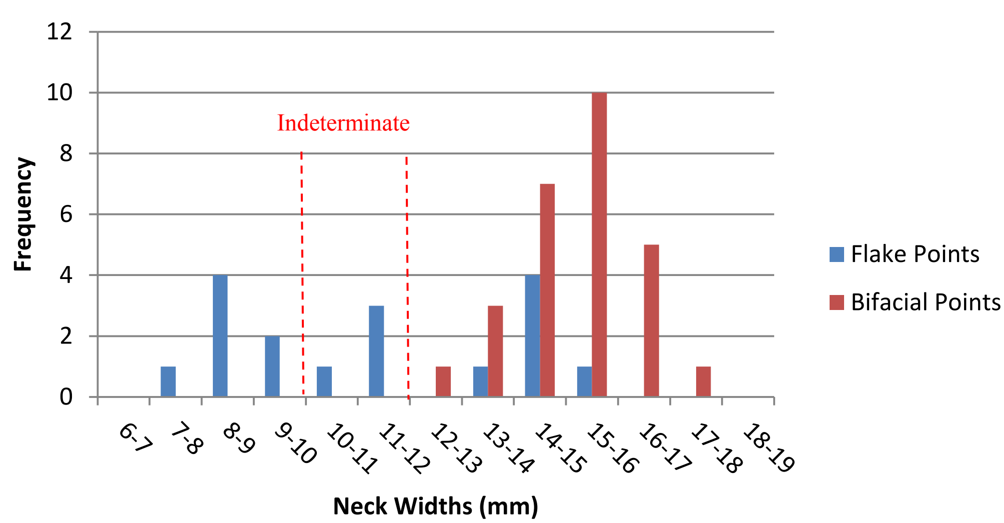

Figure 3.31: Neck widths of flake and bifacial points (N=44) from Dawe (1997:313), with arrow/dart division in red.

Although it is often stated that the bow was introduced during the Besant phase, Dawe (1997) showed how some of these small points could actually be toy dart points rather than arrows. Furthermore, researchers have used the poorly understood Samantha "arrow" point to indicate the use of bow at Besant sites. The neck width for Samantha points range between 14 and 16 mm (Varsakis 2006: 24), a value that is still higher than the functional 11 mm threshold for arrowheads. These Samantha points are simply termed arrowheads, as they are smaller than a typical Besant point, a conclusion that is not based on any metric and functional analysis. A systematic study is needed to evaluate whether arrows were actually present in Besant assemblages.

Retouched Flakes, Bifaces, and Stone Tools

Aside from the numerous projectile points from the site, there were several examples of bifacial and unifacial stone tools. Collected from the site were four retouched flakes, two endscrapers, one graver, one uniface, and four bifaces. While limited, this sample demonstrates an emphasis on tools used for butchery. Several of the artefacts are KRF (5), but the majority are locally available materials such as quartzite (6) and chert (1). The tools made from KRF tend to be smaller than those made from other materials. Descriptions and measurements of each tool can be found in Appendix B.

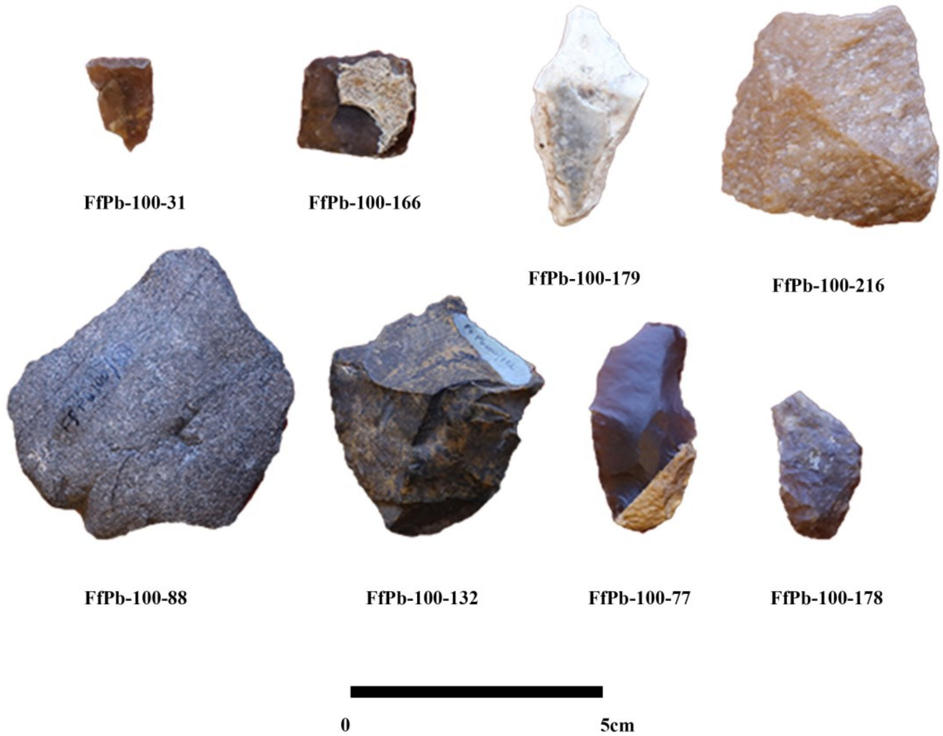

Figure 3.32: Flake tools from Muhlbach, oriented with the platforms down.

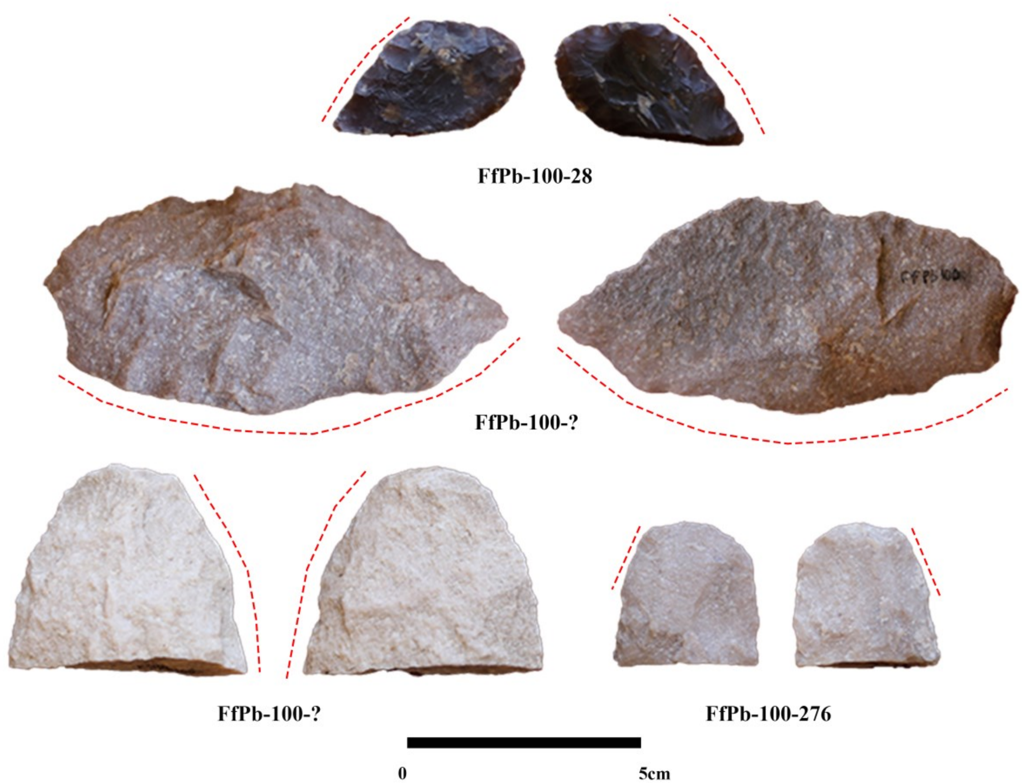

Figure 3.33: Bifaces from Muhlbach. Red indicates edge grinding.

Bone Tools

While Gruhn (1969) and her team did not initially identify any bone tools, they did note several intentionally altered faunal elements during excavation. During the inventory of the faunal collection, I identified more bone tools in the collection. The people at the site had purposefully shaped these elements beyond butchery and they exhibited wear consistent with use as a tool. Like the rest of the faunal assemblage from the Muhlbach site, these tools show considerable wear from taphonomic processes, but I was able to see cut marks, polish, and striations in certain instances, which were documented using a Dino-Light Digital Microscope. All of the bone tools reviewed here are relatively crude, this aspect likely reflects the expedient and rudimentary nature of these artefacts. I believe that these tools were abandoned at the Muhlbach site as new faunal elements were fashioned into replacement tools and taken from the site. Supplementary information and descriptions of each tool can be found in Appendix B.

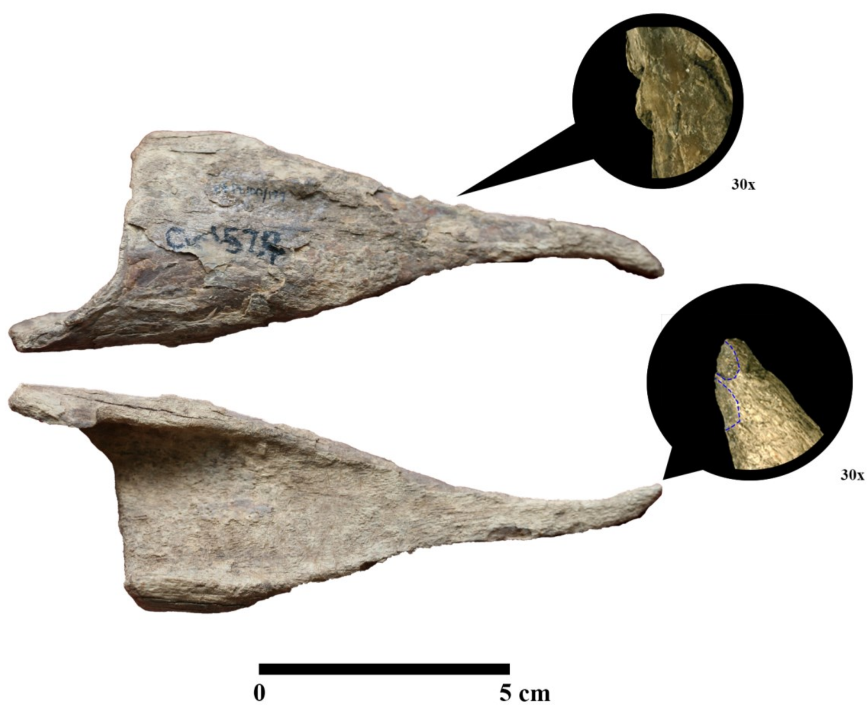

Figure 3.34: FfPb-100-117. Forward and reverse image of bone gouge with magnification of chop marks along the side and flake scars on tip.

Figure 3.35: A12-565. Scapula spokeshave with beveled groove.

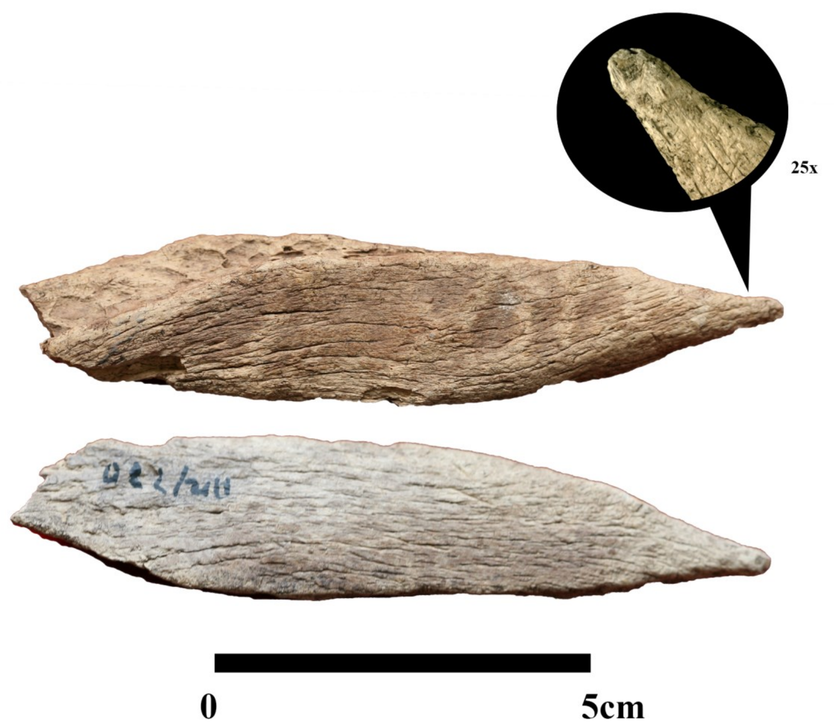

Figure 3.36: A12-780. Small awl with rounded tip.

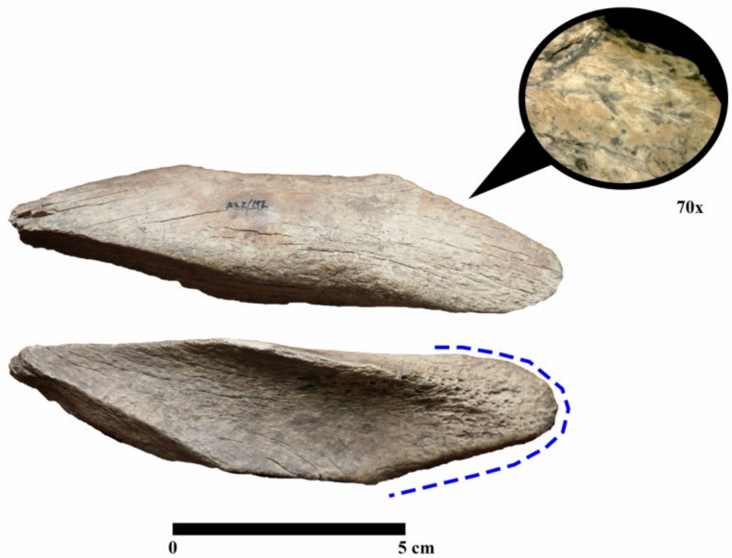

Figure 3.37: A22-192. Bison radius with heavy polish along curved edge (blue demarcates extent of polish). Magnification shows linear striations and "V" shaped cutmarks in this area.

Figure 3.38: C10-127: Scapula beamer with oblique, front, and reverse views. Blue demarcates edges of flake scars.

Debitage

Despite screening the sediments from the site, little debitage was recovered. These flakes were spread widely throughout the bone bed, and do not indicate any intensive lithic reduction work area at the site. Gruhn's crew collected 102 pieces of debitage from the site, the majority of which are KRF (Figure 3.39). The remainder is primarily quartzite, with small amounts of siltstone and various cherts. Aside from the exotic KRF, there are two flakes of tan chert recovered from the site. These are similar to some of the points made from a golden dendritic chert. This type of chert has been typically associated with sources found in the Madison Formation in western Montana (Roll *et al.* 2005:65). In addition to the limited amount of debitage at the site, the flakes are also small. Most KRF flakes are under 1 cm in size, and none exceeds 3 cm. Even the other raw materials are diminutive, with the largest flakes only reaching 4.5 cm long. Gruhn (1969:144) stated that there were large flakes over five cm in diameter, these larger flakes were actually retouched and used as tools. Furthermore, few of the flakes showed any cortex: there were 8 primary flakes, 10 secondary flakes, and 84 tertiary flakes in the collection. Almost all of the primary flakes were from small quartzite pebbles that had been split by bipolar percussion. There was a primary and one secondary KRF flake that exhibited some cortex, but these flakes were still extremely small. The minor amounts of debitage at the site all stem from the sharpening of tools and wastage from edge use, with no concerted effort toward lithic reduction.

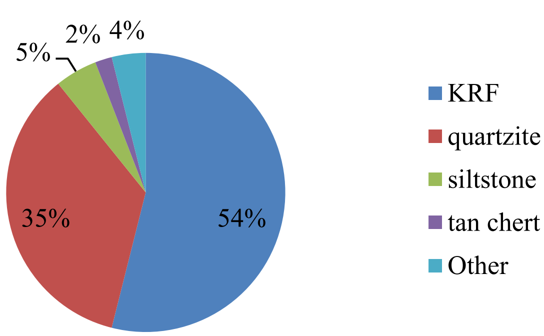

Figure 3.39: Muhlbach debitage and raw material counts.

Fire Cracked Rock and Cobbles

There were numerous cobbles that were discovered at the site, but many were not collected. I am assuming that the appearance of these larger cobbles is cultural, as the windblown sediment that comprises the matrix at the site would not have naturally-occurring large cobble inclusions. Many of these rocks had evidence of heat alteration, which could be evidence of nearby unknown boiling pits. However, the concentrated burn of large areas of the bone bed could have been sufficiently hot enough to affect the rocks. This possibility, coupled with an even distribution of the cobbles across the main trench, dissuades against the notion that the cobbles originated in boiling pits and were disposed of in the kill area of the site. There should be a concentration of fire cracked rock (FCR) where the boiling pits were emptied of rock after use, instead of an even and light distribution throughout the site.

Gruhn (1969) mapped 124 cobbles in the Main excavation area, although there could have been more. She concluded that the cobbles were used as hammerstones for breaking up the faunal remains. Quartzite, sandstone, and granite were reported for material types, roughly in equal proportions. Some cobbles may have been part of anvils for breaking bone, notably Feature 3 and 18. Feature 18 had several large cobbles surrounded by small bone flakes, suggesting a work area for bone marrow and bone reduction for grease processing. Feature 3 was an upright with a cobble, similar to anvil features at the Stelzer site (See Chapter 7 for discussion of upright features). Both of these features were located around a small hearth, further highlighting this area of the site as a potential work area.

Summary

The artefact assemblage from the Muhlbach site contains a large number of projectile points, made primarliy from KRF as well as other locally available materials. Based on the neck widths of the projectile points, it is quite likely that only atlatl technology was present at Muhlbach. The small points made on trimmed flakes may very well have been for children. Other tools included bifaces, endscrapers, and some bone tools, but these are infrequent. The limited amount of debitage recovered from the site demonstrates that intensive lithic reduction was not carried out at the kill site. With the foundation of the Muhlbcach excavation laid, we can further explore other aspects of the assemblage.

Chapter 4 – Analysis of the Muhlbach Site Faunal Assemblage

In-depth analyses of faunal assemblages can illuminate many aspects of an archaeological occupation, and are particularly useful at bison kill sites in which large samples of faunal remains can be recovered. Unfortunately, the faunal assemblage from the Muhlbach site has had a complicated history, and never received a thorough evaluation and analysis. Gruhn (1969) conducted a limited analysis on the fauna in her preliminary report, with intent to return to the subject, but this initial analysis was based largely on in-field observations and the on-site faunal catalogue. Other previous research included Shortt (1993), who used the Muhlbach faunal assemblage in his Master's thesis as a comparison to the Happy Valley Bison Kill site near Calgary. Shortt's (1993) work did not include the entire collection, as much of the collection remained stored in the original paper bags and unidentified. A stable isotope study was carried out by Chisholm *et al.* (1986), who used samples from the Muhlbach site to study bison carbon stable isotopes on the northern Plains. Aside from these three publications, several undergraduate term papers have targeted the collection over the past forty years, largely focused on calculating herd structure and determining season of occupation. This piecemeal approach to the collection has caused difficulties for organization and curation, creating a disorganized assemblage with several missing components.

In order to rectify the situation, I undertook a complete inventory of the collection, and attempted to correct several issues regarding the state of the collection that hampered this task. One such issue was the original cataloguing of the faunal assemblage. During the excavation, excavators gave every bone a catalogue number written directly on the bone, or they placed the bone in a bag with the corresponding catalogue number. This catalogue number referred to the unit the bone was from (e.g., A10) and a sequential number for identification within the unit (e.g., A10-243). The excavators created paper plan maps of the main trench using these catalogue numbers to reference individual elements, this system made it possible to relate every bone back to the unit it came from.

The issues with the cataloguing system and the collection arose because the bone was stored loose in cardboard boxes and paper bags for the past 40 years. Exposed to fluctuating levels of temperature and humidity, as well as abrasion from other bones in the boxes, the faunal remains from the Muhlbach site began to break apart. The cortical bone surface began to break off, thinner specimens simply snapped in half, and some bones simply turned into powder. As a result, the catalogue numbers that contained all the provenience information were lost, affecting the ability to recreate an accurate picture of the distribution of faunal remains across the units. Furthermore, there were errors during the initial cataloging in the 1960s; some specimens have the wrong numbers written on them, or the field cataloguer wrote down the wrong number in the notes. In some instances, a faunal element had catalogue numbers and units that did not exist; for example, someone clearly labelled one specimen as being from Unit A43. While it is not unusual to see cataloguing and clerical mistakes in any curated collection, these errors limit what can be reliably assigned to different units, and ultimately affect our ability to assess the distribution of faunal remains.

As previously discussed, the storage conditions of the faunal collection have caused attrition to the collection. As I evaluated the collection, I found that many of the cardboard boxes used to hold the bones were filled with broken bone fragments with no number, or pieces that eroded to trabecular bone, in addition to a fine powder of bone that lined the bottom of all the boxes. This post-accession attrition has seriously affected the condition of the faunal assemblage and the interpretative value of the collection. For example, a box of ribs that may have contained forty whole elements would now contain double or triple that number of rib fragments, many without any catalogue and spatial information. While it was possible to use colour to separate fresh fractures due to storage apart from the ancient trauma, some specimens had been so extensively fractured in storage that little of the original element was left. In order to prevent future damage and to organize the collection, a group of volunteers and I placed all bone fragments in resealable plastic bags with the catalogue number written on the bag. We bagged and reassigned a new number to any specimen that was missing a number or was illegible. I took these steps to create a catalogue system that would allow any future research conducted on the site to be cross-referenced with my own work.

With the cataloguing and storage issues in the collection accounted for, it was possible to address another significant issue with the collection. Muhlbach is an important site and an old collection, so important diagnostic components of the faunal collection have been loaned out over the years for analysis. Unfortunately, this practice led to the misplacement of several significant components of the assemblage with little explanation, most importantly the mandibles. Except for two specimens, all mandibles with preserved tooth rows have gone missing some time in the past twenty years. This loss is extremely significant, as mandibles are useful in determining age at death and seasonality for a faunal assemblage, but their absence from the collection makes investigation along this avenue impossible. The collection is also missing several foetal bison remains, Shortt (1993:263) reported measurements from foetal humeri and metapodials that were used to calculate seasonality for Muhlbach, but I was unable to find this collection of foetal remains. As mandibles and foetal remains are potent constituents for seasonality interpretation, their absence impedes a complete analysis of the site.

To correct these limitations and omissions, I supplemented the faunal inventory with information from the original 1965 field catalogue. This catalogue lists every bone and number that was collected from each unit, and some information regarding the element, portion, and side. The information has intermittent quality, dependent on the skill of the recorder and the level of detail ascribed. While this is not an ideal situation for analysis, it does permit the filling of gaps in the faunal data. In addition, when comparing the 1965 catalogue made at the site and the inventory completed in 2014, it became apparent that a great deal of bone had been discarded at the site. Small bone fragments, ribs, carpals, and the like were recorded during the excavation, but not retained in the collection. These missing elements were included into the final inventory, supplemented with relevant information from the 1965 catalogue.

As the 2014 inventory proceeded, we identified and catalogued each bone fragment using a variety of analytical parameters to provide further information on each specimen, such as the individual catalogue number of each fragment, and the number of bone fragments associated with those catalogue numbers. The quantity of bone per catalogue number was usually one, but some catalogue numbers were associated with multiple bone fragments that had originally comprised a single element. Any bone fragments that did not have a catalogue number were assigned a new sequential number (e.g. FbPf-1-1, FbPF-1-2, etc.), and were grouped based on similar attributes. The new catalogue number sequence does not conflict with the original faunal catalogue, as bone fragments were labelled using units and an internal sequential number (e.g. A10-501). It also does not conflict with the artefact catalogue, as the site was originally designated FfPb-100, and all the artefacts are labelled using this prefix. Identification of class and taxon was also included in the catalogue, but all elements were identified as *Bison bison* or large mammal consistent with bison, so there is little variation within the catalogue.

The element, portion, side, and age were determined for each specimen in the collection, using an assigned code for every bone in the skeleton. My volunteers and I described the portion of each element using directional terminology; we listed limb bones as complete, proximal, distal, or shaft portions, while we described vertebrae as complete, body, or the spinous process. We used head, neck, and shaft to characterize fragments of femora, humeri, and ribs, where applicable. We divided scapulae by head, neck, blade, and scapular process fragments. We classified the pelvis based on the individual bones of the pelvic girdle, and the portion of those bones. Portions included the ilium, the ischium, the pubis, and any combination of these three. If complete, we recorded the specimen as the acetabulum; in addition, we noted if the neck, blade, and crest based on the segment of each bone was present. Fragments of the skull were identified based on the segment of the cranium they comprised (e.g. basioccipital, condyles, petrous pyramid, maxilla). The majority of the cranial fragments were unidentifiable to portion, and in those cases, my volunteers and I simply listed them as fragments. We classified mandibles based on the segment present: complete, condyles, ascending ramus, alveolar process, diastema, and incisors.

We catalogued carpals, tarsals, and phalanges as complete or fragments. Unfused juvenile elements were divided into either diaphysis or epiphysis, and then the directional portion of each element (proximal, distal).

When it was possible to determine, we recorded side and age of each specimen. We listed many elements as left, right, or unknown, and classified ribs based on the type and side when possible (e.g. R1 for right first rib). I also asked my volunteers to label vertebrae in this manner, based on the vertebra in sequence (e.g., S1 for the first sacral vertebrae). Due to the poor preservation of these elements, we could not determine this aspect for much of the collection. We defined age as either adult or juvenile based on epiphyseal fusion. We identified perinatal remains when either a volunteer or I noted the extremely small bison elements in the collection; these were set aside for further analysis.

The final attribute recorded was any alterations to the bone. This category records all taphonomic evidence including cut marks, gnaw marks, types of fractures, flake scars, weathering, exfoliation, mineralization, root etching, and evidence of burning. I asked my volunteers to identify cut marks based on linear "v" shaped grooves into the cortical bone surface that had a similar colour as the surrounding bone, as opposed to fresh gouges and scrapes from recent trauma. Rodent gnaw marks were recorded when a specimen exhibited small, linear, parallel, square grooves into the cortical bone surface, typical of rodent incisors (O'Connor 2008). Evidence of canid gnawing showed as large punctures and craters into the cortical bone surface, especially around the articular ends of long bones. We defined two types of fracture patterns; linear fractures with jagged edges denoting fractures occurring after the bone had become dried, and spiral fractures from breaks occurring when the bone was still fresh and green (Byers 2008). Many specimens exhibited linear fractures, as this typically occurred when the bone desiccated in storage. Green fractures occur when fresh bone incurs significant trauma, causing the element to bend, shear, and separate (Byers 2008:318). Most of the long bones at Muhlbach demonstrated spiral fractures, which typically form when torsional forces are applied to these element after the shafts are cracked by blunt force, and twisted to expose the marrow cavity; this is a practice common among hunter-gathers to break apart large mammal carcasses (White and Folkens 2005:62).

With all of these parameters along with the catalogue information, it is possible to recreate an accurate representation of the faunal assemblage. While there are issues around the integrity of the collection, all archaeological research depends on sample size and quality, and many taphonomic processes affect these attributes. Even with the post-accession issues, there is still an enormous dataset with significant interpretative value, which can aid us in our understanding of the Muhlbach site.

Quantifying the Assemblage: NISP, MNE, MAU, and MNI

Using the previously discussed compiled datasets, we can begin to assess and quantify different attributes of the collection. These data are summarized in Table 4.1, organized by Number of Identified Specimens (NISP) per element. NISP quantifies the number of individual bone fragments that can be attributed to different species and element (Brumley 1973; Grayson and Frey 2004; Marshall and Pilgram 1993). For example, two bison scapulae elements that were broken into six fragments would have an NISP of six, even if these fragments make up two complete bones. This method of counting can be useful for representing the number of bone fragments per taxa in an assemblage, although there are many criticisms made regarding the usefulness of NISP for proportional representation of different species; luckily, these biases are reduced in a single taxon assemblage (Shortt 1993:73-74).

NISP has issues under normal circumstances, but even more so with the Muhlbach faunal assemblage. The column designation 2014 represents the actual NISP remaining in the collection, regardless of catalogue or accession numbers. As previously described, the faunal assemblage suffered enormous attrition from storage, breaking bone fragments down even further. This situation means, using the previous example, that the two scapula fragments broken into six pieces would be counted as NISP=6 instead of the original NISP=2. The NISP from the raw 2014 inventory over-represents the number of bone fragments in an assemblage, especially with specimens and elements classes that have suffered the most attrition. In total, there are 12 654 bone fragments in the collection, all identified as either bison or large mammal. While it is possible that small unidentified and long bone fragments could represent elements of other large mammals, like elk or moose, we identified neither of these species in the rest of the better-preserved assemblage. Considering that the Muhlbach site is clearly a bison kill site, bone fragments that can only be identified as large mammal are assumed to be bison.

Table 4.1 also shows the number of specimens that required new catalogue numbers in the collection, as well as a percentage of elements that needed new numbers. This figure gives a measure of how post-accession attrition affected the various components of the faunal assemblage. Overall, 17% of the collection has lost provenience information, but attrition was variable depending on the amount of bone stored in each box and size of the fragments. Categories that included more general element identifications incurred more damage; unidentified carpals and tarsals, flat bone fragments, and metapodials have the highest percentage of missing numbers, as the bone fragments in these groups had suffered more attrition than other classifications, causing the catalogue numbers to come off the bone. Ribs, vertebrae, and long bone fragments also suffered, with around 25% of the specimens missing their catalogue numbers. Also listed in Table 4.1 is the missing information from the 1965 faunal catalogue used to flesh out the database.

Table 4.1: Muhlbach NISP counts from the 2014 catalogue with the number and percentage of the collection that received new catalogue numbers, and the amount and percentage of the collection missing based on the 1965 catalog.

Element	2014	New	%	Missing	Compiled	% Missing
Mandible	105	10	9.5	220	307	72
Teeth	17	3	17.6	10	16	63
Molars	11	3	27.3	492	492	98
Incisors	1	0	0.0	30	31	97
Cranial	148	14	9.5	41	173	24
Petrous Pyramid	89	11	12.4	5	76	7
Atlas	53	7	13.2	12	49	24
Axis	44	5	11.4	10	44	23
Cervical	244	32	13.1	27	201	13
Thoracic	329	48	14.6	49	302	16
Lumbar	150	19	12.7	6	113	5
Sacrum	38	5	13.2	3	32	9
Caudal	15	1	6.7	4	17	24
Vertebrae	735	156	21.2	241	602	40
Rib	2249	531	23.6	1212	1918	63
Scapulae	349	90	25.8	59	215	27
Humerii	191	10	5.2	15	126	12
Radius	261	35	13.4	32	227	14
Ulnae	132	11	8.3	14	118	12
Lunate	107	28	26.2	0	77	0
Cuneiform	61	8	13.1	0	50	0
Pisiform	55	6	10.9	0	47	0
Magnum	71	7	9.9	0	57	0
Scaphoid	77	8	10.4	0	63	0
Uniciform	79	9	11.4	0	58	0
Metacarpal	122	10	8.2	15	130	12
Pelvic	226	59	26.1	31	163	19
Femora	217	30	13.8	42	205	20
Patella	56	4	7.1	12	54	22
Tibiae	241	12	5.0	53	247	21
Lateral Malleous	43	5	11.6	3	38	8
2+3 Tarsal	94	6	6.4	0	83	0
Calcaneum	248	19	7.7	39	259	15
Navicular Cuboid	211	13	6.2	7	175	4
Astragulus	248	17	6.9	38	258	15
Metatarsal	202	26	12.9	24	202	12
Phalanx	67	5	7.5	12	27	44
1st Phalanx	736	108	14.7	174	709	25
2nd Phalanx	616	63	10.2	148	622	24
3rd Phalanx	325	14	4.3	64	342	19
Long Bone	911	249	27.3	550	1461	38
Flat Bone	62	20	32.3	0	26	0
Metapodial	76	29	38.2	30	63	48
Carpal/Tarsal	43	18	41.9	412	429	96
Sesamoid	241	27	11.2	95	253	38
Unknown	2430	485	20.0	891	1056	84
Total	12655	2235	17.7	4324	12213	35

The comparison between the 2014 and 1965 catalogue highlight some of the deficiencies in the faunal collection; overall there is approximately 30% of the faunal materials missing from the collection (NISP=4336), with some elements missing significantly more often than others. For example, 70% of the mandibles were missing, along with approximately 99% of the loose teeth from the site. Also missing in large proportion are rib fragments, long bone fragments, and carpals/tarsals. The condition and number of these elements limited their analytical value in comparison to the time and effort involved in collecting, cataloguing, and curating, and as a result, the archaeologists on site were more likely to discard these small elements in the field over other larger elements. These elements also suffered the most attrition in storage, leading to the highest percentage of missing catalogue numbers from the collection. I gathered all of these various data sources to create a catalogue as complete as possible. This compiled count of bone will be the functional NISP used for calculating other parameters of the faunal assemblage, like Minimum Number of Elements (MNE), Minimum Number of Animal Units (MAU), and Minimum Number of Individuals (MNI).

MNE determines the lowest possible number of a particular element needed to encompass the entire faunal collection, based on the assumption that whole elements had been originally present (Grayson and Frey 2004). This assumption is particularly true for large kill sites where primary butchery is occurring. This measure is based usually on the largest number of a particular portion, regardless of side. In a situation in which there were 12 proximal femora and five distal femora, the MNE would be 12, as there had to be at least 12 femora present at the site to create this assemblage. MAU relies on the calculation of MNE, as this measure divides the number of elements represented at the site by the number of times that element appears in the skeleton. For most limb bones, I calculated the MAU by dividing the MNE by two; I determined the MAU for phalanges by dividing by the MNE of each phalanx by eight, as each type of phalanx occurs eight times within artiodactyls. This measure scales the value of MNE in terms of skeletal representation; a faunal assemblage may contain numerous phalanges, but these elements are four times more common than limb bones so it would be expected that phalanges would be common in the assemblage. Using MAU structures MNE by evaluating the minimum number of animals required to create the assemblage; it is a derived measure of abundance that can be used with an interpretive framework for analysis.

Researchers use the MNI to determine the absolute minimum number of animals required to make the entire faunal assemblage (Shortt 1993:78), and to ascertain taxa representation and meat yields. This measure takes into account element, portion, and side to determine the number of animals represented in the kill. For example, a collection with four right proximal femurs and two left distal femurs would have a MNI of four. While MNI can be calculated for all elements, it is common to use only the element with the highest value to represent the number of animals present in an assemblage. Often the values for MAU and MNI are similar, as each measure attempts to quantify the number of animal units present at the site. I have summarized the counts for NISP, MNE, MAU, and MNI from the Muhlbach site in Table 4.2. An MNI of 128 bison was determined for the site, based on right calcanei. If I extrapolate this calculation from the excavated 134 m^2 to the entire 1 250 m^2 bone bed, there should have been roughly 1 200 bison killed at the site during the occupation. This estimation is based on several assumptions: an accurate size estimation for the bone bed, an even distribution of bison faunal remains across the site, and that all bison killed at the site remained in situ. This estimate is not to be a definitive measure of the number of animals killed at the site, rather to give a sense of scale to this particular occupation.

There are some differences between the MNE, MAU, and MNI values from Shortt (1993:266-267) and the 2014 inventory, but the differences mainly stem from an overall proportional increase in the counts for all elements. Calcanei replaced astragali for highest MNE and MAU, but the three major tarsals remained extremely abundant at the site, and lumbar and thoracic vertebrae are more equally represented in terms of MAU, but still relatively low at the site. Shortt (1993:276) also noted a lack of carpals compared to the extremely abundant tarsals. He attributed this pattern to butchery techniques. As previously discussed, the lack of carpal elements at the site is likely tied to collection biases from the excavation. I combined the MNE for all carpal elements with the missing carpals from the collection, and divided by 12 for the number of times all carpal elements appear in a bison skeleton, and I employed this final MAU to calculate the %MAU used in the modelling. This adjustment inflates the representation of carpals at the site to more accurately reflect the original faunal assemblage.

Table 4.2: Muhlbach NISP, MNE, MAU, and MNI.

Element	NISP	MNE	MAU	MNI	Element	NISP	MNE	MAU	MNI
Mandible	307	166	83	63	Scaphoid	63	63	32	35
Teeth	16	16	/	/	Uniciform	58	58	29	30
Incisors	30	30	/	/	Metacarpal	130	90	45	44
Molars	486	486	/	/	Pelvic	163	88	44	52
Cranial	247	69	35	27	Femora	205	113	57	48
Atlas	49	49	49	49	Patella	54	54	27	19
Axis	44	44	44	44	Tibiae	247	144	72	68
Cervical	201	175	35	/	Lateral Malleous	38	38	19	22
Thoracic	302	236	17	/	Astragulus	258	209	105	122
Lumbar	113	88	18	/	Calcaneum	259	242	121	128
Sacrum	32	32	6	/	2+3 Tarsal	83	83	42	46
Caudal	17	17	2	/	Navicular Cuboid	175	175	88	91
Vertebrae	602	216	/	/	Metatarsal	202	112	56	55
Rib	1918	183	7	/	Phalanx	27	/	/	/
Scapulae	215	101	51	44	First Phalanx	709	701	88	/
Humerii	126	76	38	39	Second Phalanx	622	622	78	/
Radius	228	88	44	51	Third Phalanx	342	342	43	/
Ulnae	118	105	53	52	Carpal/Tarsal	429	/	/	/
Cuneiform	50	50	25	28	Metapodial	63	/	/	/
Lunate	77	77	39	47	Long Bone	1461	/	/	/
Magnum	57	57	29	30	Flat Bone	26	/	/	/
Pisiform	47	47	24	22	Sesamoid	253	253	16	/
					Unknown	1056	/	/	/

Alteration of the Faunal Assemblage through Taphonomic Processes

Taphonomic processes are classified as natural and cultural transformations affecting a bone fragment throughout time, filtering the data that is transferred from the living population to the archaeologist, and from the archaeologists to publication (O'Connor 2008:190. These processes are divided into several levels relating to the transmission of information as the bone passes through different lenses, each that bias the final dataset. These taphonomic processes included biotic, thanatic, perthotaxic, taphic, anataxic, sullegic, and trephic factors (O'Connor 2008:20-21). Biotic processes relate to the pre-death natural and cultural environmental factors that influence the faunal assemblage, such as climate and hunting strategies. For a northern Plains example, a biotic process would be the decision to target bison cow-calf herds instead of bulls. Thanatic processes reflect the manner in which the animals die and enter the archaeological record. For archaeologists, this process is mainly by hunting, but it can also include natural death. Perthotaxic processes affect faunal remains once they enter the archaeological record, and how the faunal assemblage is altered and moved before it is buried. This stage of taphonomy includes evidence of butchery, scavenging, and any geologic process that would disperse and alter the bone prior to burial. Anataxic processes are related to perthotaxic ones, since these processes occur when a faunal assemblage has been re-exposed to the geologic processes after burial. An example of this would be if a flood buried a bone, but then the bone was re-exposed centuries later by water erosion, and carried downstream. Taphic factors are commonly referred to as "taphonomy" or "diagenesis;" this category includes physical and chemical weathering after burial (O'Connor 2008:20). The final two taphonomic stages are related to archaeological excavation and research. Sullegic processes reflect sampling decisions that affect the collection and recovery of faunal remains, while trephic processes occur during curatorial and research stages of the faunal collection lifespan.

All faunal assemblages undergo these taphonomic processes, although thanatic, perthotaxic, and taphic processes are more often noted in archaeological literature. These factors affect the final available sample for analysis, and researchers need to consider them to strengthen any interpretative standpoint. I will discuss biotic processes, such as herd structure and age at death later in this chapter, but the age and location of the site means that the dominance of bison in the assemblage is to be expected. The thanatic processes affecting the site assemblage are also evident, as there are many large communal bison kill sites on the northern plains.

I will examine perthotaxic processes throughout this chapter, since these relate mainly to the butchery practices at the site. Maps of the bone bed in the main excavation trench show concentrated arcs of bone, suggesting purposeful manipulation and alteration of the distribution of faunal remains. Some elements had evidence of canid gnawing, demonstrated by crushing and puncture marks through the cortical bone on the epiphyses of long bone (Haynes 1983; Sala *et al* 2013; Watts 2008:34). While cultural processes constituted the majority of alteration to the bone bed, carnivore scavenging was an important taphonomic factor. There was also ample evidence of rodent gnawing on some elements; this observation is not surprising, as the site was riddled with rodent burrows. One interesting perthotaxic process to note is the linear cracking fractures on long bone fragments, a pattern associated with sub-aerial weathering (O'Connor 2008:24). When exposed to open air and sunlight for an extended amount of time, the cortical bone surface will begin to dry and crack, forming linear fractures that follow the internal fibre structure of the bone tissue (Grayson 2004). This observation, coupled with the generalized weathered and exfoliated state of the faunal assemblage, supports the viewpoint that the bone bed was exposed on the surface for some time before burial. This taphonomic process was observed on the current collection, but it can also be seen on in situ elements in Figure 4.1.

Figure 4.1: Unit A14 showing evidence of sub-aerial weathering on the bone. Photograph courtesy of Ruth Gruhn.

Various taphic processes were evident in the Muhlbach faunal assemblage. The most prominent alteration was the heavy staining of the bone, ranging from dark to light brown. This colouration is likely from the black sand stratum around the bone bed, and the high water table at the site, staining the bone with a brown patina. Some specimens also showed a degree of mineralization, in which a reflective patina had developed on the surface of the bone. Furthermore, water will weaken the periosteum of bone tissue, causing any cut marks and evidence of butchery to erode away (Watts 2008:33); this factor could explain the general absence of cut marks present in the assemblage. These factors indicate that the faunal assemblage had undergone variable exposure to water, enough to partially mineralize, and stain the bone, as well as damage the periosteum. Root etching was also observed at the site, but there is little information on the cause of these marks; the "U" shaped, dendritic grooves can be caused by moss and microorganisms as easily as plant rootlets (Lyman 1994:375).

The final two taphonomic processes had enormous effects on the physical faunal collection. As previously discussed, sullegic processes (i.e., collection decisions) determine the raw counts of different elements and bone fragments present in the assemblage, and this factor affected the overall counts for different elements in the assemblage. Trephic processes relate to storage attrition, and how well a collection is curated, a substantial factor with the Muhlbach assemblage. Shortt (1993:284) approached this issue by determining the affect bone density had on survivorship for the Muhlbach collection, assuming that there should be a correlation between bone density and overall abundance if the collection was compromised. By comparing %MAU element abundance in the collection to Kreutzer's (1992) bone volume density for bison elements, Shortt found that there was a weak positive correlation between increasing abundance and increasing density, meaning that more dense bone was more likely to survive the taphonomic processes. Rather than arguing for attrition-based utility curves for Muhlbach, Shortt (1993:284) pointed out that high food utility elements have low bone density, so that they would likely be removed from a primary kill site in either case. Furthermore, he noted that several lower density elements that were more abundant than higher density elements at the Muhlbach site (Figure 4.2), such as the distal tibiae over the atlas vertebrae or the carpals over several other long bone elements. This finding is contrary to the notion that the Muhlbach faunal assemblage reflects only natural taphonomic processes, as these low-density elements should be less abundant than the high-density elements (Shortt 1993:287), demonstrating that some cultural transformations in the assemblage can be detected, and that abundances in the Muhlbach assemblage do not only reflect weathering and attrition.

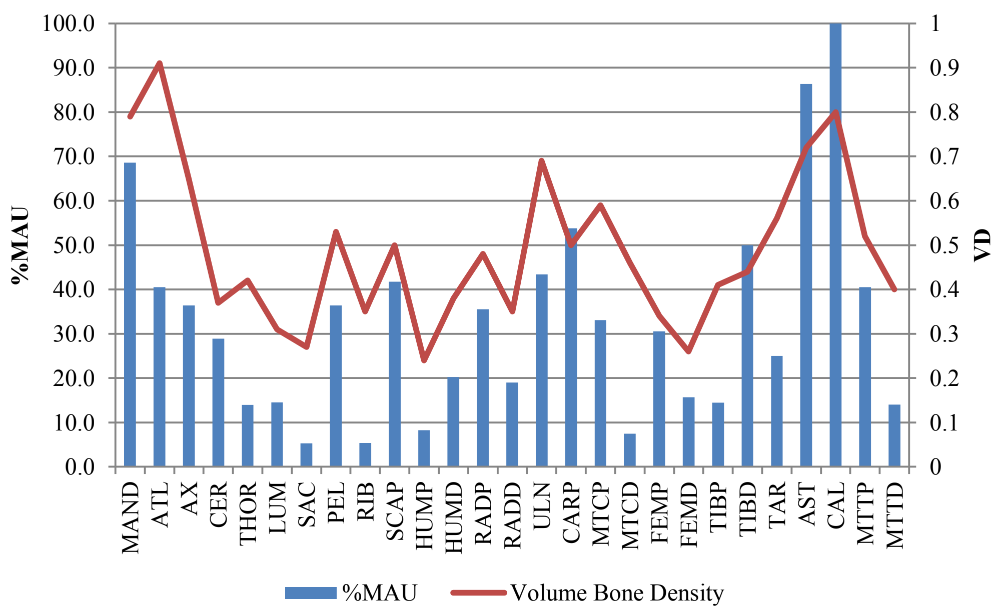

Figure 4.2: Muhlbach Element %MAU plotted against bone density (Kreutzer 1992:278).

Element Portions –The Axial Skeleton

Mandibles

There were 307 mandible fragments collected from the site (Table 4.3), although the majority of these are currently missing. Excluding the unknown component, the majority of mandible fragments are comprised of the ascending ramus and condyles, and the diastema between the incisors and molars. Gruhn (1969:137) noted that the mandibles from the site often had the ascending ramus and the mandibular symphysis broken off, although there were numerous intact mandibles from the site. Piles of mandibles were also found in areas of the site, suggesting purposeful work areas that were accumulating mandibles (Figure 4.3).

Table 4.3: Muhlbach mandible portions.

Portion	Ascending Ramus	Condyles	Aveolar Process	Diastema	Incisor	Unknown	Complete
NISP	11	59	25	34	3	171	1

Likewise, Shortt (1993:268) noted the fractured ascending ramus and symphysis, and suggested that these breaks were related to either gaining access to the tongue or the marrow cavity. Mills (2008:63-64) stated that smashing the condyles is a common method for removing the mandible from the skull to gain access to the highly valued tongue. Marrow extraction from mandibles has received little attention in Plains archaeological literature (Adams 1977; Head *et al.* 2002; Kehoe 1973; Watts 2008:65), but it is characterized by breaking the horizontal ramus into small pieces to obtain the limited marrow contents of the mandible. Marrow exploitation of the mandible likely did not occur at Muhlbach, as portions of the ascending ramus were typically large and complete and not pulverized.

Figure 4.3: Mandibles stacked in Units A13/B13 baulk. Trowel indicates in situ projectile point. View west. Photograph courtesy of Ruth Gruhn.

Crania

The excavators collected 249 cranial fragments from the site, including 76 petrous pyramid fragments. Gruhn (1969:137) indicated that most cranial fragments were small and difficult to identify, and similarly Shortt (1993:265) reported an absence of complete skulls from the site, with only a small amount of heavily weathered cranial fragments. Aside from the numerous cranial fragments, the most common portion of the skull was the petrous pyramid. This hard, dense portion of the inner ear is incredibly durable, and appears more likely to survive taphonomic processes than other portions of the skull. Based on an MNI calculated on right petrous pyramids, there were at least 28 skulls in the excavated area at the site; although there should be considerably as there are 26 petrous pyramids which were not attributable to side. Furthermore, with an MNI of 128 bison from the excavation, the number of crania represented at the site is significantly lower than I would have expected.

While there were no intact crania recovered from the site, several in situ skulls were described in the field notes. These crania were heavily weathered and fragmentary, falling apart upon extraction, but were intact prior to excavation. These specimens were often inverted, and with the brain case exposed. Precontact people often removed bison crania from kill sites for a variety of reasons (Watts 2008:61-62). For example, bison skulls from kills have been moved and gathered into ceremonial contexts: piles of skulls were interred in the Sonota burial mounds (Neuman 1975), bison skulls were gathered into a tight circle at the Vore site (Reher and Frison 1980), and inverted skulls were gathered into a ceremonial structure at the Ruby site (Frison 1971). Skulls were also processed to extract the brain for hide tanning, either by smashing through the side of the skull in the temporal occipital region (Frison and Stanford 1982), smashing underneath the skull through the basioccipital (Kehoe 1973), or chopping the forehead to go through the frontal (Frison 1973; Watts 2008:61-63). I cannot deduce any of these methods based on the meagre amount of cranial fragments present, although descriptions of the *in situ* skulls suggest that the occipital was chopped through to reach the brain. Gruhn recorded an inverted, fragmentary skull with an exposed brain case in the northern trench, suggesting that the rear portion of the skull had been smashed, possibly to access the brain.

Table 4.4: Cranial fragments

Portion	Fragment	Maxilla	Orbit	Basioccipital	Condyle	Horn Core	Petrous Pyramid
NISP	145	8	1	2	1	2	76

Vertebrae

Vertebrae are among the most common elements represented at the site, with a number of vertebrae attributable to either the cervical, thoracic, or the lumbar segments of the vertebral column. The bulk of the vertebral assemblage was not identifiable to specific types. Gruhn (1969:137) thought that the abundance of vertebrae was an indication that the site was a primary butchery location, and segments of articulated vertebrae found at the site support this notion (Watts 2008:68).

Atlas and axis vertebrae had higher MAU values than other vertebral elements (49 and 44 respectively), suggesting that these elements were relatively more common at the site than other vertebral segments. Shortt (1993:269) and Gruhn (1969:137) both noted that there were a number of unmodified atlas vertebrae from the site, although Shortt ascertained that a degree of cultural modification to the lateral wings of the atlas vertebrae had occurred. Shortt (1993:169) also attributes some cultural modification to the axis vertebrae, but with a degree of uncertainty. Spinous process and neural arches were removed from specimens, a procedure which Shortt (1993:269) suggested occurred during the separation of the head from the vertebral column. I did not observe this modification to the elements during the 2014 inventory, but collection attrition could have affected the preservation of this cultural modification. The edges of the transverse and spinous processes of vertebrae were often broken from the "rock tumbler" effect that occurred while loose in the boxes and any cultural modification on the vertebrae's lateral edges or spinous process could have been obliterated in the 20 years since Shortt's analysis. Smashing the occipitals of the skull was a common technique used at other archaeological sites (Watts 2008:61), and considering the extremely fragmentary nature of the skulls and absence of basioccipital fragments at the site, this procedure seems a more likely scenario.

The remaining cervical, thoracic, and lumbar vertebrae are also numerous at the site, but have relatively low MAU values compared to overall representation (35, 17, and 18 respectively); Shortt (1993:270) proposed that these vertebral sections were removed from the site for further processing, all though vertebrae are often missing from assemblages due to their low overall density. It is important to note that there are number of unidentifiable vertebral fragments in the collection, in addition to the many vertebral fragments missing from the collection. The relatively low number of cervical, thoracic, and lumbar vertebrae in relation to the overall number of animals at the kill might be related to the difficulties in identifying poorly preserved specimens or density related attrition issues. While most cervical, thoracic, and lumbar vertebrae have unique structures, transitional vertebrae in the spinal column have characteristics of both adjacent vertebrae (e.g. the seventh cervical vertebra has physical characteristics of cervical and thoracic vertebrae). When a faunal assemblage has been heavily weathered these landmarks are quickly destroyed, making accurate identification difficult. Considering these factors, there may be more vertebrae represented in the collection than what I can demonstrate.

Vertebral portions present in the collection were fairly consistent, as many of the vertebrae were missing transverse and spinous processes. Shortt (1993:270) attributed this feature on the cervical vertebrae as evidence of removing the muscles associated with the neck, and related the missing thoracic lateral articular facets to removing ribs. Spinous processes would have been smashed on thoracic vertebrae to separate the meat on the hump from the axial skeleton (Adams 1977:93), or the meat could be carefully removed from the thoracic spinous process (Brink and Dawe 1989:144). The spinous process was missing from most of the Muhlbach thoracic vertebrae, with spiral fractures at the base of the spine, suggesting that a strong blow and torsional forces were used to separate the spinous process from the body. Transverse processes on cervical and thoracic vertebrae were often missing, but I cannot attribute the damage to cultural factors, due to pre- and post-accession attrition and damage to many of the specimens. It is likely that the transverse processes were being broken to remove the ribs, although alteration and breakage patterns with the ribs demonstrate alternative techniques for removing the rib cage.

Lumbar, sacral, and caudal vertebrae showed limited alteration, likely as these vertebrae would receive limited attention during butchery. Often the transverse processes of lumbar vertebrae would be broken off when the sub-lumbar muscles are removed, and the spinous process on the L1 and L2 would be snapped off in association with the thoracic vertebrae (Watts 2008:72). Due to the poor preservation of the Muhlbach collection, I could observe little cultural alteration on any lumbar, sacral, or caudal vertebrae. The caudal vertebrae in the collection appear to be all first and second caudal vertebrae. Considering the state of the collection, the incrementally smaller Ca3-10 sequence of caudal vertebrae would be hard to find, and likely would not preserve. The extremely low number of caudal vertebrae at the site could suggest that these were being removed from the site, possibly still attached to the hide when it was removed.

Table 4.5: Muhlbach vertebrae portions.

Element	Complete	Body	Spinous Process	Unknown
Atlas	1	35	0	13
Axis	1	34	0	9
Cervical	9	143	22	27
Thoracic	11	220	59	11
Lumbar	3	85	11	14
Sacrum	1	28	0	3
Caudal	0	17	0	0
Vertebra	2	183	199	218

Ribs

Ribs are extremely common at the site, although the majority of these are shaft fragments that have broken down due to natural taphonomic process. Considering that there are 28 ribs in a bison skeleton, the MNE and MAU values for ribs are relatively low for the number of animals present at the site, indicating that most of the ribs were separated from the bison carcasses and removed from the site. It appears that ribs were separated from the thoracic vertebrae by breaking the element just below the head and neck; Shortt (1993:271) also noted this pattern.

Pelvis

The pelves from the Muhlbach site were extremely fragmentary, often broken into the individual three bones of the *os coxae*. In order to separate the femur from the pelvis, the acetabulum needed to be smashed (Kehoe 1973; Watts 2008:77); alternatively, the femoral head and neck could be removed to separate the hind limb from the axial skeleton (Agenbroad 1978; Watts 2008:78). Spiral fractures were often present around the acetabulum, on the ramus of each bone; this characteristic suggests that the pelvis was broken up to separate the hind limb from the pelvis. There is some available meat associated with the pelvis, but poor preservation of the cortical bone surface made ascertaining cut marks difficult.

Table 4.6: Muhlbach pelves portions.

Element	Acetabulum	Neck	Blade	Crest	Unknown
Pelvis	25	/	/	6	59
Ilium	13	12	3	/	1
Ishium	17	2	/	/	1
Pubis	22	2	/	/	/

Element Portions – The Appendicular Skeleton

Forelimb

Gruhn's team collected 215 scapulae fragments from the site, largely composed of the head and blade fragments. Spiral fractures and flake scars from strong impacts were present just below the head, around the neck of the element. This pattern suggests that the forelimb was removed by smashing the scapula, a technique that is common at bison kill sites (Watts 2008:79). Blade and scapular process fragments were also common, but they show evidence of only natural alteration from drying and general weathering. Shortt (1993:271) proposed that the absence of distal portion of the scapulae was due to removal of the muscles associated with the forelimb; however, taphonomic factors prevent identification of any cut marks that would confirm this interpretation.

Table 4.7: Muhlbach scapulae portions.

Portion	Head	Neck	Scapular Process	Blade	Unknown
NISP	89	1	28	35	46

The remaining forelimb bones were heavily comminuted, although some portion variation occurred among the different long bones. Excavators did not find any complete humeri or ulnae at the site, but they did unearth several complete radii, and numerous complete metacarpals. Distal humeri fragments were the most common element portion at the Muhlbach site; a pattern that researchers have remarked upon at other kill sites (Watts 2008:81). The proximal end of the humeri has high grease yields, and absence at sites can be evidence of grease extraction. Proximal humeri could also be a target to separate the forelimb from the scapulae, with a heavy blow to the head or neck, effectively rendering the portion unidentifiable (Watts 2008:82). The humeri fracture pattern at Muhlbach typically was 10 to 20 cm along the shaft, a breakage thought to be typical of marrow extraction (Gruhn 1969:137; Watts 2008:82). This type of breakage can also be used to separate the humerus, radius, and ulna joint from the rest of the forelimb, as the lower portion of the forelimb has limited meat value.

Table 4.8: Muhlbach forelimb portions.

Portion	Complete	Proximal	Shaft	Distal	Proximal Epiphysis	Distal Epiphysis	Diaphysis	Unknown
Humeri	0	24	41	68	14	4	36	7
Radii	15	75	39	50	2	38	27	4
Ulna	0	107	9	3	1	0	0	9
Metacarpal	60	26	1	19	0	9	7	8

Radii were common at the site, with several complete specimens in the collection. The representation of radii portions seems to suggest that proximal radii are more prevalent than distal portions, but including the distal radial epiphyses into the distal portion count brings the number of distal radii on par with the proximal portions. Gruhn (1969:137) observed that many of the radii were broken approximately 10 cm from the articulations, presumably for access to the marrow cavity. Ulnae were largely limited to the proximal portion, as the body and distal end of the ulna become fused with the body of the radius as the animal matures; thereby, separating the ulna from the radius requires the breaking of the distal portion. The olecranon process was missing from many specimens, and was likely removed during butchery (Shortt 1993:273).

Complete metacarpals were abundant at the site, but proximal and distal portions were not uncommon. Metapodials have low meat value, but it has been suggested that these elements would be targeted for marrow extraction (Addams 1977; Head *et* al. 2002; Kehoe 1973; Watts 2008:89). Gruhn (1969:137) and Shortt (1993:273) both noted that some elements had been targeted for marrow extraction, but many specimens had natural taphonomic damage causing blocky, angular breaks.

Carpals

There were a limited number of carpals collected from the site, ranging from 47 to 77 identified specimens for each carpal. Carpals should be extremely common at a kill site, as these elements are small, numerous, and have no meat or grease value (Emerson 1990; Watts 2008:86). The low number of carpals is likely due to the fact that there were a large number of uncollected, undifferentiated carpals/tarsals from the site (N=412), as well as several carpals in the collection that were too poorly preserved to be attributed to any element. The carpals were either complete or fragmented from natural taphonomic factors and a number of specimens were burned.

Hind Limb

There were no complete femora recovered from the site, rather 74 proximal femur fragments and 34 proximal epiphyses present were present in the assemblage, as well as numerous shaft fragments. Shortt (1993:274) noted that many of specimens exhibited breaks along the shaft just above or below the articular surfaces. Gruhn (1969:137) reported this break occurring 5-15 cm below the head and 5-10 cm above the distal condyles. The femur was often highly processed during the separation of the hind limb from the pelvis (Watts 2008:89), and the femur has high meat and grease value, making it a valuable choice for further processing (Brink 1997; 2004). This characteristic could explain the higher fragmentation of this element as compared to other long bone elements.

Tibiae were also fragmented, but some complete elements were present. Distal tibiae fragments are more common than proximal portions, and this pattern was observed at other kill sites (Watts 2008:93). Researchers related the dearth of proximal tibiae at sites to the separation of the femur and tibia, by smashing the proximal end of the element to release the lower portion of the hind limb (Shortt 1993:275). Similarly, the low number of distal femora at the Muhlbach site is likely linked to this technique. Like other long bones, the pattern of smashing the bone within 5-15 cm of the articular surfaces was observed with the tibia (Gruhn 1969:137), likely stemming from marrow extraction.

The metatarsals were largely complete, following a similar exploitation and fracturing patterns as the metacarpals, as these elements had limited alteration or any evidence of cut marks on the cortical bone surface. There was some articulation between metatarsals and phalanges, further supporting the conclusions that this element received little attention during primary and secondary butchery operations. In terms of portions, there are more proximal metatarsal segments than distal in the collection, but poorly preserved distal and shaft portions of metacarpals and metatarsals are extremely difficult to attribute to either category.

Table 4.9: Muhlbach hindlimb portions.

Portion	Complete	Proximal	Shaft	Distal	Epiphysis	Diaphysis	Unknown
Femora	0	74	36	38	43	13	1
Tibiae	2	33	49	121	24	13	5
Metatarsal	50	48	17	34	12	10	15

Tarsals

Tarsals were more numerous than carpals, but demonstrated similar taphonomic alteration, as many specimens were either complete or small fragments that suffered considerable weathering. The numbers of the major tarsals are roughly double or triple the counts for carpals, suggesting an overabundance of hind limb portions at the site. I would suggest the dominance of different tarsal elements over carpals is not cultural, but a product of collection and identification biases. As previously discussed, significant sullegic processes affected the Muhlbach faunal assemblage, and it is likely that the larger tarsal elements, like the astragali, navicular cuboids, and calcanei, were retained more frequently as they are larger and more readily identifiable than the smaller carpal elements. Similarly, the lateral malleolus and the 2+3 tarsal (also known as the cuneiform pez) have MNE counts similar to carpals even though these are hind limb elements, supporting the notion that major tarsals are abundant at the site due to collection biases.

Phalanges

Phalanges were abundant at the site, which is expected, as these elements have no useable meat associated with them (Emerson 1990; Watts 2008:97). I divided phalanges into first, second, and third, but did not separate them into forelimb or hindlimb, as it is extremely difficult to separate phalanges into these categories. Researchers have attempted this separation for bison phalanges, with the objective of using metrics to separate male and female specimens in the death assemblage and thereby determine seasonality (Roberts 1982). The unreliability of siding poorly preserved phalanges makes replicating these studies problematic, and therefore I avoided this procedure during the 2014 inventory.

Herd Structure and Seasonality

Reconstructing bison herd structure for kill sites is an important research objective, as it can reveal different hunting strategies and help in determining the season of occupation. There are two main approaches used when investigating herd structure: sex ratios and age at death. The first method, determining the ratio of males to females in a kill assemblage, can assist in determining the season of occupation for a site. Research focused on this topic often divides bison into two groups, a larger cow-calf herd and a smaller bull herd (Arthur 1974; Brink 2008; Duffield 1973; Fawcett 1984; McHugh 1958). The size of a cow-calf herd varies, but the bull herds typically are composed of between 1-12 animals over the age of four (McHugh 1958:37). These satellite bulls live in close proximity to the cow-calf herd for most of the year, but the two herds maintain this division. The sex ratio changes during rut, when fertile cows come into heat during later summer and early autumn, and competing bulls begin to infiltrate the cow-calf herd, increasing the number of bulls in the cow-calf herd. Observations on modern herd populations show that the number of bulls in the main herd increases from 17% in the spring to 44% during rut (Fawcett 1984 ;McHugh 1958:15-16). This observation means that during most of the year, females and juvenile animals dominated a cow-calf herd, and a bull herd would be comprised primarily of males. During rut, the cow-calf herd structure should change to roughly equal or greater number of males to females. It is important to note that there are always adult bulls with the cow-calf herd; the presence of bulls in a kill site is not enough to indicate that the kill occurred during rut.

This observation means that the ratio of male to female animals can be used at kill sites to indicate if targeted hunting strategies were used, as well as the season of occupation. A mass kill assemblage dominated by male specimens could indicate that the hunters targeted a bull herd. Likewise, a mass kill assemblage dominated by female and indeterminate juveniles could indicate that the hunters targeted a cow-calf herd. A herd ratio of roughly equal males and female animals would suggest that the kill occurred during rut, and that the hunters targeted an aggregated herd. At the Happy Valley Kill site, Shortt (1993:182-183) determined that the ratio of male to female animals in the kill assemblage closely matched modern herd demographics during rutting season; depending on the element used, bulls comprised from 27-45% of the Happy Valley assemblage.

It is important to consider these variations in conjunction with other aspects of the kill assemblage, such as butchery practices and utility indices, as these factors can skew the representation of sex based on portion selection and element retention. Conventional wisdom places the timing of large communal bison kill during the fall, when bison had fattened up over the summer and hunters needed to gather and store food for the winter (also known as the Annual model, Fawcett 1987:27). While bull carcasses produce absolute higher meat, fat, and marrow quantities as compared to cows, culturally they were generally considered a poor quality of meat by northern Plains hunters (Brink 2004), suggesting that hunters at communal kill sites would have preferentially targeted cow-calf herds to obtain a high quality of meat and fat. Furthermore, because of the perceived lower quality of bulls, these animals would receive less attention during butchery, leading to an overabundance of male elements in certain faunal assemblages. Consequently, one needs to evaluate critically the sex ratio of a death assemblage before using this information to infer seasonality.

Measurements of particular elements are typically used to determine the sex of individual specimens, as this technique is rooted in the sexual dimorphic differences between male and female animals. The largest difference for bison lies in overall size and body mass, whereas the male bison are typically 30-40% bigger than female animals (Brink 2008:53; Meager 1986), and most of this weight difference is carried over the forelimbs. The structural requirements of this weight difference mean that male bison require more robust skeletal elements over females in order to support the extra weight, particularly in the front. This trait can be exploited in different archaeological faunal assemblages to separate out male and female animals. Some elements are more useful than others; elements from the axial skeleton will display a sexual dimorphic size difference (Reher 1973), but do not have a strong bimodal distribution for size, limiting their potential analytical value.

The sex ratio approach to seasonality studies using the Muhlbach assemblage has been a popular student topic over the past 40 years; unfortunately, I could acquire only a few of these papers. These unpublished undergraduate papers are unvetted and have methodological issues, but do contain valuable metric data regarding different elements in the Muhlbach faunal assemblage. Tait (1980) wrote the earliest known term paper; I was not able to locate it but fortunately, Harpham (1984) summarized the work. Tait applied a method developed by Reher (1973) to calculate sex based on mandibular depth. Tait estimated a ratio of 57% male to 43% female at the site, representing an occupation during the late summer rutting season (Harpham 1984). Harpham (1984:4) questioned the reliability of Reher's methods and Taits's results, as the ratio seemed high when compared to modern bison herd structures. In addition, axial bison elements show only a weak correlation for sexual dimorphic patterns, limiting their usefulness for this type of study.

Harpham (1984) applied Roberts' (1982) method of using first phalanges to discriminate between male and female specimens. With a sample of 201 first phalanges, Harpham (1984:15) calculated a ratio of 22% males to 78% females. Furthermore, she compared the size of the immature first phalanges from the Muhlbach site to modern bison calves and yearlings, and noted that there was little difference in size between the Muhlbach juvenile specimens and the full term fetal material (Harpham 1984:17). This information, in combination with the female-dominated faunal assemblage, suggested a May-June occupation of the site. There are concerns regarding the accuracy of using first phalanges for this type of study, as difficulties with attributing side for phalanges affect the reliability of determining the MNI for the sample. Roberts (1982:54) asserted the reliability and replicability of siding first phalanges with her methods, but the accuracy of identifying of poorly preserved and fragmentary elements is questionable at best.

While analyzing the Muhlbach collection for comparative purposes, Shortt (1993:265) did not apply any discriminant functions to calculate sex ratios, stating that eroded specimens could not offer reliable results. He does note that the majority of the Muhlbach specimens were more similar to the identified female specimens from Happy Valley than the male examples, suggesting a cow-calf herd.

Tiegan and Studer-Halbach (2010) used metapodial metrics to differentiate sex, applying the multivariate analysis proposed by Duffield (1973). Duffield (1973) proposed several different measurements that could be used to separate male and female animals in a faunal assemblage; the method for separating metapodials requires the distal width of the metapodials to be plotted against an index calculated by dividing the shaft width by the maximum length, then standardized by multiplying by 100 ([Shaft Width/Length] x 100). Adapted results of this analysis are summarized in Figure 4.4 and 4.5. By comparing the distal width of metapodials to Duffield's index, they determined that there were male and female bison present at the site and that the occupation occurred during rut. Unfortunately, rut cannot be inferred by simple presence or absence of male bison, but only by calculating the actual ratio of males to females.

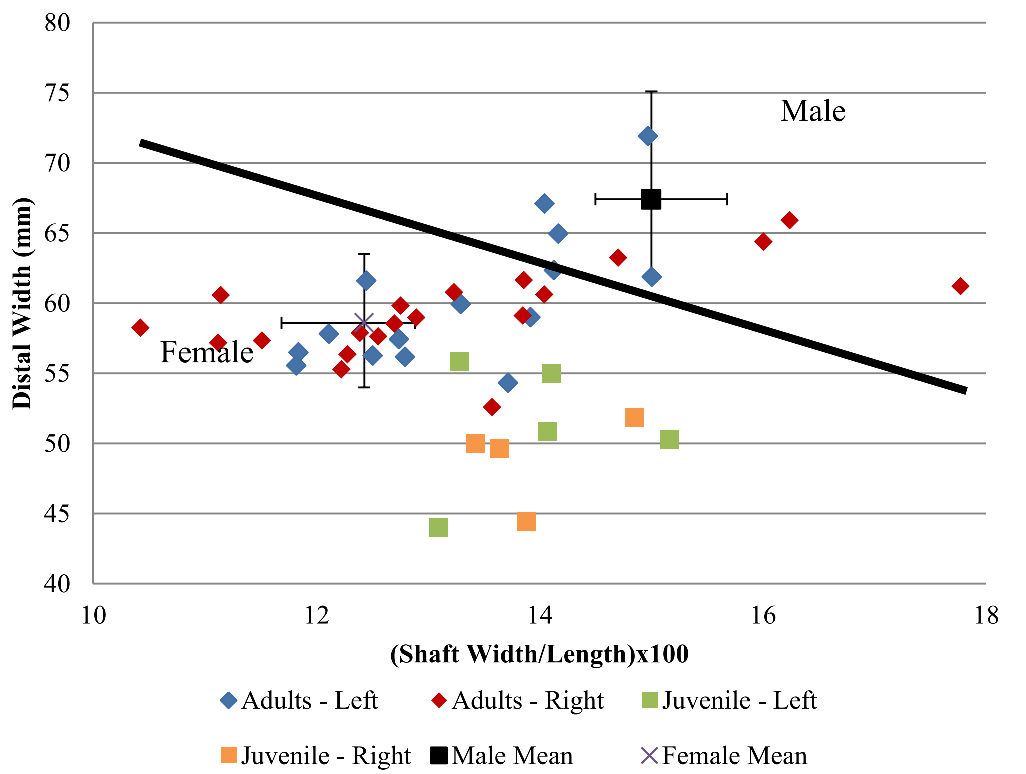

Figure 4.4: Metatarsal distal width and Ratio 6 (Duffield 1973) bivariate plot from Muhlbach with male and female distal width mean and maximum and minimum population values derived from Lewis *et al.* (2005:162).

It is possible to delineate sex clusters within Tiegan and Studer-Halbach (2010) metric data using Duffield's (1973) discriminant functions, and averages for modern male and female bison from Lewis *et al.* (2005) principal component analysis of bison metapodials aimed at delineating sex. Based on the MNI of metatarsals from the Muhlbach site, there are four male, 13 female, and 7 indeterminate specimens, giving a ratio of 24% males to 76% females (Figure 4.4). When MNI is accounted for, metacarpals produced 9 male, 16 female, and 15 indeterminate animals, giving a ratio of 36% males and 64% females (Figure 4.5). These ratios are suggestive of a higher male presence in the herd structure and thereby a rutting season occupation. These male ratio values also fall close to the 27-45% range that Shortt (1993:182-183) considered to represent a rut season kill at Happy Valley.

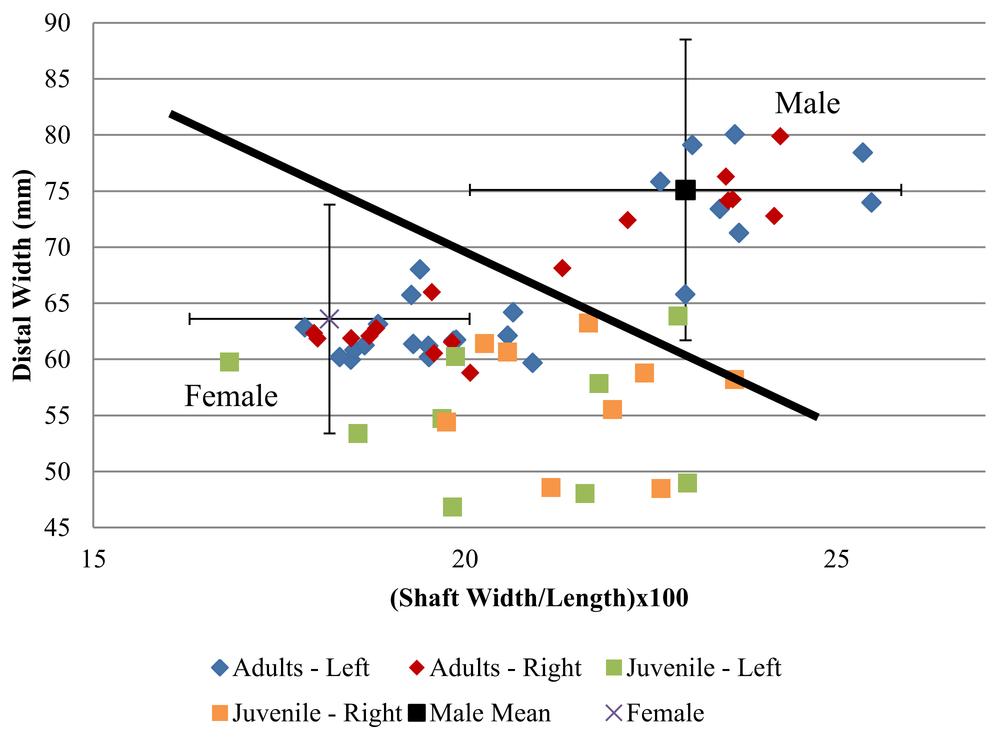

Figure 4.5: Metacarpal distal width and Ratio 6 (Duffield 1973) bivariate plot from Muhlbach with male and female distal width mean and maximum and minimum population values derived from Lewis *et al.* (2005:162).

I also used the calcaneus to calculate the sex ratio of the Muhlbach site, using Morlan's (1991:223) standardized measurements and bivariate plots for separating male and female bison. In his analysis of the Fitzgerald site, Hjermstad (1996:163) stated that the calcaneus was the only carpal/tarsal that showed a bimodal division based on sex. He argued that the calcanei length and proximal width are the two defining factors for delineating sex in bison. The calcaneus was also the most abundant element at Muhlbach in terms of MNE and MNI (242 and 128 respectively), and a good candidate for providing the largest possible sample to represent population in the death assemblage. I applied Morlan's (1991:223) measurements to the assemblage, and compared my results with Hjermstad's (1996:163) conclusions for Fitzgerald (Figure 4.6), in which he determined that there were at least nine male and 11 female animals represented at the site. The measurements from the Muhlbach calcanei suggest that there were at least three males, 23 female, and two indeterminate bison represented at the site, indicating a sex ratio of 11% males to 89% females.

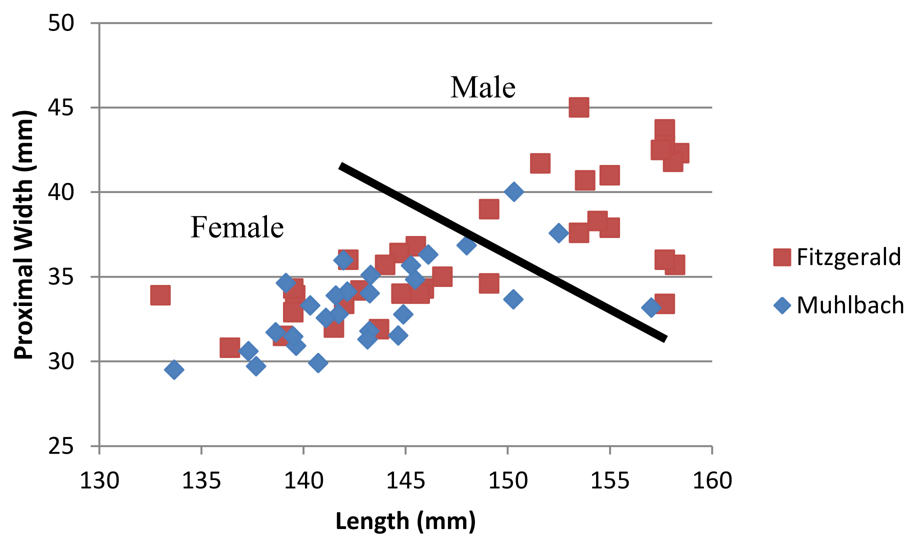

Figure 4.6: Calcanei length and proximal width bivariate plot from Muhlbach and Fitzgerald (Hjermstad 1996:325).

So what do all of these different results mean? Depending of the element used the representation of males in the faunal assemblage ranges from 11% to 57%; calcanei suggest a ratio of 11% male to 89% female, but metapodials indicate a more male-dominated assemblage with 36% males to 64% females. These are contradictory results in terms of assemblage composition and thereby seasonality. The ratio of male to female bison in a herd should fluctuate between a low of 17% in the spring, to 44% during rut (Fawcett 1984; McHugh 1958:15-16; Shortt 1993:182), and the ratios calculated from different elements in an archaeological assemblage should be roughly the same, thereby indicating the season of occupation. Part of the problem is that there are only 27 percentage points for analytical wiggle room in which bison herd sex ratios will fluctuate, creating a small range to derive meaningful interpretation of seasonality. At what threshold does a sex ratio for a bison herd move from representing a cow-calf herd to rutting herd? What about when each element gives a different evaluation of herd structure? How do the various taphonomic processes affect the ratio of male and female animals in a death assemblage? There are serious issues with the use of bison herd sex ratios to determine seasonality.

Recent research has explored the use of sex ratios in communal kills, and called into question the legitimacy of the catastrophic kill population model assumed to be present at sites like Muhlbach. This form of analysis is based on the assumption that when bison were driven over a cliff or into a trap, the herd would contain a representative sample of the entire living population, young and old, male and female. Conversely, Speth (2013:178) noted that when bison are gathered and moved, they string out in a column with adult females leading the group, calves trailing behind, and bulls bringing up the rear, and not in a random assortment of the entire population. Once the animals are stampeded, more adult females will be killed at the site as they are leading the group, with bulls and juveniles more likely to escape (Speth 2013:178). This aspect means that most bison kill sites will contain more adult female animals because the moving herd structure can bias the death assemblage in this manner.

Driver and Maxwell (2013:106) also demonstrated that neonatal animals in ungulate herds were heavily targeted by predators, removing over 50% of the younger segment of the herd demographic. Heavy predation of bison herds would not only remove the younger animals from the death assemblage; it would also further bias it towards adult animals. Driver and Maxwell (2013:108) also propose that northern Plains bison hunters would have targeted bison herds with lower numbers of young and neonatal animals, as these herds would have fatter and healthier females who have not suffered nutritional depletion through gestation and lactation.

The ratio of male to female elements in a collection can also be less representative of season and more indicative of butchery preferences. For example, the overabundance of male metapodial elements in the Muhlbach collection is similar to what Hjermstad (1996) observed at the Fitzgerald site. Hjermstad (1996:162) noted that the butchers selected against male elements at the kill site, leaving the male elements unaltered and unbutchered, while female elements showed evidence of marrow exploitation. The calculation of male and female animals based on metapodials uses whole elements. Considering the number of complete and unmodified metacarpal and metatarsal elements at the Muhlbach site (60 and 50 respectively), and the increased number of male animals represented in these complete metapodials, this distribution could suggest that a similar pattern was occurring at the Muhlbach site. This tenuous assessment is complicated by the attrition that the current assemblage has suffered, but it is suggestive that more complete male metapodials were left at the kill site, while more female elements removed from the assemblage and the population sample, possibly as they were targeted for marrow extraction. The calcanei, which I believe to reflect a more accurate assessment of the herd population, reveal a more adult female-dominated herd. These lines of evidence suggest that primarily cow-calf herds were trapped at the site. These results do little to narrow down a season of occupation, only indicating that rutting season is unlikely.

As the sex ratios do not help determine seasonality, other methods, such as age at death, must be employed. Using age at death to reconstruct the season of occupation is based on the assumption that communal kill sites represent a catastrophic event in which a representative sample of the entire population will be present in the death assemblage (Hjermstad 1996:128). By determining the age of the animals in the kill, it is possible to create a demographic profile of the living herd population, which has be used to infer hunting and butchery decisions (see Emerson 1990 for discussion of sex and age based differences in meat quality and quantity for bison), the general health of the herd (Hjermstad 1996), and the season of occupation (Duffield 1973; Lewis *et al.* 2005). There is a variety of techniques to approach this problem: epiphyseal fusion (Duffield 1973), cementum layers in teeth (Moffitt 1998; Peck 2001), and tooth eruption and enamel wear (Frison and Reher 1970; Reher and Frison 1980). The applications of each of these methods have their own strengths and weakness, but the absence of the mandibles from the collection limits what types of analyses can be carried out.

The only viable sample available from Muhlbach is the foetal and neonatal (newborn) remains recovered from the site, which can be used to infer the season of occupation. There has been limited research into the correlation between foetal bison bone and age, but identification of foetal development stages can be used to infer seasonality based on the assumption that there is a seasonally restricted rut and calving season (Playford and Nicholson 2006:411). The generalized pattern for the bison reproductive cycle is that bison rut occurs between early June and late September with a peak during mid-August, followed by a gestation period of 270 to 300 days, with 80% of calving occurring between mid-April and beginning of June (Walde 2006a:482). It is possible using these parameters to infer the age at death if the stage of foetal development is known. The presence of foetal or neonatal bison remains at bison kill sites has been used to infer anything from a late fall through to spring occupation at sites (Hjermstad 1996:147; Ramsay 1991:157; Shortt 1993:263). Despite originally developing formulas for this method (see Unfreed and Walde 2005), Walde (2006a:482) has since criticized this approach, remarking that the 20% of calves born out of the peak season is a significant amount and can significantly skew any attempt using foetal remains. Furthermore, Walde (2006a:489) reported a previously unknown extended conception season for bison in the Antelope Island herd in Utah, an extension that in some circumstances could blur any meaningful seasonal extrapolation from foetal remains.

Locating and identifying foetal bison remains at kill sites can be extremely difficult since these small porous elements are susceptible to a number of taphonomic variables, such as weathering and scavenging carnivores (Ramsay 1991:164). In fact, it has been noted that there is a general absence of the bottom two years in bison herd demographics; animals under two years of age are simply not represented in kill site assemblages, despite representing 50-80% of a normal population structure (Reher and Frison 1980:75). Hjermstad (1996:172) suggested that the missing neonatal bison at Fitzgerald were associated with preferential butchery, and the smaller calf carcasses were removed en masse from the site. Driver and Maxwell (2013:107) demonstrated that neonatal animals in ungulate herds suffer high mortality rates from predation, and they proposed that this predation would be extremely high during the first few weeks and months after birth, and continued throughout the year, effectively removing the younger cohort from zooarchaeological assemblages. This situation is problematic for Muhlbach, as without a larger sample of foetal bones, conclusive seasonality interpretations are tenuous. Yet, without other avenues of investigation for determining seasonality, using foetal and neonatal bison remains is the only viable option.

There are six foetal/neonatal elements identified in the collection (in Table 4.11): two humeri, three metacarpals, and one metatarsal element, all consisting of near complete diaphysis segments. I measured the diaphyseal length and midshaft diameter for these elements using a Fisher Scientific digital caliper. These data were then applied to the linear regression equations calculated by Unfreed and Walde (2005) to determine the gestational age in days (Table 4.10). The results of this analysis produced a gestation age for the Muhlbach foetal remains ranging from 273 to 358 days of development. I then applied this age forward from the August 15th peak of conception proposed by Unfreed and Walde (2005:340) to give the season of occupation. This analysis would suggest that at least part of the occupation occurred sometime between early May and early September.

Table 4.10: Foetal linear regression equations adapted from Unfreed and Walde (2005) where X= measurement in cm and Y= gestation age in days. One standard deviation provided for each equation.

Element	Measurement	Equation	Error
Humerus	Cranio-Caudal Diameter	y=91.2396+89.3745x	13.72
	Medio-Lateral Diameter	y=105.389+84.9952x	14.46
	Diaphyseal Length	y=125.866+11.3673	15.4
Metacarpal	Cranio-Caudal Diameter	y=92.077+117x	6.845
	Diaphyseal Length	y=139.265+10.2586x	11.94
Metatarsal	Cranio-Caudal Diameter	y=105.806+99.172x	9.308
	Medio-Lateral Diameter	y=76.009+109.265x	5.18
	Diaphyseal Length	y=136.499+8.55773x	10.94

Table 4.11: Muhlbach foetal remains and estimate gestation age in days based on Unfreed and Walde (2005).

Number	Element	Side	Max Diaphyseal Length	Gestation Age	Min Midshaft Diameter	Gestation Age
A20-426	Humerus	L	NA	/	25.54	320
A14-800	Humerus	R	NA	/	28.13	343
B11-448	Metacarpal	R	130.59	273	19.86	324
FBPF-1-400	Metacarpal	R	144.7	288	NA	/
A11-42	Metacarpal	L	153.53	297	22.71	358
FbPf-1-403	Metatarsal	L	173.4	285	21.06	315

One ought to treat these results cautiously. At one standard deviation, the error ranges for the linear regression equations are higher than ideal, reaching as high as 15 days; using two standard deviations will increase the error range to a month on either side of the estimated gestation age. Furthermore, the estimated ages extend well beyond the averaged 275 day gestation period for bison, suggesting that the elements are neonatal rather than foetal. The development of neonatal animals would likely follow a different growth curve, and should not be calculated based on foetal parameters. Conversely, the estimated ages are closely clustered to a period directly after birth, and the elements are sufficiently small enough not to be from older calves, based on a six-month old bison specimen in the University of Alberta comparative faunal collection. They fall within the expected range of newborn animals, and this result supports a late spring, early summer occupation, but does not refine the timing further. In his thesis on Happy Valley, Shortt (1993:263) cited an unpublished study Dale Walde conducted on the Muhlbach faunal assemblage in which he had:

> "… measured foetal humeri and metapodials and, by comparing bone dimensions with modern foetal specimens, has suggested that at least two temporally separate winter/early spring events are evident (Walde pers. comm; research in progress)"

As previously discussed, Walde (2006a) has since criticized his own methods for determining seasonality using bison foetal remains (see Unfreed and Walde 2005), citing a poor resolution for seasonality using foetal remains. In regards to the study on the Muhlbach site, Dale Walde (personal communication 2014) reaffirmed that the stages of foetal developments and their metric indicators are not reliable fine-grained measures of seasonality, and that at best foetal remains at the Muhlbach site would suggest a non-summer occupation of the site.

Based on the compilation of data from all available sources, I would tentatively propose that the Muhlbach site was occupied during the late spring and early summer. The sex ratios of different elements indicate that a cow-calf herd was killed at the site, suggesting at least a non-rut season occupation. The neonatal remains at best indicate a non-summer occupation (Walde 2006a), but the size of the elements suggests that fully developed bison calves were killed at the site, which would be more likely present during and after calving season. The neonatal animals in question are too small to have been killed in the fall after rut occurred, indicating that the kill occurred prior to rut. These lines of evidence suggest that a component of the Muhlbach occupation occurred sometime after calving season had started, but before rutting occurred: a late spring, early summer occupation of the site.

Butchery Practices, Utility Indices, and Transportation Decisions

In order to study subsistence and butchery patterns at archaeological sites, researchers have frequently used indices to calculate the utility of different animal portions. These approaches attempt to derive meaningful interpretations based on the ratio of different skeletal elements and their inherent food value. Binford (1978) developed the Modified General Utility Indices (MGUI), based on ethnographic observations of Nunamiut hunters and their butchery practices and portion selection of sheep and caribou. Hunters, having killed an animal some distance from their camp, would need to make various decisions regarding the butchery and transportation of the foodstuffs, and the eventual consumption. These decisions should vary based on the economic value of the available meat, marrow, and bone grease, and the faunal remains present at archaeological sites should reflect these decisions.

Binford (1978) laid out three separate indices that needed to be calculated first, in order to determine the MGUI of a specific element: Meat Utility Index (MUI), Marrow Index (MI), and White Grease Index (WGI). These three indices were combined to calculate the General Utility Index (GUI). He later altered this index to create the Modified General Utility Index (MGUI), to address concerns regarding low utility elements riding higher rated portions from the kill to camp. Once the MGUI of an element is determined, this information can be plotted against the percent of the total MAU each element represents at the site (%MAU); the distribution of high to low ranked elements would represent the transportation strategies used at the kill site.

Bulk and gourmet are the two main patterns for this type of analysis (Binford 1978). Of the bone remaining at a kill site, an inverse relationship between MGUI and %MAU suggests a bulk transportation strategy, in which hunters carried away the majority of the bone with the meat for further processing at camp. If high and low ranked elements were both frequent at the kill site, this situation would indicate a gourmet transportation strategy, in which the hunters remove only the elements with the largest amount of meat, marrow, and grease from the site. At a camp setting, this pattern is reversed; a trend of only high utility elements at a campsite indicates a gourmet transportation strategy, while an abundance of high and low elements demonstrate a bulk strategy.

Binford's (1978) approach to portion selection and butchery practices has remained popular amongst zooarchaeologists, although there are criticisms of the MGUI. Metcalfe and Jones (1988) pointed out how the formulas used to calculate the MUI, MI, and WGI are needlessly complex, and confuse how the variables interact to give to final utility evaluation. They proposed an alternative, simplified version of Binford's formulas, called the Food Utility Index (FUI). There are also concerns regarding the application of caribou and sheep data to other species like bison. In a comparison of Binford's GI and his own calculation of Ranked Fat Weight values for bison, Brink (1997:267) found that Binford's measure of caribou grease yield for elements was opposite of the actual fat yield from bison bones, even though Binford's (1978) GI index closely matched Brink's (1997) Rank Fat Weight. Brink determined that Binford inadvertently adjusted his caribou grease value by multiplying by the bone volume and density to scale his calculations, variables that Brink (1997:267) stated are intrinsically tied to the amount of bone grease in different skeletal elements.

Emerson (1990) further expanded on utility indices specific to bison, as well as investigating differences between individual product yields for male, female, and juvenile animals. There is a large difference between male and female bison in terms of overall meat products, but also the quality of the meat varies throughout the year and with the animal's age. Fat deposits within bison develop later in life, and vary with nutritional and environmental stress (Emerson 1990:574). Younger animals in a large kill site could have been selected against, as their overall fat weight was too low for further processing and transport from the site. Cows would be in better condition during the fall, after consuming high quality forage all summer, but bulls would be the best just prior to rutting season, before they expend all of their energy and fat stores on mating competition (Speth 1983). In order to incorporate all of this variation, Emerson (1990) developed the Standardized Modified Averaged Total Products Model [(S) MAVGTP]. This index provides the total food products per element from the averaged bison carcasses in Emerson's study, with adjustments made for "rider" elements. It is based on each element's cumulative values from the Standardized Modified Average Protein Model [(S) MAVGPRO], the Standardized Modified Average Marrow Fat Model [(S) MAVGMAR], the Standardized Modified Average Grease Fat Model [(S) MAVGGRE], and the Standardized Modified Average Total Fat Model [(S) MAVGTF]. Emerson developed several other indices for more specific uses, but these are the most commonly applied.

The success of any particular utility index is based on its ability to assist in interpreting a faunal assemblage, but a correlation between an index and a faunal assemblage does not indicate that people optimized their diet (Brink 2004:159). Brink shifted away from the optimal foraging paradigm of previous utility indices, and conducted an in-depth analysis of Wilson's (1924) ethnographic work with Buffalo Bird Woman in order to explore more emic ranking of meat portions. In this account, a Hidatsa woman named Buffalo Bird Woman participated in a pedestrian bison hunt around the spring of 1870, in which over the course of three weeks, 12 people with dog-travois hunted and killed several dozen bison. They butchered the animals and selected portions for transportation back to camp, as well as the portions for immediate disposal. Brink (2004:176) detailed the carcass portions selected by Buffalo Bird Woman and the skeletal elements that would be associated with these cuts of meat (Table 4.12).

Table 4.12: Buffalo Bird Woman portion selection and skeletal association, adapted from Brink (2004:176).

Portions Selected	Skeletal Association
Tongue	Hyoid, Mandible
Ribs	Ribs
Leg Bones	Femur, Tibia, Humerus, Radius
Sinew	Thoracic, Lumbar
Portions Rejected	**Skeletal Association**
Head	Skull
Neck	Cervical
Backbone	Lumbar, Sacrum
Pelvis	Pelvis
Lower Legs	Carpals, Tarsals, Metapodials, Phalanges, Sesamoids
Organs	None
Heart (sometimes)	None

Brink (2004) then compared this portion selection to the indices developed by Emerson (1990) in order to evaluate the differences in culture specific portion selection and optimal foraging selection. Looking at muscle and fat weight of specific elements retained by Buffalo Bird Woman, Brink noted several discrepancies of element ranking. The femur was the highest ranked in terms of muscle mass, but this element was often desired for the marrow rather than the meat; the inner muscle tissue would be retained after trimming off the majority of the tougher exterior meat (Brink 2004:178). A large portion of the meat on the femur would have been rejected, despite having the highest amount of muscle available and the highest ranking under Emerson's (1990) indices. Another discrepancy concerned the cervical vertebrae, as this axial portion rated high in terms of muscle and fat weight, but was considered to be too tough and was often discarded (Brink 2004:179). Other issues involved the tongue and sternebrae; these portions had muscle and fat weight rankings lower than their higher perceived foodstuff status among the Hidatsa.

Even when Brink (2004) combined muscle and fat weights, the ranking of elements did not match the portion selection described by Buffalo Bird Woman.

The combined weight ranking closely matched the muscle weight ranking, since the muscle component significantly outweighs the fat (Brink 2004:179). A correlation appeared when Buffalo Bird Woman's portion selection was compared to the fat weight as a percentage of total weight. The tongue was ranked the highest, with 21% fat content, followed closely by the thoracic vertebrae (the hump) at 20.9% and the sternebrae at 16% (Brink 2004:180). The fat weight percentage was a better predictor of Hidatsa portion selection than the other utility indices, although there were some idiosyncrasies. Brink (2004:181) noted that Buffalo Bird Woman did not keep the liver, even though it has been documented as a delicacy in other groups. Brink concluded that simple indices of muscle and fat were not useful for predicting carcass portion selection, that qualitative aspects of food were as important as quantitative, and that no one formula will account for all human behaviour (Brink 2004:182).

With this framework, it is possible to make some inferences regarding the Muhlbach faunal assemblage. Shortt (1993) had previously explored utility at Muhlbach, and applied Emerson's (1990) (S) MAVGTP model to the site. He reported that the Muhlbach site followed a similar reverse utility strategy as Happy Valley, in which low utility elements were in high frequency and high utility elements were in low frequency (Shortt 1993:276), but there were some discrepancies in the data. Shortt (1993:276-277) noted an overabundance of astragali, navicular cuboids, and calcanei at the Muhlbach site, a frequency which he attributed to butchery methods. He correlated the abundance of major tarsals with the abundance of distal tibiae, stating that when the distal tibiae were smashed off, the lower portions of the hind limbs would have been left behind in greater abundance (Shortt 1993:279). Similarly, Shortt attributed an abundance of proximal femora at the site to smashing the femoral head to remove the hind limb, thereby creating an abundance of this element portion. Proximal humeri were underrepresented in the assemblage, and this situation is thought to be related to the removal for grease processing or because they suffered attrition due to their lower bone density (Shortt 1993:280).

Shortt (1990:283) concluded that the Muhlbach faunal assemblage showed a general reverse utility or bulk strategy, in which the majority of high and medium utility elements were removed from the site. The axial skeleton showed a flattened gourmet trend, in which only the higher utility elements are being removed from the site. Medium ranked elements like cervical vertebrae and the pelvis appeared in higher abundance than the high ranked thoracic and lumbar vertebrae. With the 2014 inventory of the faunal collection, more accurate counts of element abundance are available; as well as data on bone fragments missing from the collection.

Table 4.13: Muhlbach %MAU and index values used from Emerson (1990).

Element	Code	MAU%	(S) MAVGTP	(S) MAVGPRO	(S) MAVGMAR	(S) MAVGTF	(S) MAVGRE
Petrous Pyramid	SKULL	28.5	14.2	10.9	0	16.7	0
Atlas	ATL	40.5	6.4	6.6	0	5.9	2.4
Axis	AX	36.4	7.8	8.1	0	7.1	1.6
Cervical	CER	28.9	56.6	59	0	50.7	4.8
Thoracic	THOR	13.9	84.7	62.9	0	100	24.1
Lumbar	LUM	14.5	82.9	60	0	99.5	29.8
Sacrum	SAC	5.3	54.7	51.3	6.7	54	97.6
Pelvic	PEL	36.4	54.7	51.3	6.7	54	97.6
Caudal	CAU	1.4	1.5	0.9	0	1.8	4.5
Rib	RIB	5.4	100	100	0	93	55
Scapulae	SCAP	41.7	31.6	43.7	36.9	16.7	43.6
Proximal Humerii	HUMP	8.3	31.6	43.7	71.5	17.1	71.8
Distal Humerii	HUMD	20.2	25.1	33.1	69.2	15.3	58.5
Proximal Radii	RADP	35.5	16.5	20.6	68	11.2	51.9
Distal Radii	RADD	19.0	12.1	14.3	50.3	8.9	48.5
Ulnae	ULN	43.4	16.5	43.7	68	11.2	51.9
Carpals	CARP	53.8	6.6	7.1	36.2	5.6	38.2
Proximal Metacarpal	MTCP	33.1	3.9	3.6	29.2	3.9	33
Distal Metacarpal	MTCD	7.4	2.6	1.8	18.2	3.1	30.4
Proximal Femora	FEMP	30.6	69.4	94.1	97.2	38.7	100
Distal Femora	FEMD	15.7	69.4	94.1	98.2	38.7	100
Proximal Tibiae	TIBP	14.5	40.8	52.7	100	25.4	71.7
Distal Tibiae	TIBD	50.0	25.5	32	84.5	17	56.9
Astragulus	AST	86.4	13.6	16	55.2	10.1	49.6
Calcaneum	CAL	100.0	13.6	16	55.2	10.1	49.6
Navicular Cuboid	NCUB	72.3	13.6	16	55.2	10.1	49.6
Tarsal	TAR	25.0	13.6	16	55.2	10.1	49.6
Proximal Metatarsal	MTTP	40.5	7.5	8	40.6	6.4	38.9
Distal Metatarsal	MTTD	14.0	4.5	4	25.2	4.6	33.5
Phalanges	PHAX	57.3	2.9	2	15.5	3.5	30.6

I applied Emerson's (1990) indices using the new %MAU values, and since they are proportionally similar to Shortt's (1993) evaluation of the site, the (S) MAVGTP model still demonstrates a bulk transportation strategy at the site (Figure 4.7). The pattern shows that high to medium utility elements were removed in bulk from the kill site for further processing, likely at a nearby campsite. Sites like the Richards Kill and Village Site (Hlady 1967), Fitzgerald

(Hjermstad 1996), and the Hokanson site (Norris and Hamilton 2004) all have processing sites within a few hundred meters of the kill site, so it is likely that the meat-bearing elements were not transported far. Furthermore, the axial elements still demonstrate the flattened gourmet curve noted by Shortt (1993:283). Excluding the caudal and sacral vertebrae, axial elements of low to medium utility appear in moderate abundance, but the higher ranked thoracic, lumbar, and rib elements are extremely low.

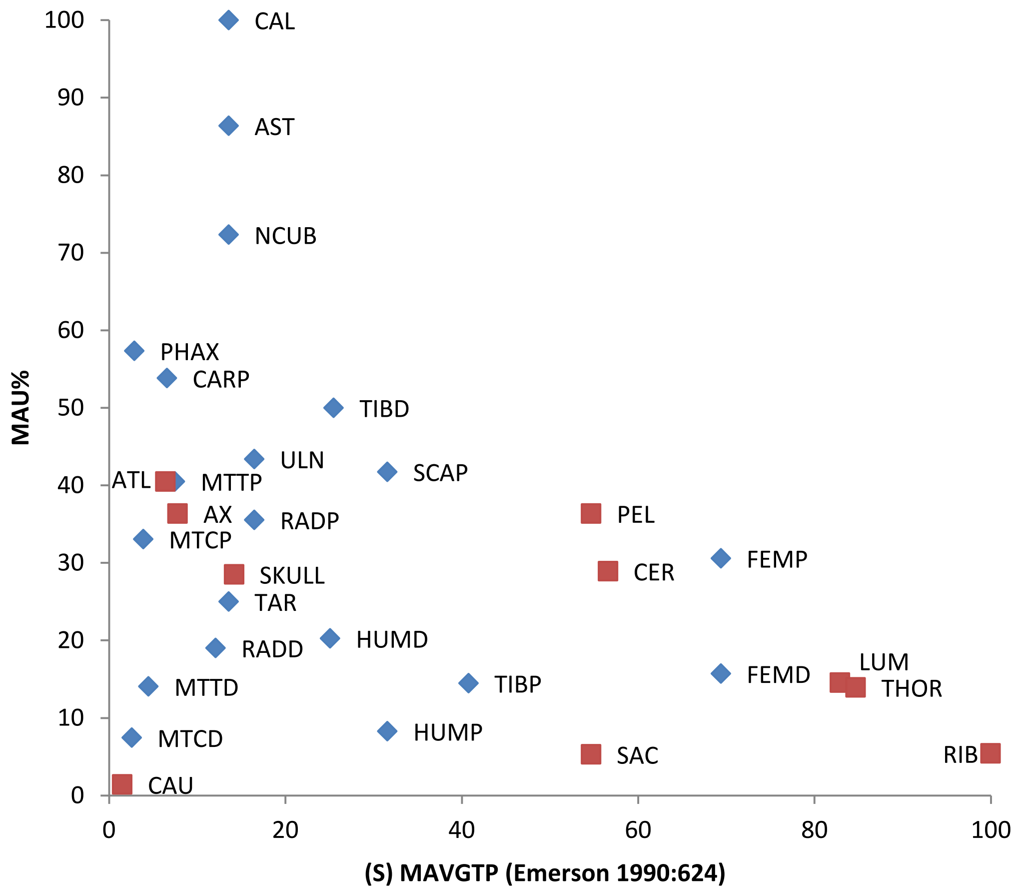

Figure 4.7: Muhlbach %MAU and Total Products Index adapted from Emerson (1990:624). Red points represent the axial skeleton, and blue point represent appendicular elements.

The results from the (S) MAVGPRO model follow the same bulk utility pattern as the (S) MAVGTP results (Figure 4.8). The larger quantities of low protein yielding elements over those with high protein yield values indicates that large quantities of meat and bone were likely carried away for further processing.

The same pattern is displayed for the (S) MAVGTF model (Figure 4.9), showing an even stronger bulk utility trend than the protein utility. This pattern could be evidence of preference of fat over protein, a food resource that is known to be important for hunter-gather societies (Brink 2004).

The (S) MAVGMAR index shows a different result than the previous indices (Figure 4.10); instead of a bulk utility strategy, large amounts of high marrow utility elements are present at the site, while low marrow utility elements range from low to moderate frequency. This pattern is best described as an unbiased trend (Emerson 1990:643), in which marrow content is not affecting decisions to remove bone from the site. Part of this trend is due to the modified aspect of the (S) MAVGMAR index; to adjust for low utility elements riding higher ranked elements out of a site, tarsals and carpals have their utility value inflated. These elements do not actually have any marrow value; this factor is largely a statistical measure to assist in accurately assessing the trends within the data. Their abundance indicates simply that these tarsal elements were not carried off attached to high utility elements.

This unbiased trend does not mean that marrow was not exploited at the Muhlbach site; rather, there is ample evidence that limb bones were being broken open to extract the marrow, and that marrow extraction was practiced on site, where the animals were killed. Bone marrow fat is an extremely valuable resource, as it is more resistant to seasonal and nutritional stresses that affect the overall fat quantity and quality in bison (Brink 1997:271). Bone marrow will spoil relatively quickly (Binford 1978:100), but will last longer than fresh meat or fat. Once killed, bison need to be skinned within a few hours to cool down the meat and prevent spoilage (Brink 2008). This trait means that in a mass kill context, bone marrow in bison can be exploited later, after other aspects of butchery have been completed, and the abundance of high marrow utility elements at the Muhlbach site reflects this behaviour. Limb bones were broken open at the kill to extract the marrow, and then discarded at the kill site.

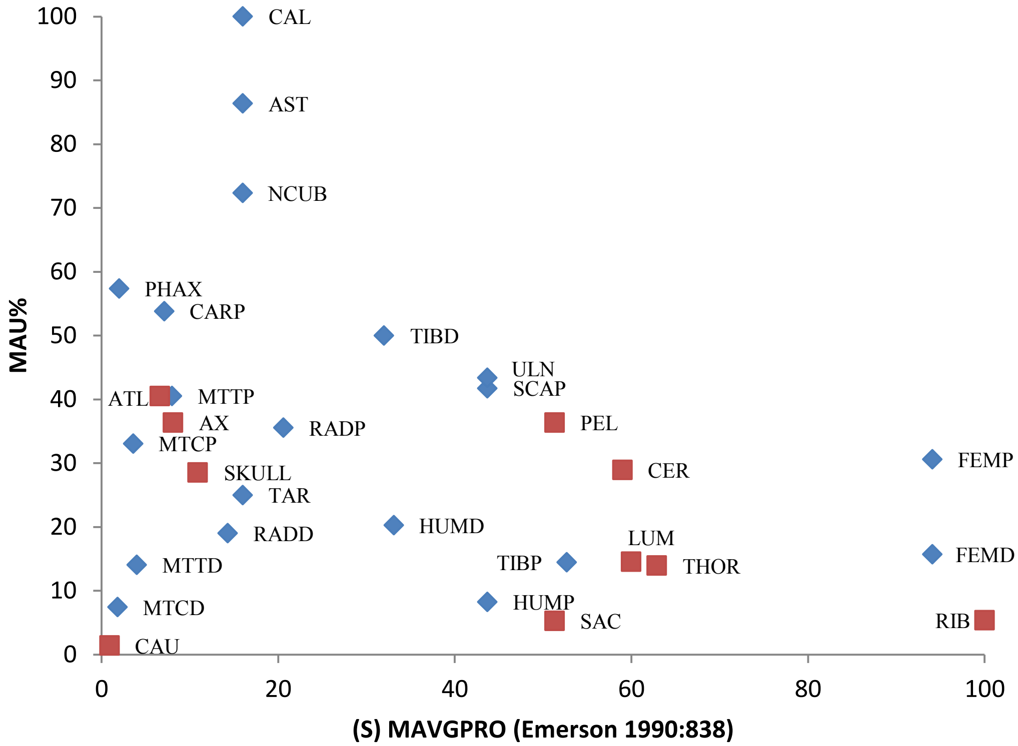

Figure 4.8: Muhlbach %MAU and protein index from Emerson (1990:838). Red points represent axial elements and blue indicates appendicular

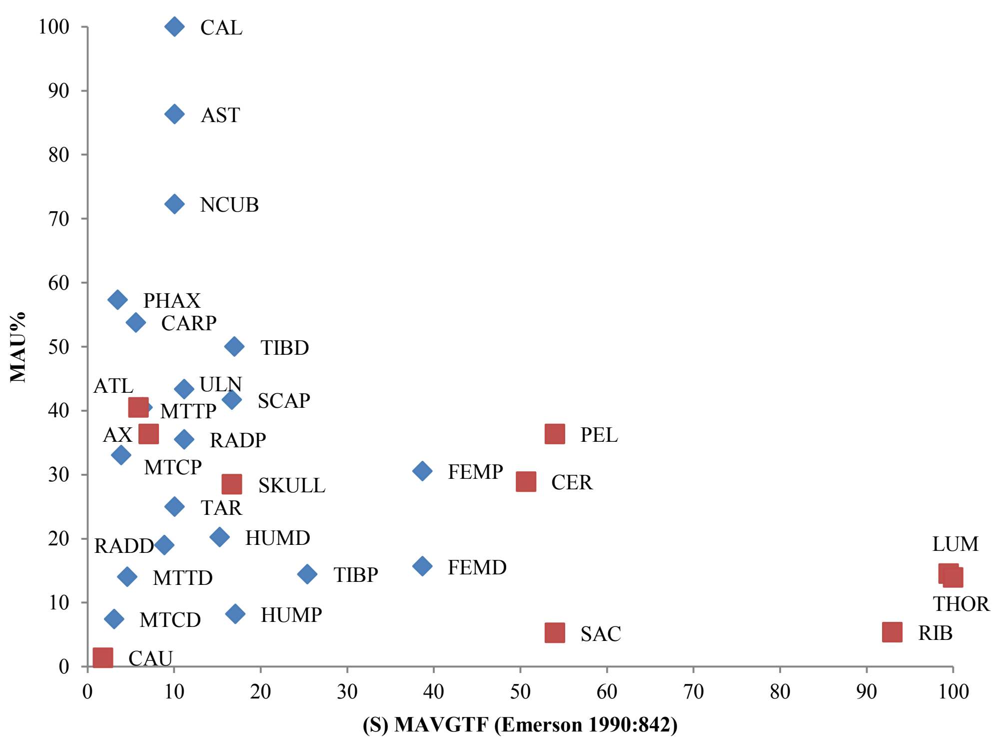

Figure 4.9: Muhlbach %MAU and total fat index from Emerson (1990:842). Red points represent axial elements and blue indicates appendicular

This behaviour can be demonstrated in the ratio of complete to incomplete elements at the site. In order to access the bone marrow, the limb bones need to be broken open, thereby leaving ample evidence of this exploitation. Except for the metapodials, there are few complete long bone elements from the site. In terms of MNE, there are 50 complete and 48 incomplete metatarsals, and 57 complete to 24 incomplete metacarpals. The abundance of complete metapodials is apparent when the ratios of complete metapodials to incomplete (50:48, and 57:24) is compared to ratios of tibiae (2:121) and radii (14:72). Furthermore, the rank of metapodials in the (S) MAVGMAR index is relatively low for limb bones (Figure 4.10), showing that high marrow utility elements were preferentially exploited over moderate marrow utility elements.

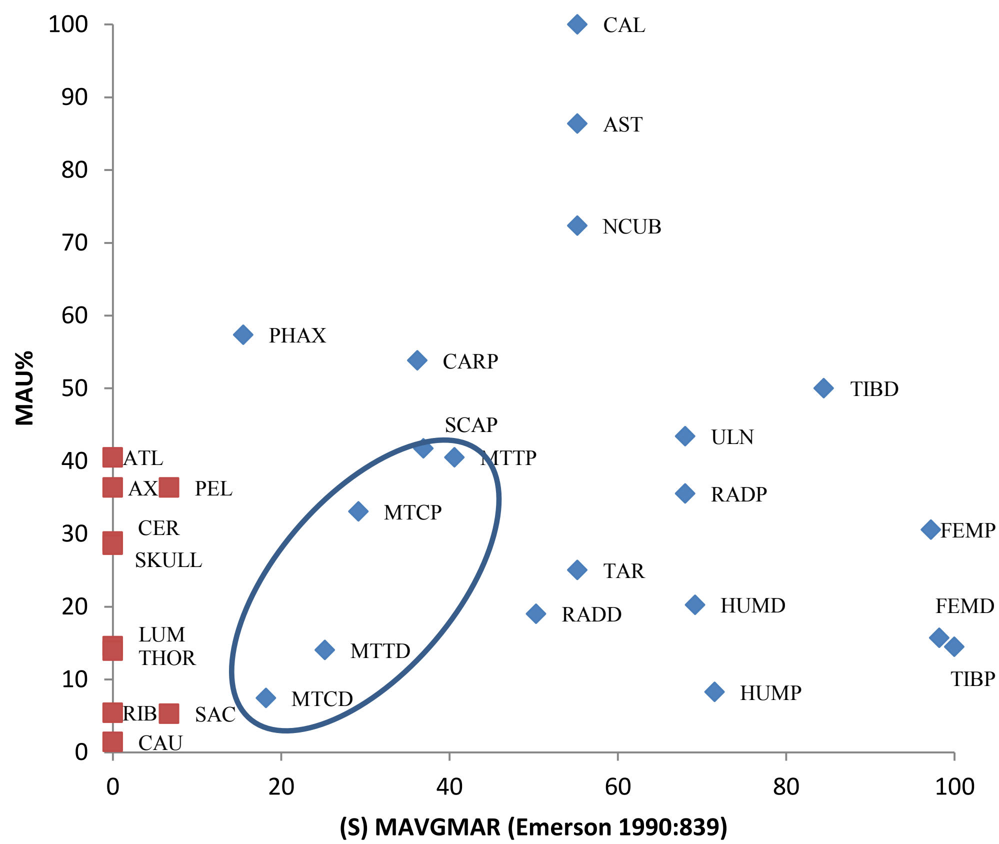

Figure 4.10: Muhlbach %MAU and marrow index from Emerson (1990:839), with metapodial elements circled. Red points indicate axial elements, and blue indicate appendicular elements.

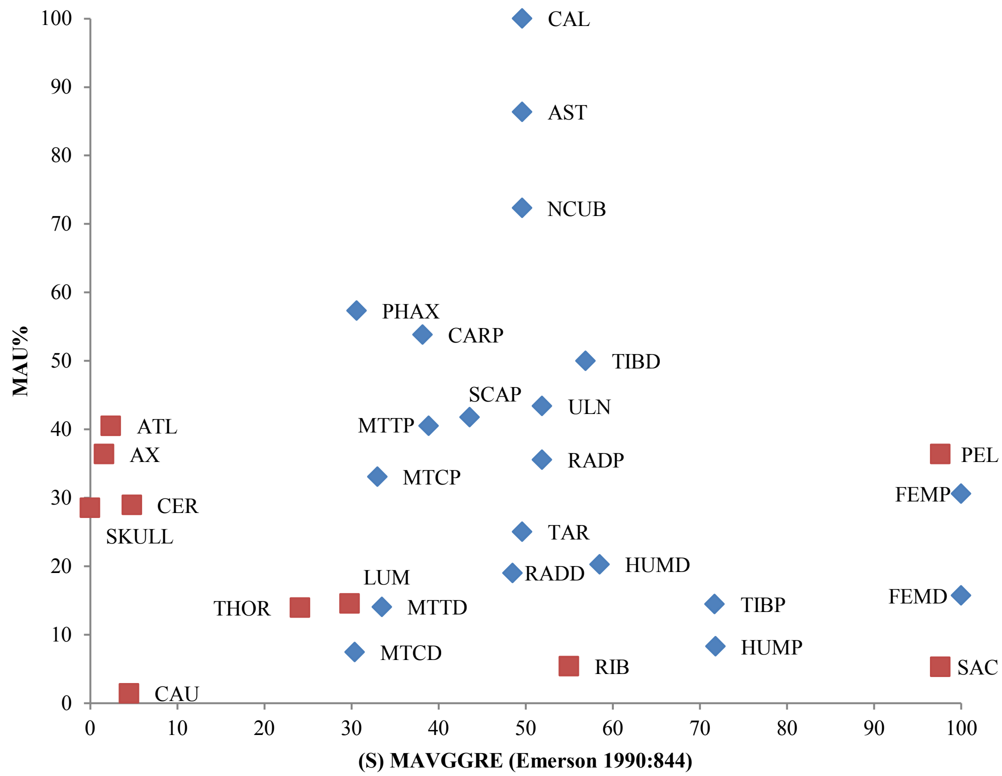

Figure 4.11: Muhlbach %MAU and bone grease index from Emerson (1990:844). Red points represent axial elements, and blue points indicate appendicular elements.

The results of the (S) MAVGGRE model follow the unbiased (S) MAVGMAR pattern, with high to moderate bone grease utility elements appearing in higher abundance than low ranked elements (Figure 4.11). Rather than indicating that bone grease exploitation followed the same pattern as bone marrow, this trend indicates that bone grease was not exploited at the site. In order to exploit bone grease, the elements needed to be virtually destroyed and boiled to remove the fatty acids from the bone structure (Brink 1997). This process would effectively destroy any identifiable features on elements, reducing one's ability to accurately identify skeletal elements in an archaeological faunal assemblage. The scale of bone grease rendering activities at a site would be represented in the undifferentiated long bone fragments, one of the most abundant element categories at the site (NISP=1025). Scaling bone grease indices against these long bone fragments is difficult because there is considerable variation between different long bones and even different portions of long bones (Emerson 1990). Bone grease deposits in bison decrease distally in long bone elements, and have been correlated with bone volume and density (Brink 1997:266). Therefore, without knowing the type of long bone these fragments represent, it is not possible to scale their abundance against their utility. It is apparent that high utility grease elements were not targeted for transport away from the site; furthermore, these undifferentiated long bone fragments from the site do not fit in the size category expected as a by-product from extensive grease rending activities. These long bone fragments seem to be a by-product of marrow extraction rather than grease.

Overall, Emerson's indices reveal a pattern of bulk removal of high to moderate meat and fat ranked elements from the site, with a gourmet exploitation of bone marrow elements, and a limited exploitation of bone grease products. Brink's (2004) criticism of these utility indices and his analysis of portion selection do warrant some reassessing of element representation at the Muhlbach site. One major issue with the Emerson (1990) indices is that the tongue is not represented in the equation. Many different hunter-gather groups consider the tongue a delicacy, and Buffalo Bird Woman's group always retained the tongue of the bison carcass (Brink 2004:179). The other anomaly is with the cervical vertebrae. Despite ranking relatively high in fat and muscle ranking, the Hidatsa discarded this segment since the meat was considered too tough (Brink 2004:179). These idiosyncrasies can influence the abundance of elements, and affect the application of any indices.

I applied the Fat Weight % ranking proposed by Brink (2004:179) to the Muhlbach assemblage to see if the culturally based preference and taste demonstrated by Buffalo Bird Woman could explain variation in the faunal assemblage (Figure 4.12). This model included the tongue as represented by the mandible, an assumption based on the many mandibles that exhibit butchery and breakage patterns associated with tongue removal (see discussion of the mandible portion). While the mandibles lacked evidence of cut marks demonstrating tongue removal, the high %MAU values for mandibles and piles of mandibles recovered around the site (Gruhn 1969), suggests that this element was accumulating in work areas in which the tongues were removed from the carcasses on site and transported elsewhere

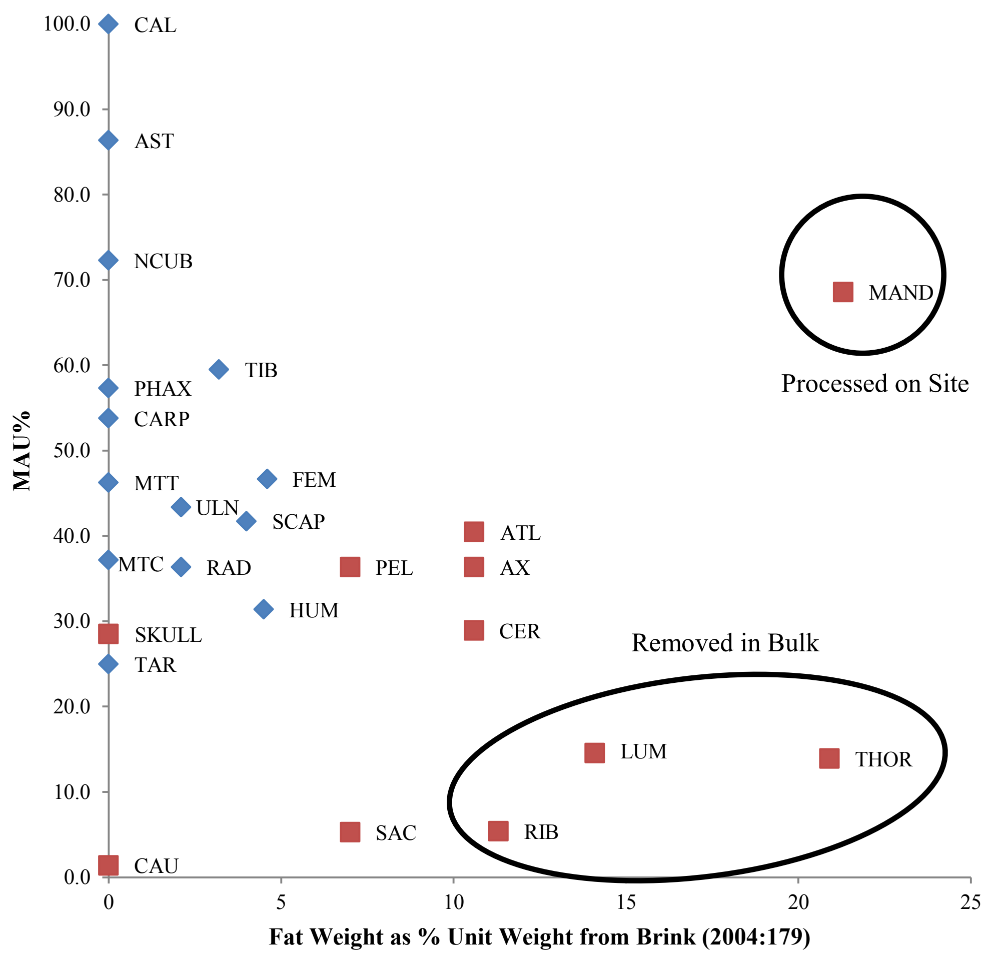

Figure 4.12: Muhlbach %MAU and fat weight % ranking from Brink (2004:179).

The vertebrae also show an interesting pattern in terms of abundance and Fat Weight % rank. Overall, cervical, thoracic, and lumbar vertebrae are rare at the site; under 30% of the total MAU for the site. This pattern could be related to density mediate attrition (Kreutzer 1992), but the cervical vertebrae are at least twice as abundant as thoracic and lumbar vertebrae at the site, despite having comparable utility values (Emerson 1990) and bone volume densities (Kreutzer 1992). The cervical vertebrae are less dense than thoracic vertebrae, but appear twice as abundant at the Muhlbach site (see Figure 4.2). The higher abundance of cervical vertebrae at the site could be related to Brink's (2004:181) assertion that the neck was considered a poor quality cut of meat.

Finally, the higher abundance of appendicular elements seems to reflect their lower ranked status in terms of fat weight % at the site. The overall pattern demonstrated by these utility indices reveals a targeted gourmet strategy for the axial skeleton at the site, and bulk transportation of appendicular elements to the camp for further processing.

Conclusion

By analyzing the faunal assemblage from the Muhlbach site, I was able to illuminate many aspects about the occupation that were previously unknown. Based on an inventory of the collection, supplemented by original catalogue information, there were at least 128 bison killed at the site. The hunters at Muhlbach employed a targeted gourmet strategy for the axial skeleton, and carried out bulk transportation for the appendicular skeleton. The herd structure at the site appears to be dominated by adult female animals, with some male specimens and a limited number of juvenile bison present. Based on the available data, it appears that the site was likely occupied between late spring and early summer, but this assessment needs further refinement. Now armed with a better knowledge of the faunal assemblage, it is now possible to explore the spatial relationships among the different areas of the bone bed, as well as to investigate possible methods used to drive the bison into the site.

Chapter 5 – Spatial Analysis of the Muhlbach Site

Since the 1960s, there have been significant advances in Geographic Information System (GIS) and mapping technologies, making it possible to explore the spatial relationships within a site in a way that was not previously possible. Luckily, Gruhn carried out extensive mapping of the Muhlbach site and its material culture, allowing us to use these advances to address important spatial questions about the site. Using ArcGIS 10.1, various attributes about each mapped object can be recorded and used to explore spatial relationships within the site.

Methods and Sample

There are essentially four different spatial datasets that could be analyzed from the site: artefacts, faunal remains, features, and unit contents. These datasets needed to be converted in forms that are readable by ArcGIS 10.1. The first data format is vector point data, which refers to any spatially referenced information that can be given as a point on the globe, and is the most commonly known form of spatial data. The best example of this data format is archaeological site location data, which represents one three-dimensional location on the globe, but could also include the distribution of artefacts and faunal remains represented by a single point or polygons. Various types of information can be associated with a vector data, like type and raw material for artefacts, or element for faunal remains, but the point itself is one discrete value in space.

The Muhlbach artefact, feature, and unit datasets were easily converted into Vector data, as Gruhn recorded the northing and easting of the artefacts like projectile points, bifaces, scrapers, cobbles, debitage, and some of the faunal remains. The coordinates for some features were recorded, but the information for most features was compiled from descriptions in the field notes, information from the profiles, and plan maps of the excavation. The unit content dataset was created by making a 2 m^2 grid for the excavation units and associating these polygons with data amassed from the 2014 inventory of the faunal collection.

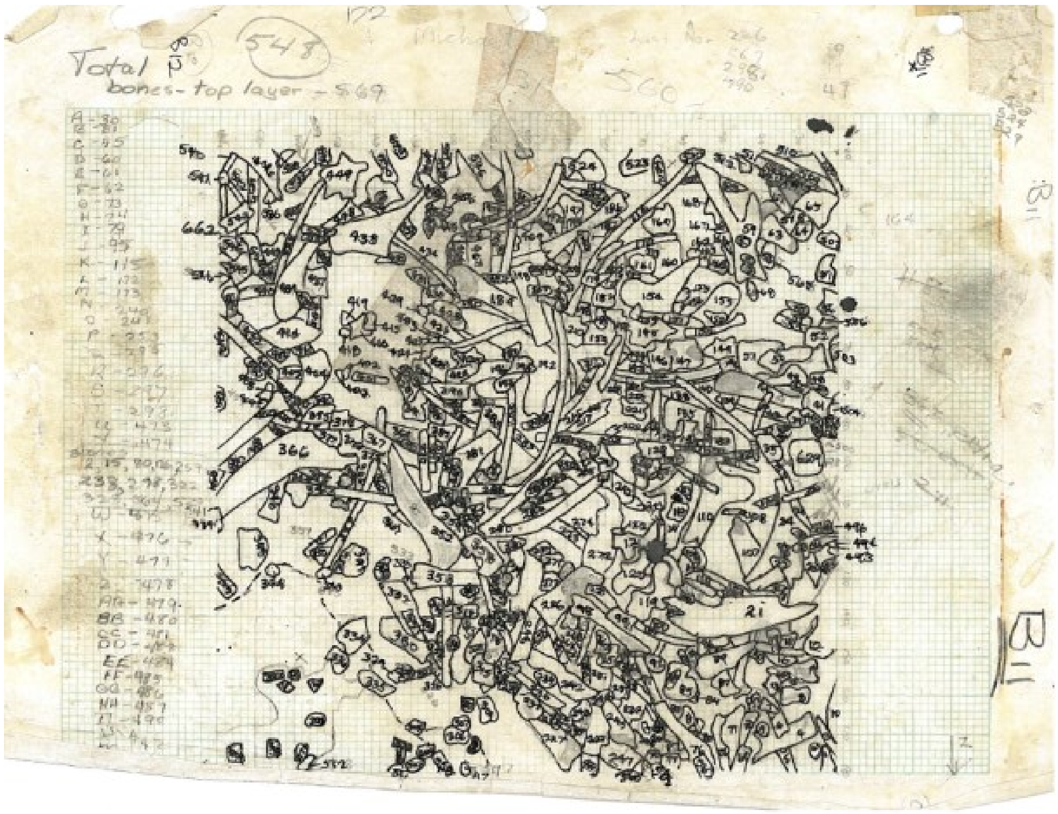

Figure 5.1: The Unit B11 paper map from the main trench.

The most significant dataset from Muhlbach was the distribution of faunal remains in the main trench. Due to time constraints, Gruhn mapped the bone only in the main trench, using 1 mm grid paper to draw a bone bed plan map in each unit and baulk (Figure 5.1). These paper maps included catalogue information for each bone, allowing for information from the 2014 inventory to be related to each object on the map. To explore the spatial distribution of faunal remains in the main trench, I needed to introduce these paper maps into a GIS environment by converting them into a vector data. First I scanned and uploaded the maps into Adobe Illustrator, in which the units and baulks maps were adjusted for scale and placed in correct geographic position (Figure 5.2); this composite map was then added to ArcGIS 10.1 and scaled accordingly. The final product was a juxtapositioning of different plan map sheets revealing the distribution of faunal remains in the main trench; Mills (2007:55) employed a similar approach in her analysis of the Fincastle bone bed.

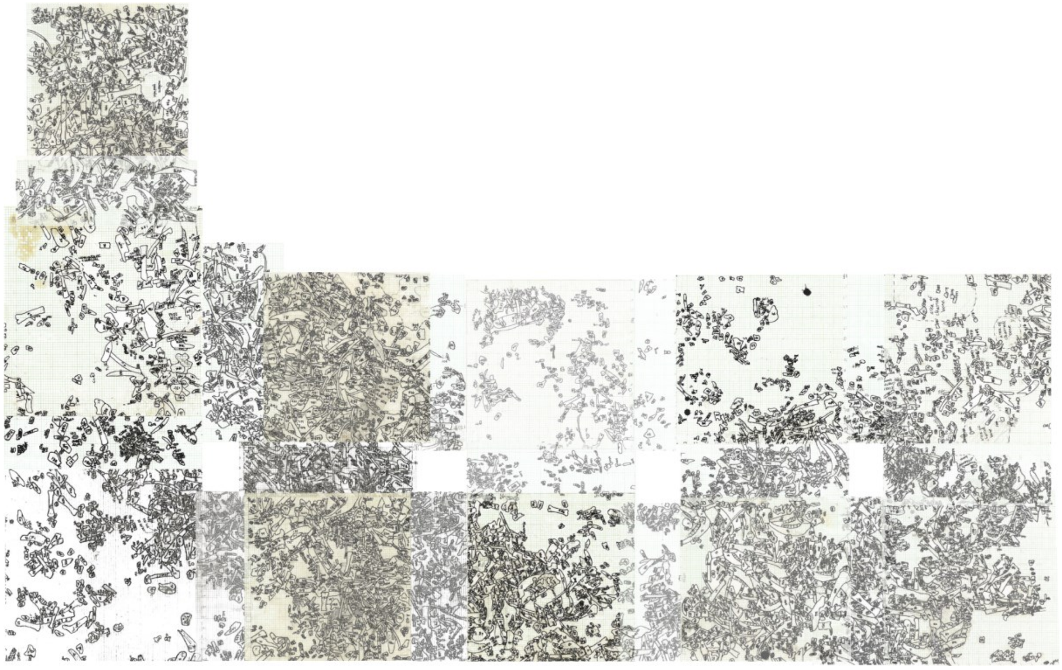

Figure 5.2: Scaled and adjusted plan map sheets from the main trench, showing the position of each bone fragment.

Once in ArcGIS, I created a shapefile and traced the outline of each bone into a polygon with the catalogue number associated with it, allowing 6427 of the 8667 bone fragments (~75%) from the main trench to be mapped in this manner. The faunal catalogue numbers in this polygon shapefile were then associated with information from the 2014 inventory, allowing for each polygon to be related to the respective element, portion, side, age, and alterations associated with each object. The final result was a spatially accurate map of the main trench bone bed that could correlated with the different types of artefacts and features in this area of the site (Figure 5.3). The different counts of elements per unit were used to model the spatial relationships among different areas within the site, since the bone bed had not been mapped in other areas of the site.

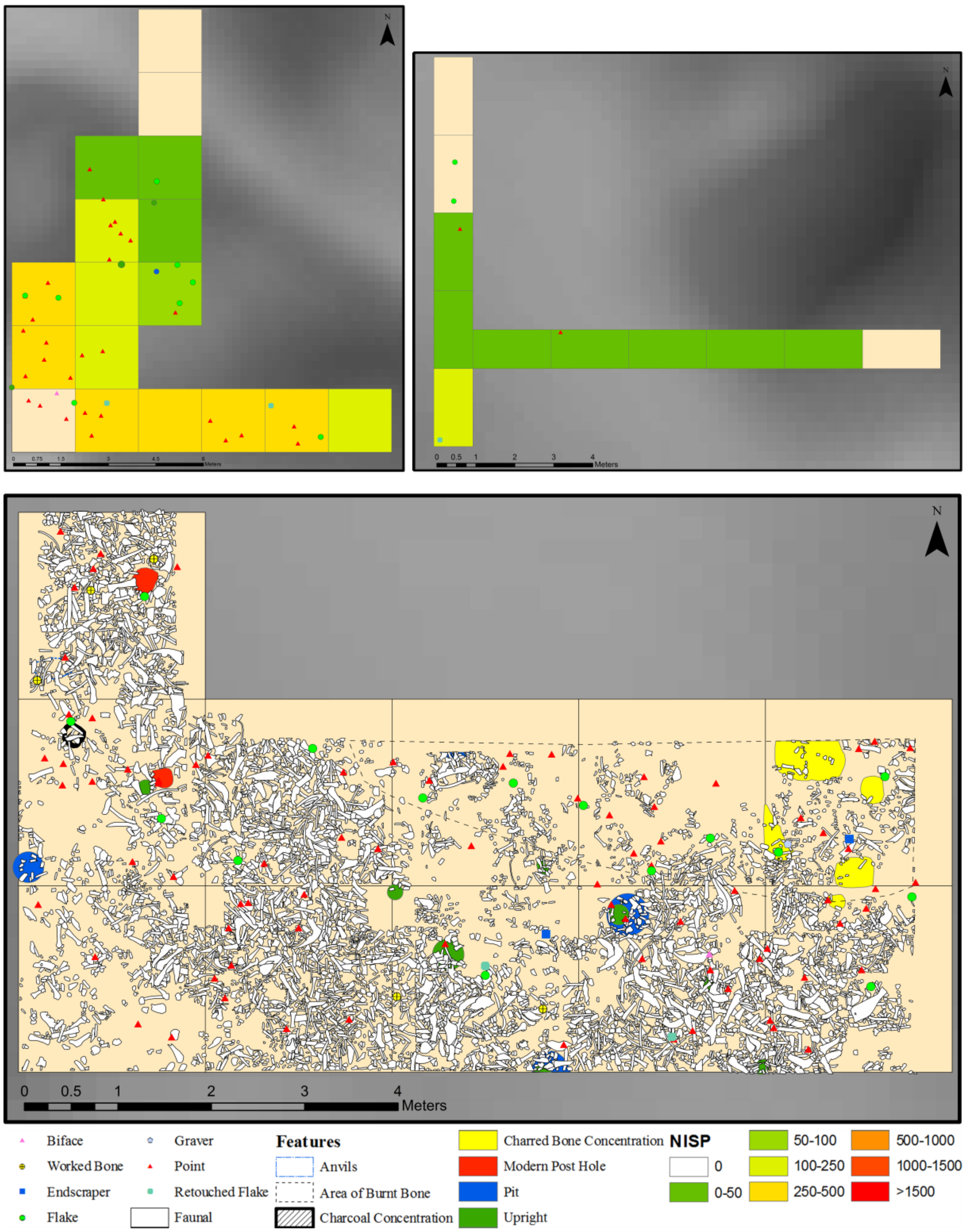

Figure 5.3: Completed bone bed map, artefacts, and features. Faunal remains in the northern and eastern trenches are represented by raw NISP counts.

The polygonal representation of the bone bed is a useful tool for visual illustration and comparison, but comparative spatial analyses and statistics need point data to determine surface densities, which produces the second form of spatial data used in ArcGIS, Raster data. While vector data is represented spatially by x, y, z coordinates, raster data is a continuous spread of cells with the same dimensions and one changing variable; essentially, raster data is a chart spread across the landscape, with each cell containing a numeric value, and this format allows for continuous data coverage over a spatially referenced region. Different spatial analytical models that calculate surface density require at least two points to produce raster data, and extrapolate a smooth distribution surface over the point data. By converting the bone bed polygons into a single point at the centre of each polygon, called a centroid, it is possible to use density tools in ArcGIS to create a surface density raster.

The surface density tool used in this analysis is called Kernel Density Estimation (KDE), which calculates the density of points by placing a two dimensional probability density function over two points; the magnitude of this "kernel" is related to the value and distance between these points (Conolly and Lake 2006:175; Mills 2009:11). The most important parameter used to determine KDE is the search radius, the distance from a reference point used to calculate the density: all points within this radius of the original point will be included in the calculation of the "kernel's" magnitude.

This search radius can distort results depending on the scale of the analysis. If the search radius is too high, the resulting distribution will smooth over any meaningful results, and the resulting map will merge clusters as one continuous surface density without reflecting the underlying pattern in the data. Similarly, if the search radius is too low, the surface density will be rough, patchy, and isolated, thereby impeding meaningful interpretation. By experimenting with these variables, a best fit for the data can be determined, but one must be cautious to achieve the best representation of the data (Mills 2009). For the Muhlbach site, I used a search radius of 20 cm to define the density of the faunal remains and artefacts; this radius will consider all points with 20 cm of the original reference point. This is following the methods carried out at the Fincastle site, which used a search radius of 25 cm to create a KDE (Mills 2009).To compare different areas of the site, I employed a quadrant analysis to look at the different counts of bones in each unit.

Results – Distribution of Artefacts

Now armed with spatially referenced data regarding the distribution of faunal remains and artefacts, it is possible to begin to explore the site. Interpretation regarding the spatial distributions of artefacts is limited, as there is simply not enough data for meaningful correlation. Visual analysis confirms an association between the distribution of all artefacts and the density of faunal remains across the site; as the density of bone increases, so does the number of artefacts (Figure 5.3). The most common artefact types, projectile points and debitage, are evenly spaced around the site, and not clustering in any significant manner. For projectile points, this distribution likely reflects where the projectile landed after being fired, or where the point was left as it was moved during the butchery process. The analysis of the debitage determined that most of the flakes were small tertiary flakes, likely from edge-wastage and sharpening activities. The even spacing of tertiary debitage at the site indicates that intensive lithic reduction was not carried out. There were flakes recovered outside of the bone bed in the northern trench (Figure 5.3), a distribution which demonstrates that the occupation does extend beyond the bone bed. Other artefact types, like scrapers and bifaces, are too few in number to develop meaningful conclusions on spatial distribution.

Evaluation of the Faunal Remains Distribution using Quadrant Analysis

By using quadrant analysis based on compiled faunal data from the Muhlbach site, it is now possible to explore the spatial distribution of faunal remains at the site in reference to primary and secondary butchery locations. This distinction differentiates between the primary stages of butchery and dismemberment of a carcass and the secondary removal of meat, marrow, as well as any grease rendering (Brink *et al.* 1985; Rixson 1988; Watts 2008). Primary butchery is often detected at the kill sites, and can be identified by the abundances of articulated elements, chop marks, and spiral fractures targeted at disarticulating the carcass; there may be an absence of certain elements present in the assemblage (Brink *et al.* 1985). Additionally, since articulated segments of the axial skeleton were too heavy to haul away from a kill site, a profusion of axial elements is thought to demonstrate a primary butchery location (Brink *et al.* 1985:175; Watts 2008:36). Secondary butchery areas are often located at the camp setting, and can be demonstrated by cut marks aimed at removing the flesh from the bone. Comminuted bone from marrow extraction and/or grease rendering should also be common. It would be expected that a secondary butchery area would produce an abundance of disarticulated, high meat utility elements (i.e., proximal femora, ribs, cervical, thoracic, lumbar vertebrae; see previous discussion of utility indices in Chapter 4), and a poor representation of low utility elements (Brink *et al.* 1985:169).

A major issue with identifying primary and secondary butchery locations is that these activities will co-occur within a site, meaning that any evidence of primary butchery activities could be eliminated by subsequent secondary butchery actions. After the initial butchery of the animals is completed, the hunters could return to the kill site and further exploit other food resources, like bone marrow and grease. As previously discussed in Chapter 4, bone marrow exploitation can be delayed until the meat processing is finished (Binford 1978:100) and bone grease will not spoil until long after the kill. These secondary activities will eliminate most of the evidence for primary butchery locations, and thus we must be mindful of the variations in human activities that can affect the material record.

One technique for separating primary and secondary butchery areas is to compare the representation of axial and appendicular elements at the site. The axial skeleton composes roughly 60% of a bison carcass (Brink *et al.* 1985:175), so an abundance of axial elements over appendicular should indicate a primary butchery area. Additionally, the presence of articulated skeletal segments should further demonstrate a primary butchery area. Unfortunately, it is not possible to quantify the number of articulated units at the site, but just to confirm their presence. Gruhn (1969:136) reported short columns of articulated vertebrae and lower limbs left in association, but these were the exception not the rule.

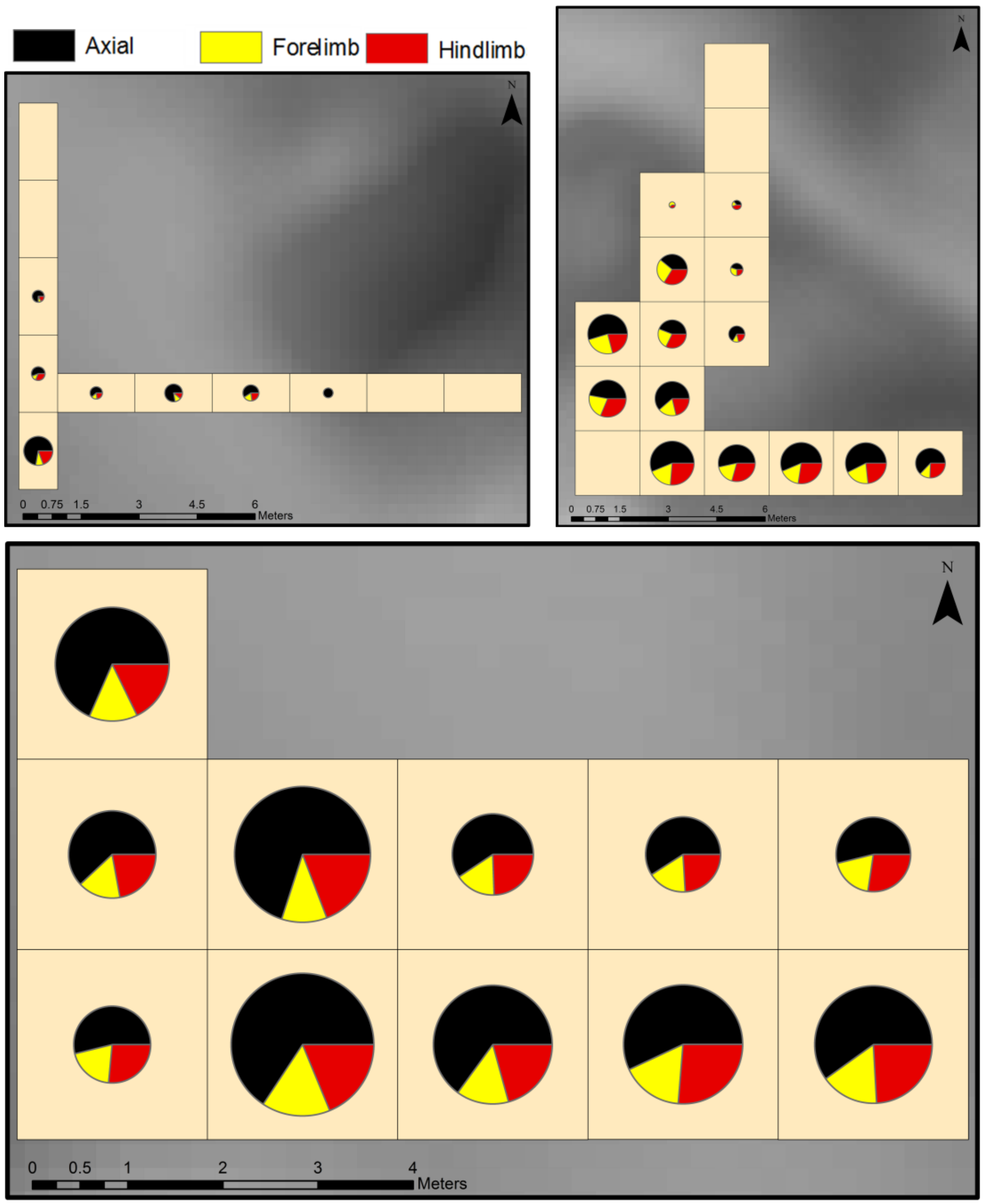

Figure 5.4: Ratios of NISP for axial and appendicular elements per unit. Each pie chart depicts the percentage of each carcass portion that is present in the unit; the overall amount of bone is reflected by the size of each chart.

The presence of primary and secondary butchery locations should be revealed by quantifying axial and appendicular elements by units. Using NISP counts for the whole site alone, axial elements comprise the majority of the Muhlbach faunal assemblage, with a total of 4397 axial elements from the site, compared to the 1163 forelimb and 1666 hind limb elements present. These numbers indicate that the axial skeleton represents 60.8% of the identifiable assemblage, exactly the percentage the axial skeleton should represent at a primary butchery location where whole carcasses where present (Brink *et al.* 1985:175).

The NISP of axial, forelimbs, and hind limbs broken down by unit are illustrated in Figure 5.4. Each pie chart shows the percentage of each category per unit, and is proportional in size to the amount of faunal remains in each unit. In the main trench, the ratio of axial to appendicular varies slightly across the units, but the axial portion comprises roughly 60% of the each unit. NISP for elements from the forelimbs and hindlimbs are roughly equal as well, but hindlimbs consistently outnumber the forelimb. This difference between the hind and forelimbs is likely not connected to any cultural activity, but rather due to biases in collection practices for the larger, more visible tarsal elements over the smaller carpal elements. The eastern trench has slightly more appendicular elements as compared to axial, but the axial elements are still more common than appendicular in these units. The northern trench has the most axial as compared appendicular elements out of any area of the site, but the small amount of bone from these units means that idiosyncrasies in collection and preservation issues could significantly bias the assemblage. Overall, the NISP per unit data reveals a primary butchery pattern, with some possible secondary butchery occurring in the eastern trench, represented by the slightly higher abundance of appendicular elements over axial.

Using only NISP to discern patterns at the site is problematic, as the change in ratio among different excavation areas is too small to reveal any significant patterns; the NISP in each unit gradually declines towards the north and east, but the ratios of each unit remain relatively close over space. NISP is also problematic, as the repetition in a skeleton and fragmentation of different elements can cause an overrepresentation of particular carcass segments. There may be a large number of ribs and vertebrae in each unit, but these elements repeat the most in a skeleton, and in terms of animal units, they may not be as abundant as their NISP counts would suggest. Utility indices use %MAU to correct for the overabundance of certain skeletal elements at kill sites by scaling element counts by the number of times each element occurs in a body and the minimum number of animal units from the site (Emerson 1990). Charting the spatial distribution of each unit's %MAU will allow us to adjust the spatial representation of elements and correct for overrepresentation of certain elements. This procedure will allow us to begin to investigate the distribution of food utility and carcass exploitation at the site, as well as explore secondary butchery locations.

Mapping the ratios of axial and appendicular elements by %MAU per unit gives a completely different pattern than the NISP ratios. Figure 5.5 shows the %MAU for each unit as compared to the overall representation of animal units from the entire site. The number of animal units in each unit was scaled against the element with the highest MAU; in this case the calcaneus, with a MAU of 121 (Table 4.2). This procedure will illustrate whether or not each unit has higher percentage of a particular element or portion in comparison to the overall expectation for the site. The pie charts in Figure 5.5 denote the percentage of each carcass segment present in the excavation unit (i.e., how many animal units of axial skeleton are present, how many forelimb and hindlimb elements are present). The %MAU ratios in Figure 5.5 are closer to 30% axial and 70% appendicular in most units, a polar reverse from the 60% axial based on NISP. A trend can be observed for the axial %MAU in the main trench that closely follows the densely clustered bone arc present on the bone bed map in Figure 5.3. Units outside of this arc have noteworthy lower fractions of axial %MAU (See Units A10 and B14 in Figure 5.5).

Overall, %MAU shows a pattern of higher appendicular %MAU over axial, with one exception in the eastern trench, Unit A24 (Figure 5.5). Most units exhibit an axial %MAU around 25% or lower, but the axial %MAU in Unit A24 exceeds 50%. This pattern is a stark contrast from neighbouring units and even units in the main trench. This pattern is also seen in the northern trench within Unit L10, although there is significantly less bone in this unit, and the abundance of different elements could be subjected to a variety of biases that influence bone counts and representation. The high appendicular %MAU over axial elements in most excavation units and the Unit A24 and L10 exceptions warrants further exploration.

To explore this trend further, we can break the %MAU of axial elements down into the individual elements %MAU that make up the assemblage. Figure 5.6 represents the %MAU portion of different types of axial elements, such as the mandible; the skull represented by petrous pyramids; the cervical, thoracic, and lumbar vertebrae, and the pelvis. Excluded from this map are caudal and sacral vertebrae, as well as ribs, since these elements have such low %MAU values per unit that they are almost non-existent at this scale.

When this data structure is used, one apparent pattern emerged from the axial assemblage; the most abundant axial elements in terms of %MAU are the mandibles, cervical vertebrae, and pelves, which are significantly more abundant than ribs, thoracic, and lumbar vertebrae (Figure 5.6). This pattern can be illuminated by returning to the discussion of utility indices in Chapter 4, in which it was determined that high utility axial elements were transported away from the site, and low to moderate axial elements were only selectively butchered, and the processing and representation of each element reflects this behaviour. For example, the butchers separated the tongues from the mandibles, disposing them into piles at the site. Furthermore, the abundance of mandibles in the main trench, and the west edge of the eastern trench, suggests that these locales were significant work areas for tongue processing.

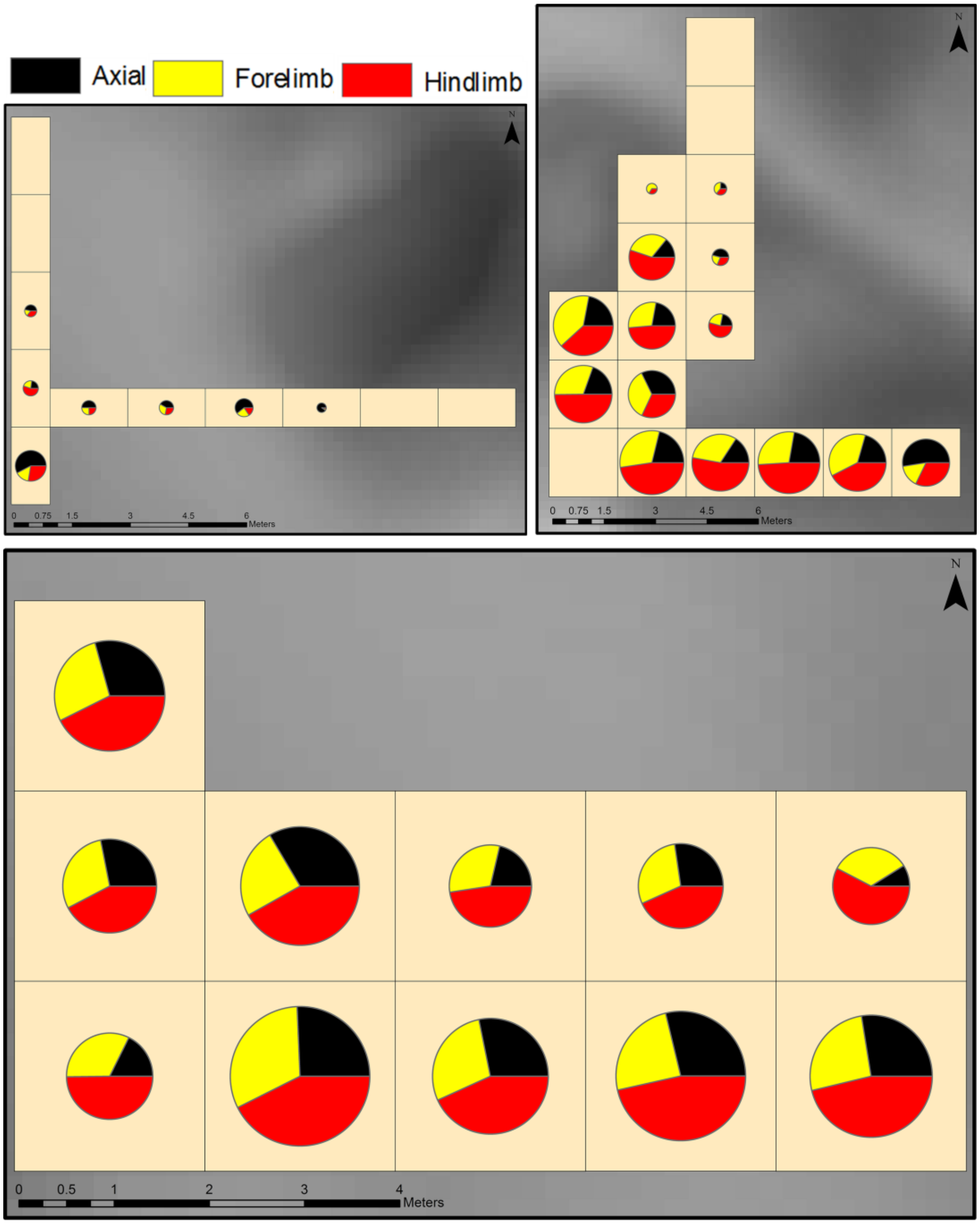

Figure 5.5: Percentage of axial and appendicular elements per unit by %MAU of axial and appendicular elements per unit. Note the higher proportion from axial %MAU in Unit L10 (northern trench bottom left) and Unit A24 (eastern trench bottom right).

The other dominant axial element, the cervical vertebrae, follows a similar spatial pattern as the mandibles. Based on Emerson's (1990) indices and the Fat Weight % index from Brink (2004), cervical vertebrae have a lower utility value than thoracic or lumbar (See discussion of utility indices in Chapter 4). In addition, cervical vertebrae had a lower perceived food status, according to some ethnographic and historic sources (Brink 2004:181). This factor could also explain the higher %MAU values for cervical vertebrae as compared to the thoracic and lumbar vertebrae. The pelvis also occurs in higher abundance than other axial elements, like reflecting its moderate utility ranking. The high ranked elements, ribs, thoracic, and lumber vertebrae, have low %MAU values, and were likely removed en mass from the kill area, while moderate to low utility elements were discarded. These values speak to the gourmet strategy employed for the axial skeleton discussed in Chapter 4.

Returning to the units with higher axial %MAU as compared to appendicular %MAU, Units L10 and A24, we can determine the source of this anomaly (Figure 5.6). Breaking down their axial %MAU, these units have an abundance of pelves, mandibles, and cervical vertebrae like other units, but they also have an usually high %MAU for skulls, which was calculated using the number of petrous pyramids in each unit. There are few cranial fragments from the site, either from poor preservation or butchery practices (see discussion of cranial fragments and treatment in Chapter 4). Excavators uncovered some intact bison skulls at the site, but these specimens disintegrated when they attempted to remove them. On the other hand, the dense petrous pyramid is better able to resist the taphonomic factors that removed the complete skulls from the assemblage. Based on this durability and the descriptions of fragmentary in situ bison skulls, I assume that the petrous pyramids reflect the in situ position at which the rest of the skull had either eroded away or was broken up during processing.

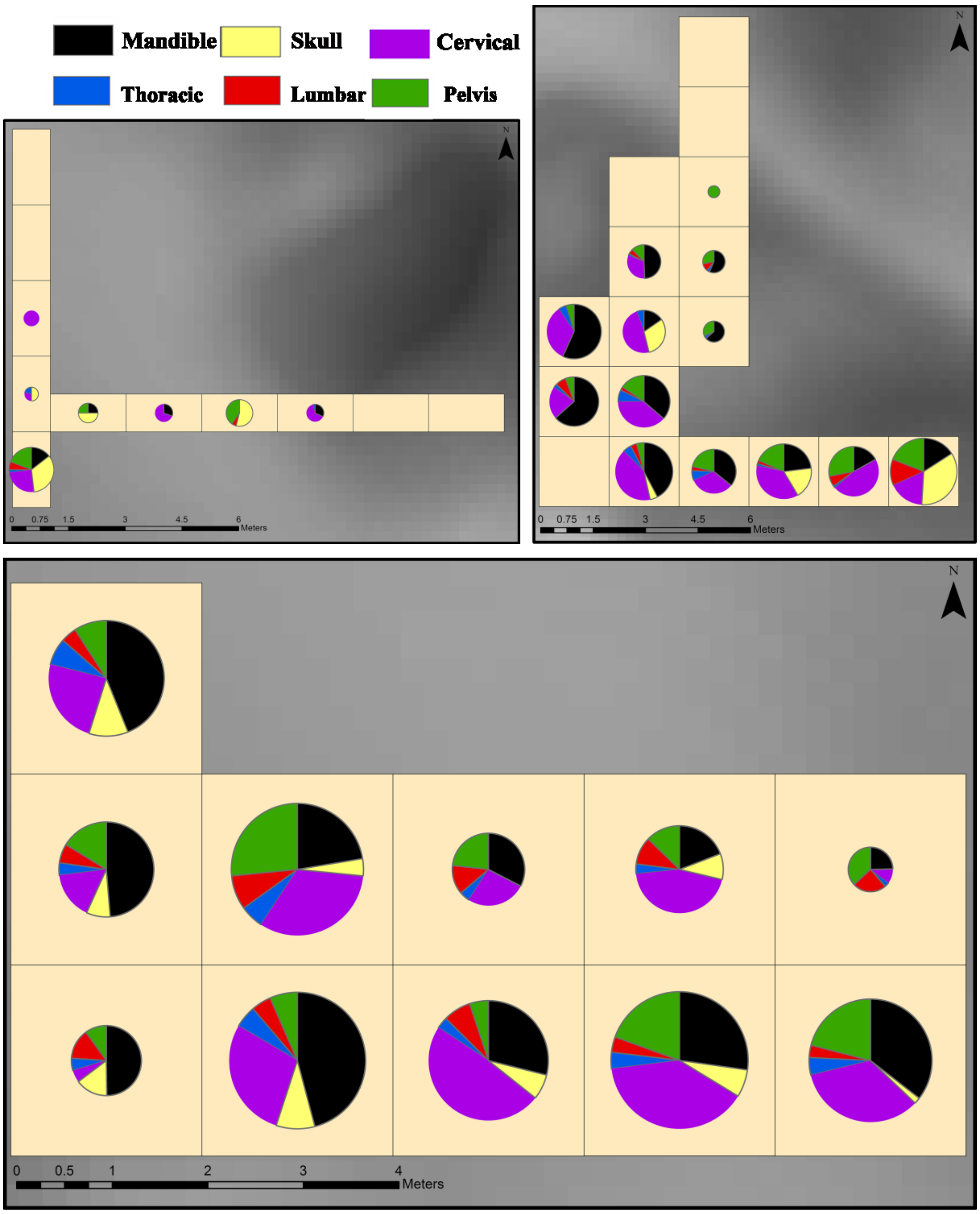

Figure 5.6: Axial elements %MAU per unit.

Looking at the %MAU of petrous pyramids (i.e., bison skulls), the overall axial %MAU values (Figure 5.6) from these two units are inflated because they have a greater number of skulls as compared to other units and overall expected number of skulls from the site. By MNE, Unit A24 has 11 petrous pyramids, with an MNI of five, and Unit L10 has seven petrous pyramids, with a MNI of four. This pattern is significantly more than what we observe in other units. Some excavation units are similar in terms of MNE and MNI: Unit C10 has six petrous pyramids with an MNI of four, and Unit A11 has seven with an MNI of three. While these values are comparable to Units A24 and L10, the main trench has significantly more bone than the other areas of the site, leading to the expectation that there would be more petrous pyramids (i.e., skulls), as there is more bone in general. Similarly, one would not expect as many petrous pyramids in Units A24 and L10, as they are removed from the densest area of the bone bed.

Since many bison kill sites have fewer skulls than would be expected (Watts 2008:61-62), the distribution of bison crania at Muhlbach is important for the discussion of secondary butchery locations. Bison crania can serve many purposes; the brain is used during hide processing, and bison skulls can be used for ceremonial purposes. Several other kill sites have bison skulls clusters: Ruby had several bison skulls associated with the ceremonial structure next to the bone bed (Frison 1971); the Vore site had a circle of bison skulls inside the bone bed (Reher and Frison 1980).

An historical example can be seen in the photograph of Chief Poundmaker’s Last Great Corral (Figure 5.7). This photograph, taken near Lloydminster during the late 1800s shows several concentrated rings of bison bone, similar to the distribution of faunal elements seen in the main trench at Muhlbach, and thought to represent where the pound structures originally stood. Numerus bison skull can be seen in the foreground, which are oriented in a variety of directions; many specimens appear to be broken open, either from the bottom, or by punching a hole through the frontal bone. This could be taken as evidence of brain extraction.

If the butchers transported the bison skulls away from the kill site and the primary butchery location, then an abundance of skulls in another location might indicate a secondary butchery area in which these skulls were accumulated for another purpose. The higher than normal skull %MAU for A24 and L10 could indicate secondary butchery locations in which skulls were brought away from the primary butchery location for further processing. This interpretation is difficult to prove conclusively because these units are both on the periphery of the excavation trenches, and could be part of a pattern in the unexcavated areas. Such a finding does point towards a direction for future exploration at the site, to determine if these two areas of the site are secondary butchery locations.

Figure 5.7: Chief Poundmaker's last great corral. Image courtesy of Provincial Archives of Alberta. Note the distribution of bison skulls in the foreground, and the fragmentation of the skulls thought to be associated with brain extraction.

Spatial Analysis of the Main Trench

It is evident from the polygon map of the bone bed (Figure 5.3) and a KDE of all faunal remains (Figure 5.8) that a concentrated arc of bone exists in the main trench, starting in Unit C10 and ending in Unit A14. This arc of densely clustered bone has over 400 fragments per square meter, with a steep drop off in density to 50 fragments per square meter in the space around the arc. Quadrant analysis of the Muhlbach site; demonstrated that by NISP, axial elements dominate across the site, but %MAU proved that appendicular elements are more common. However, the quadrant analysis of the site is coarse, as it is based on a 2 m^2 grid. With the digitized paper plans, it is possible to use analytical tools like KDE to further explore the faunal assemblage in the main trench, and address the formation of this feature.

With the polygon map of the bone bed converted into point data, it was possible to explore the distribution of different elements and their utility using KDE. A total of six different KDE were produced for this analysis: density of all faunal remains (Figure 5.8), axial elements (Figure 5.9), forelimb elements (Figure 5.11), hindlimb elements (Figure 5.10), high food utility elements (Figure 5.12), and zero food utility elements (Figure 5.13). These different surface densities could then be compared visually to discern any spatial patterns and associations. Simply by visually comparing the KDE of different element classes, several correlations can be observed; correlations that can be statistically tested. The density of axial elements (Figure 5.9) most closely aligns with the distribution of all faunal remains, and the arc of bone in the main trench. While intriguing, this trend is not unexpected; axial elements make up 60% of the faunal assemblage by NISP. It would make sense that their distribution would closely match the density of all faunal remains, as they are the dominant category at the site; although the fact that the axial elements follow the densest part of all faunal remains is significant and warrants further exploration.

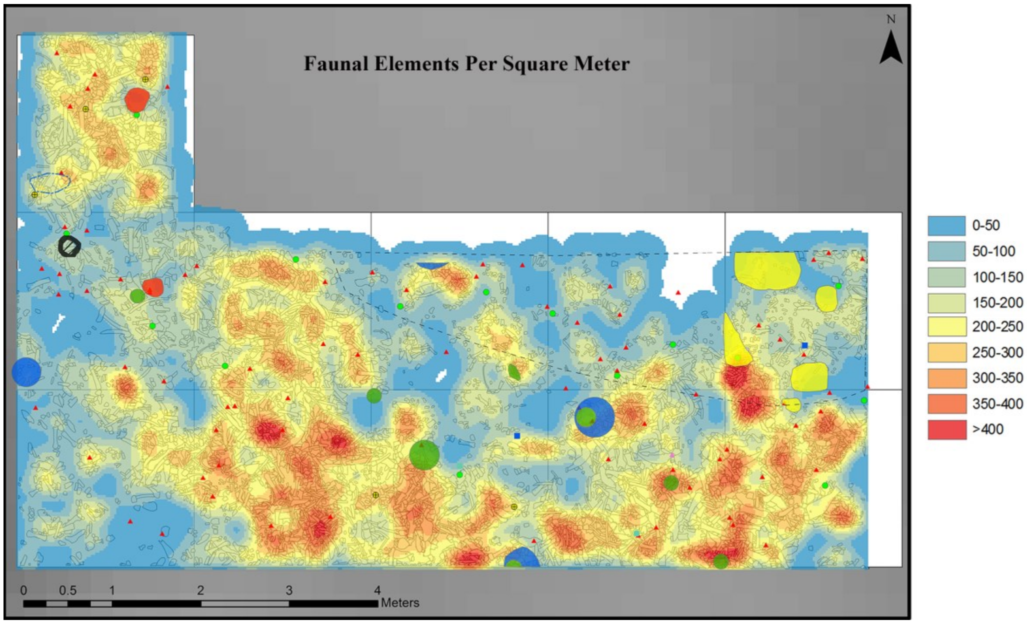

Figure 5.8: KDE of all faunal elements mapped in the main trench.

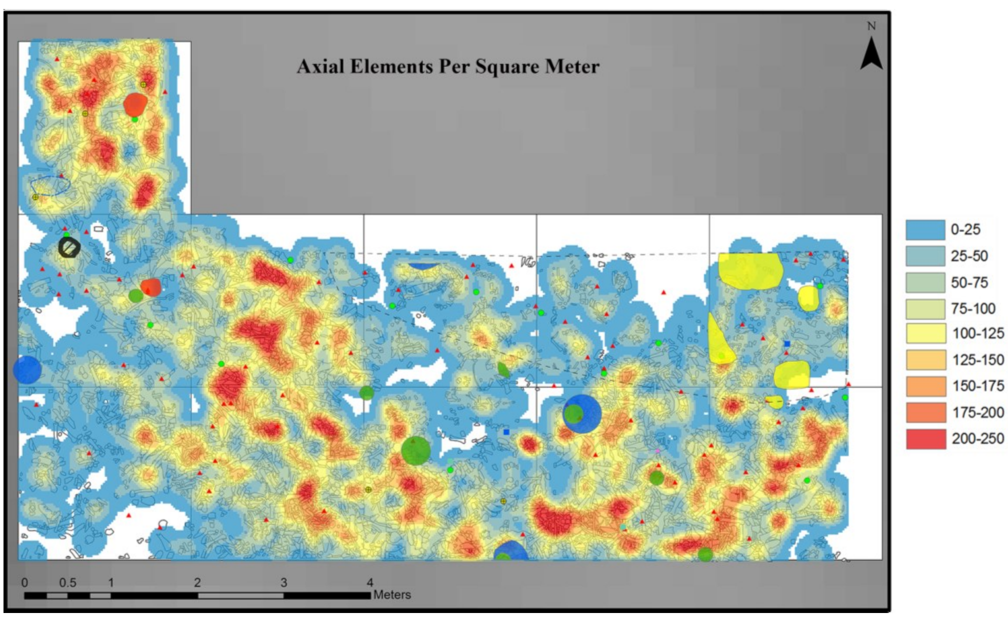

Figure 5.9: KDE of all axial elements per square meter.

The density of the forelimb elements (Figure 5.11) and the hindlimb elements (Figure 5.10) also match the density of all faunal remains, clustering in the arc of bone, but the appendicular elements are more widely dispersed than the axial elements in the units. Overall, the maximum density of appendicular elements (80 fragments/m^2) is lower than axial elements (250 fragments/m^2), but since appendicular elements only are 40% of the whole assemblage by NISP counts, it is logical that the density is lower. The %MAU quadrant analysis demonstrated that appendicular portions are more abundant than axial portions, even though there are significantly more axial elements in terms of NISP.

Another interesting pattern lies in the shape of density hotspots within each KDE. High densities areas of axial elements tend to form linear features following the arc of bone in the main trench. Appendicular elements, on the other hand, tend to be clustered in hot spots rather than forming linear features, particularly in Unit A11 for hindlimbs (Figure 5.10). This distribution suggests that the appendicular elements tend to be clustered into piles, while axial elements are distributed thickly along the arc. The clustering of appendicular elements could be related to how butchery was carried out; portions of limbs could be brought to individuals who were systematically breaking down parts of the carcass. Different limb bone portions would accumulate in the work areas as they were disposed of, similar to the stacking of mandibles at the site from extracting the tongue (Gruhn 1969). The concentration of hindlimb elements in Unit A11 (Figure 5.10) could represent a work area in which femora, tibiae, and tarsals are being disposed of after removing the meat, fat, and marrow. By plotting the density of high and low utility elements, we can further explore this behaviour and see if work areas were present in which butchery units are accumulating.

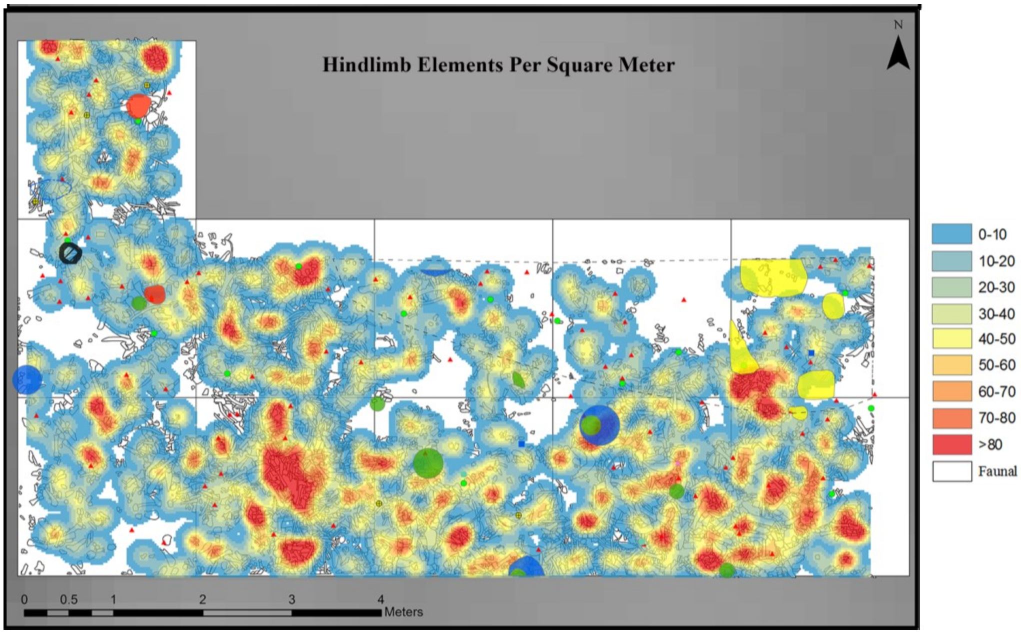

Figure 5.10: KDE of all hindlimb elements per square meter.

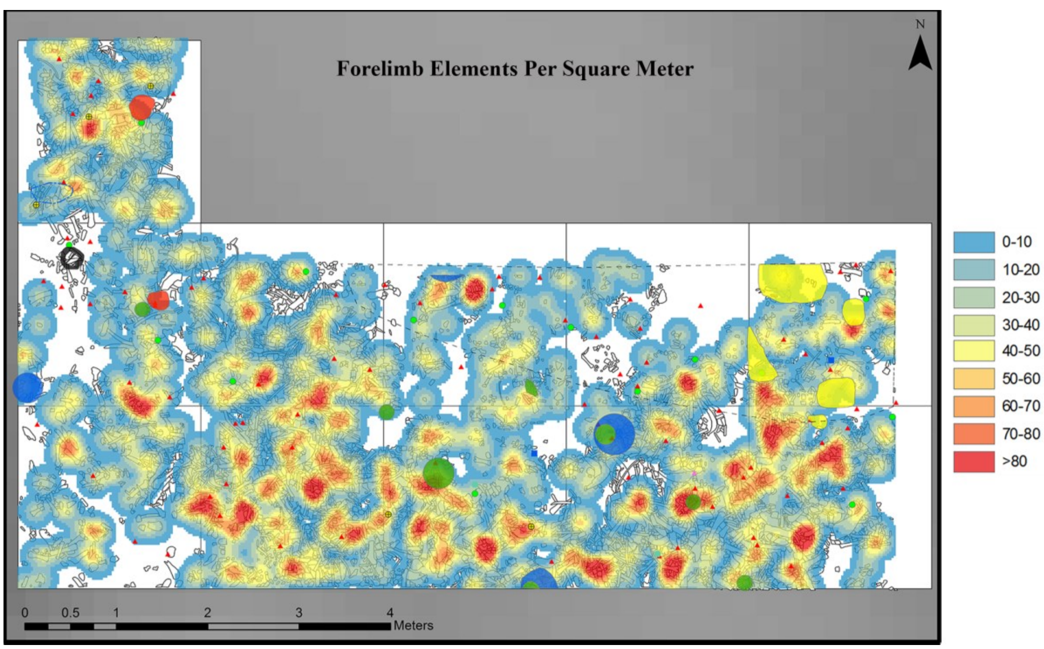

Figure 5.11: KDE of all forelimb elements per square meter.

I selected from the general faunal assemblage the highest utility elements and elements with no food utility, and produced a KDE to determine if there were any density hotspots reflecting food utility. The highest food utility KDE was based on the spatial distributions of ribs, thoracic vertebrae, and lumbar vertebrae, as these three elements have the highest utility value based on Emerson's (1990) evaluation of total products (Figure 5.12). Similarly, I produced a KDE using elements with no food utility: phalanges, carpals, tarsals, and metapodials (Figure 5.13). By comparing these two KDE, it could be possible to isolate concentrations of low utility elements, in which the butchers separated high utility portions from low utility elements, and ultimately carried away these valued segments to a secondary butchery location.

The results of these KDE demonstrate that distribution of high utility elements closely matches the density of axial faunal remains and all faunal remains (Figure 5.12). Since the highest utility elements are all axial elements, this result is expected. On the other hand, the distribution of low utility elements had a different result; these elements are much more widely dispersed across all the units, with no particular pattern. The density of low utility elements does slightly increase with overall density of bone, but not to the same degree that axial elements or the high utility elements did. If low utility elements were separated as a by-product of primary butchery, they should cluster in hot spots where they were left in situ after separation from the high utility portions, nevertheless this clustering is not observed. It appears that low utility elements do not cluster as would be expected from primary butchery, but rather the distribution of all faunal remains seem stem from disposal of high utility elements and axial elements, not low utility by-products.

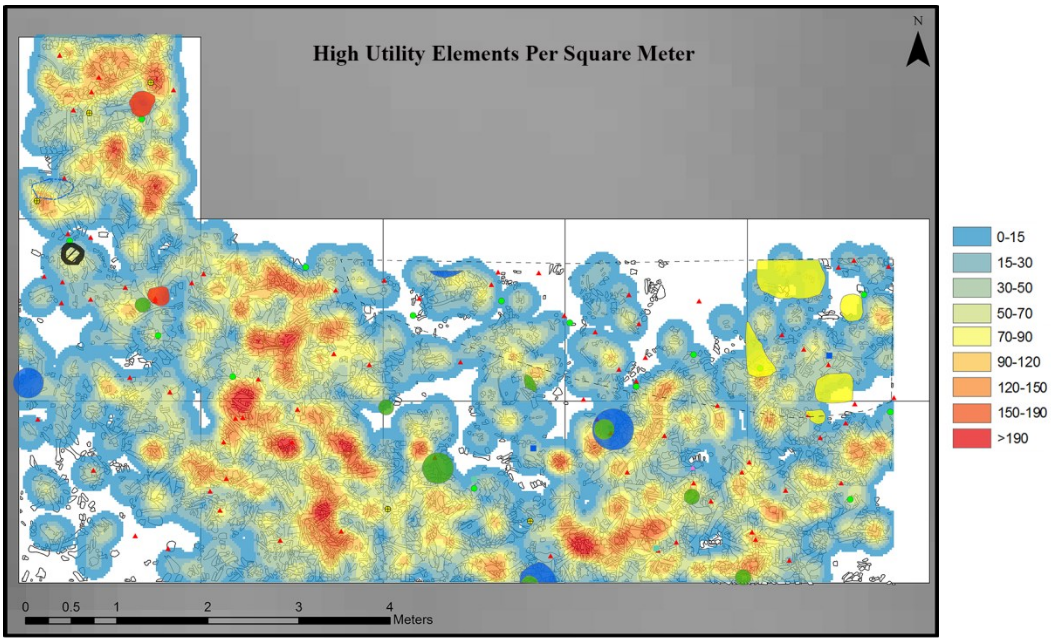

Figure 5.12: KDE of high utility elements per square meter as determined by Emerson (1990).

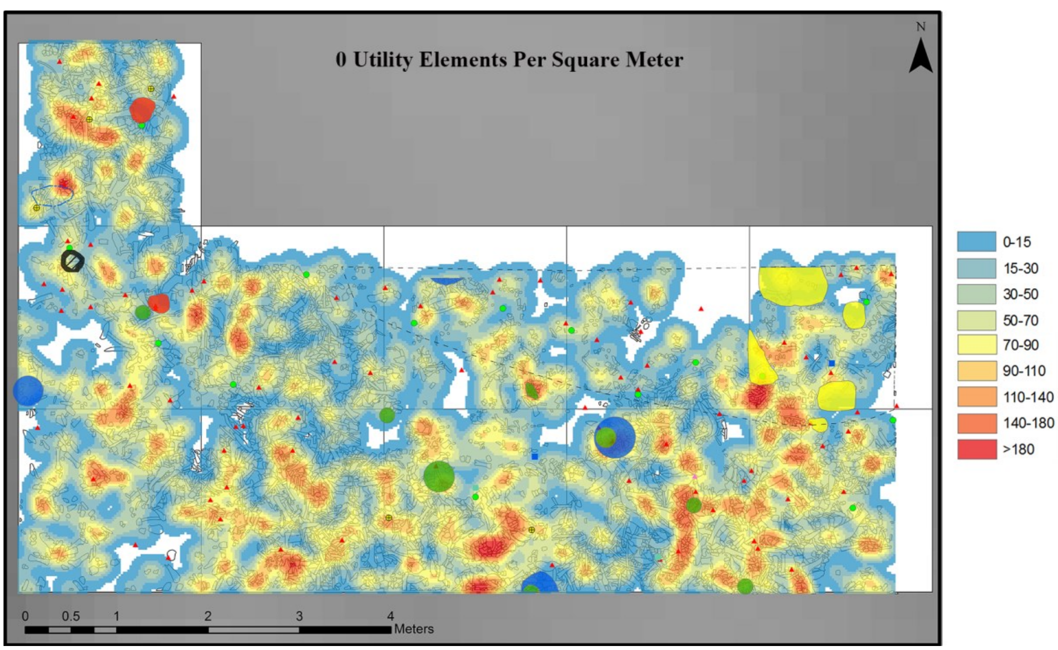

Figure 5.13: KDE of elements with no food utility value per square meter.

In order to test the relationship among the distributions of different faunal elements, the degree of correlation was calculated using Band Collection Statistics to determine the Pearson Correlation Coefficient between each surface density. Band Collection Statistics is a spatial analytical tool in ArcGIS 10.1 that can compare values of the two overlapping raster datasets, and deliver a suite of statistical information regarding the relationship between each dataset. It produces the Pearson Correlation Coefficient, which measures the linear relationship between the two rasters, and presents it as a ratio (r = n) ranging from +1 to -1 (Conolly and Lake 2006:151). It is similar to a linear regression equation signifying the spatial relationship between two variables, in this case the density of different types of faunal bone. A positive correlation, denoted by the r value of +1, indicates a 1:1 relationship, whereas the density of one type of bone increases, so does the density of the second type of bone in equal measure. A negative correlation between two KDE, denoted by an r value of -1, or, indicates that as the density values for one type of bone decreases, the density of the other type is increasing in equal measure. If r is zero, then no correlation between the two variables, and the two datasets are independent of one another. An r-value in between these extremes reflects the strength of the relationship: if r = 0.75 then the two variables have a 4:3 relationship, if r = 0.5 then the two variables have a 2:1 relationship.

The correlation coefficient between each of the six KDE was calculated using Band Collection Statistics, and these results are presented in Table 5.1. While this tool can provide the correlation coefficient for all the layers, it is important to recognize whether the variable is the independent or dependant on the other variable. The independent variable for this analysis is the density of all faunal remains in the main trench; as the density of all faunal remains changes, the density of different elements will change in relation to it, and not the reverse. With this framework in place, it is possible to interpret the degree of correlation between densities.

Table 5.1: Correlation Coefficient (r) for each KDE, with the layers on the left as the independent variable and the layers on the top as the dependant variable.

KDE	all faunal	axial	forelimb	hindlimb	high utility	0 utility	artefacts
all faunal	1.00	0.87	0.72	0.70	0.79	0.77	0.94
axial	0.87	1.00	0.51	0.48	0.92	0.53	0.75
forelimb	0.72	0.51	1.00	0.48	0.45	0.63	0.66
hindlimb	0.70	0.48	0.48	1.00	0.43	0.67	0.64
high utility	0.79	0.92	0.45	0.43	1.00	0.44	0.65
0 utility	0.77	0.53	0.63	0.67	0.44	1.00	0.78
artefacts	0.94	0.75	0.66	0.64	0.65	0.78	1.00

Overall, there is a positive correlation between the density of all the faunal remains and all other variables, meaning that as overall density increases, so does the representation of different elements. Positive correlations are present even among the other variables. In the main trench, there is so much faunal material concentrated in one location that it is not possible to achieve anything but a positive correlation. If this kill was a small single event with limited butchery, there might be a negative correlation between the densities of different elements, but this is not the case. As previously discussed, the Muhlbach site likely had multiple kill events in close succession, and the distribution of faunal remains is far too dense to discern any separation in carcass portions using this method.

Not all the positive correlations are equal, and several relationships have particularly weak positive correlations. The relationship between all faunal remains and axial elements is the strongest (r=0.87), followed by the high utility elements (r=0.77). This result means that the density of all faunal remains can best be explained by the distribution of axial elements. This distribution includes not only the high utility elements, but the low utility axial elements as well, such as the pelvic bones and cervical vertebrae. As the quadrant analysis previous demonstrated, these moderately ranked axial elements have high %MAU values, highlighting their abundance within the assemblage relative to overall representation. With axial elements as the independent variable, the high utility elements have the strongest correlation (r=0.92), but there is a relatively weak positive correlation between the distribution of axial elements and the forelimb (r=0.51) and hindlimb (r=0.48) elements. This result confirms what was visually determined from the KDE; axial elements are more concentrated, while appendicular elements are more dispersed.

Interestingly, forelimbs and hindlimbs also share a weak positive correlation (r=0.48). While appendicular elements are not particularly correlated with axial elements, the appendicular elements do not have a strong correlation with each other either, suggesting a degree of separation between forelimb and hindlimb elements. High utility elements have a weak positive correlation with zero utility elements (r=0.44), forelimbs (r=0.45), and hindlimbs (r=0.43). These relationships are weakly positively correlated in a highly concentrated area of the bone bed, suggesting that high utility elements are distributed independently of limb bones.

The correlation coefficient only provides the strength of a positive or negative correlation, but the coefficient of determination (r^2) can provide a better understanding of the predictive power of the independent variable by the dependent variable (Connolly and Lake 2006:154). For example, the correlation coefficient (Table 5.1) and coefficient of determination (Table 5.2) was calculated for the density of all faunal remains and all artefacts in the main trench. The correlation coefficient, r, for all faunal remains and artefacts is 0.94. This is a strong positive correlation: as the density of faunal remains increases, so does the number of artefacts, almost in equal proportions. This observation also confirms the pattern that was visually determined across the site. The coefficient of determination, r^2, for this relationship is 0.97, an extremely strong result. The coefficient of determination, r^2, can be represented as a predictive percentage (Connolly and Lake 2006:151); in other words, 97% of the artefact density can be explained by increases in faunal density. The coefficient of determination can move the spatial analysis past a simple positive or negative correlation, and determine what variables are affecting the density of faunal remains at the site. By comparing the KDE for different elements and portions and the correlations among the spatial distributions, it should be possible to determine what faunal remains contribute to the arc of bone in the main trench, and perhaps why it formed.

As the independent variable, the density of all faunal remains is best explained by the density of axial elements; 93% of the overall faunal density can be explained by the distribution of axial remains. It is a better predictor than high utility elements (r^2=0.89), since the arc of bone contains more than just high utility axial elements; cervical vertebrae and pelvic fragments are extremely common in this area as well. The densities of appendicular elements are poor predictors for the distribution of axial elements (r^2=0.72 and r^2=0.70). Forelimbs and hindlimbs are poor predictors for one another (r^2=0.69), but have a relatively good association with the zero utility elements (r^2=0.8 and r^2=0.82). This result suggests that where there are phalanges, carpals, tarsals, and metapodials, you are likely going to find some upper limb portions. The likelihood of finding both fore and hindlimb elements together is lower.

Table 5.2: Coefficient of Determination (r^2) for each KDE.

KDE	all faunal	axial	forelimb	hindlimb	high utility	0 utility	artefacts
all faunal	1.00	0.93	0.85	0.83	0.89	0.88	0.97
axial	0.93	1.00	0.72	0.70	0.96	0.73	0.86
forelimb	0.85	0.72	1.00	0.69	0.67	0.80	0.81
hindlimb	0.83	0.70	0.69	1.00	0.66	0.82	0.80
high utility	0.89	0.96	0.67	0.66	1.00	0.66	0.81
0 utility	0.88	0.73	0.80	0.82	0.66	1.00	0.88
artefacts	0.97	0.86	0.81	0.80	0.81	0.88	1.00

Therefore, what do these relationships suggest about human behaviour and activity at the Muhlbach site? Overall, the density of faunal remains is dictated by axial elements, particularly high utility elements, but other axial elements are significant as well. Limb bones are more dispersed, but still cluster in the high-density arc through the site. Applications of utility indices to the general assemblage indicate that the people living at the site were removing bone with the best selections of meat and fat for further processing at a secondary location (See Chapter 4). While the axial elements dictate the overall density pattern, there has been a hollowing out of the faunal assemblage in terms of food utility. There should be considerably more axial elements represented in terms of %MAU, but the majority of them have been removed. Returning to the axial %MAU per unit (Figure 5.6) and the units through which the dense arc of bone pass through (C10, B11, A11, A12, A13, A14), the axial components of these units are primarily mandibles, cervical vertebrae, and pelvic fragments, which are low to moderate utility elements. The mandibles are a special case, as this element is associated with the tongue, a highly valued food item, but once the tongue has been removed, the element has little inherent food value.

It appears that the arc of bone is largely composed of the axial elements left behind after processing, piled up in a heap at the edge of the pound after initial processing. The appendicular elements are also concentrated in this arc, but are more dispersed than their counterparts. This distribution could be related to secondary butchery activity, like marrow extraction; there is evidence that after the primary butchery was completed, the bone bed was reworked to exploit marrow, a behaviour which could cause the appendicular elements to become more dispersed from the arc of bone. However, the butchers did not exploit bone marrow heavily at the site, as many elements with moderate bone marrow utility, like the metapodials, were left whole rather than cracked open. If the distribution of bone was heavily influenced by bone marrow extraction during secondary butchery activities, there should be more intense exploitation of the resource. Instead, there is a gourmet utility strategy employed at the site, in which most of the long bone cracking at the Muhlbach site occurred during the initial dismemberment of the bison carcass (Watts 2008), rather than moderate utility ancillary targets. The marrow extractions at Muhlbach likely occurred alongside the processing of the axial portions of the carcass, while the arc of bone formed.

Analysis and Implications of Kill Mechanics

The bone beds from large bison kill events are highly visible in the archaeological record, but there are other activities that occur around a kill. For example, ceremonies and ritual were an important component for the success of communal bison hunting (Brink 2008; Verbicky-Todd 1984), and these ceremonies often required specific structures and features. At the Ruby site, Frison (1971) identified an elliptical timber post structure next to the bone bed that he interpreted as a ceremonial structure in association with the kill. In addition, understanding how a kill was oriented can indicate the location of the processing camp. The Muddy Creek site in Wyoming had a large pound structure with a large tipi ring site adjacent to it (Reher 1987). Knowing how a pound and the drive lanes were oriented would also indicate where these structures and work areas would likely not be, and direct future testing and exploration of a site. In addition, features associated with the drive, such as the cairns used to control the bison, could also be better located during a site survey. Some sites have preserved drive lanes showing the approach to a kill site, but many sites do not.

Byerly *et al.* (2005) provided a useful framework for determining how other kill sites in the archaeological record functioned by exploiting several shared ecological and topographical characteristics of jump sites that allowed aboriginal hunters to manipulate herds of bison into the traps (Barsh and Marlor 2003; Brink 2008; Byerly *et al.* 2005; Frison 1978). Based on these historical and archaeological sources, Byerly *et al.* (2005:599) defined six functional characteristics of bison jumps that could be explored in a GIS format: proximity to large grazing areas and permanent water source; a long, flat, and relatively direct path from the gathering basin to the jump; a large enough herd to remain cohesive while moving (also see Frison 1978); a cliff edge that is obscured until the final meters; prevailing winds which are upwind of the bison jump and drive lanes, and a cliff steep enough to kill the bison. Many of these characteristics are specific for bison jumps, but aspects of Byerly *et al.* (2005) analysis can be applied to other communal bison kill sites on the Plains.

This type of analysis for communal bison kill sites is relatively new, as most discussions regarding drive lanes and approaches to kill sites are focused on finding cairns or “Dead Men.” These cairns permanently marked the locations of the drive lanes, so that groups could return after years away from the site and know how to set up the “Dead Men” (Brink 2008:99). The “Dead Men” were branches and sticks supported by rock cairns with cloth and hide tied to them (Verbicky-Todd 1984). The objective was not to create an actual physical barrier, but rather to give the illusion of one; Brink (2008:100) suggested that a bison herd moving through the lane way would develop a sort of tunnel vision, as the series of “Dead Men” blurred together, they would appear as a barrier to the animals. This illusion would direct the movement of the bison without having to expend energy to build a physical barrier. Another common characteristic in the drive lanes is to incorporate a turn just before the end, which will further disguise the trap (Verbicky-Todd 1984), but there are many examples without this feature. This analysis is based on the assumption that the hunters planning the kill would select the easiest, simplest, and most direct path to approach the kill, in order to reduce the number of complicating variables that could allow the animals to escape the trap.

Sample and Methods

Byerly *et al.* (2005) used two main methods to determine possible drive lanes, Least Cost Path and Viewshed Analysis. Several parameters are needed to calculate these two spatial analyses. Least Cost Path analysis requires at least two points of vector data to provide some frame of reference to evaluate the cost of traveling across a landscape. Viewshed analysis uses either a single point or a multitude of points to provide spatial reference for the analysis. The second form of data used in these analyses is raster data, the continuous spread of data over a spatially referenced region. For this analysis, a Digital Elevation Model (DEM) is needed to provide data on changes in elevation. The precision of a DEM is extremely important for many analyses, as the individual cell values of the DEM raster are determined from an average of all the elevations within the area of the cell. This aspect means that smaller the cell size, the more accurate the elevation data. Most DEM are widely available to the public through various government portals and agencies, with cell sizes range from 20 to 90 m. It is possible to develop DEMs with a cell size of 0.5 m with the application of LiDAR imaging, but the amount of data involved at larger scales can impede the analysis. While smaller cell sizes and more accurate data are more desirable, it takes considerably more computing power and time to run these types of analyses effectively.

The DEM used in this analysis was obtained from the Canadian Digital Elevation Data Series available on Geobase.ca, and is composed of several 1:50 000 DEM map sheets linked together to provide a continuous representation of the elevations around the site locale. The final DEM had a cell size of 20 m, meaning that the DEM will smooth over any sharp changes in elevation within that 20 by 20 m square. This process will flatten subtle changes to topography, like in a sand dune environment. While a cell size of 20 m is accurate enough for most analyses, this level of precision is unable to recognize small elevation changes in a sand dune environment. Additional, sand dune activation and stabilization can change the topography surrounding of a site (Wolfe *et al.* 2007), making modern elevation data inapplicable. This situation is evident at the Fincastle site, which was uncovered inside a 2 m high parabolic sand dune, an unrelated feature to the occupation, as it formed afterwards (Bubel 2014). These issues raise some serious concerns that need to be addressed prior to any analysis of the Muhlbach site.

We can mitigate some of these issues with an intimate knowledge of the local topography and environment around Muhlbach. The site is located within large eolian sand dune deposits (Figure 5.17). Topographic features like these would have significant impact on Least Cost Path and Viewshed analyses. However, the landscape and sand dunes at Muhlbach have relatively low relief, so low that it is almost imperceptible in the site photographs (Figures 5.15 and 5.16). This observation is supported by the 0.5 contour topographic map of the site from Gruhn (1969:131, Figure 3.3).

Figure 5.14: Muhlbach Site Locale. View SW. Site is to the left of the barn.

Figure 5.15: Main Excavation Area. View west.

This low relief means that even though undulating sand dunes surrounded Muhlbach, these changes in elevation and slope are so small that they likely would not have any effect on Least Cost Path analyses. The accuracy of a Viewshed analysis, on the other hand, is dependent on the precision of the elevation data, as subtle changes in elevation and perspective can reveal or obscure a location for the observer. These subtleties are important for disguising the trap from approaching bison, and the 20 m DEM would not reliably detect the intervisibility of locations on the landscape. To circumvent this issue, the 0.5 m contour map created by Gruhn (1969) using a Cowley Automatic Level was extrapolated using the Kriging function in ArcGIS 10.1 and converted in a 0.5 m DEM of the local topography. Using this more precise DEM, Viewshed analyses could now be run with more confidence over the 20m DEM previously available.

Now armed with a reliable DEM, the Least Cost Path and Viewshed analyses could be computed. Least Cost Path is based on the principle of energy friction, the cost inflicted on an individual crossing a landscape; as the analysis runs, each raster cell is evaluated for the incremental friction in relation to its neighboring cells, a procedure which requires the development of a cost surface raster. This is typically created using the degrees of slope calculated from the DEM (Byerly *et al.* 2005), but other parameters can be added to give more complexity to the analysis. Using a slope cost surface in Least Cost Path analysis will produce a path that will follow the lowest possible change in slope, meaning that the analysis will select cell values in which the slope's grade is closest to zero.

To refine the cost surface, any areas that are covered by modern bodies of water were removed, as all extant water bodies in DEM are rendered as flat surfaces at the elevation of the water level. This procedure creates an area of low slope that would be interpreted as low travel friction and a viable travel corridor. Driving bison into a kill site is difficult in the best circumstances; trying to drive the animals through any significant body of water would only further complicate the affair, unless the goal was to mire the animals in the mud. To account for this aspect, existing water bodies were removed from the cost surface, in order to force the Least Cost Path analysis to navigate around the small bodies of water near the site.

The last parameter to be determined was the size of the catchment basin for the kill, and the length of the drive lanes. The drive lanes at Head-Smashed-In, demarcated by the stone cairns above the site, are thought to stretch as far back as 16 km; historical references to the length of drive lanes from pounds range from two to four miles (3.21-6.43 km) (Brink 2008; Verbicky-Todd 1984). I used a radius of 3.75 km from the Muhlbach site for this analysis, with eight starting locations along the cardinal directions from the site. While the drive lanes at Muhlbach could have been longer, the last few kilometers of the drive are the most important.

From these eight starting points, Least Cost Paths were calculated to the Muhlbach site using the cost surface produced by changes in slope. There are several possible outcomes from this analysis. A meaningful result from Least Cost Path would be demonstrated by a convergence in paths, in which a convergence would indicate that a low travel friction corridor existed near the site, through which movement would be more efficient than by traveling straight between points. Alternatively, the paths might not converge, but rather travel straight between the starting points and the site. This result could indicate that the underlying DEM is not refined enough to accurately detect the pathway, and that a higher resolution elevation model is needed. Alternatively, it might be possible that the site did not result from a bison drive, but rather from other means of trapping and killing animals, possibly by ambush when they came to drink water (Bubel 2014:31). In this scenario, the status as a bison pound would need to be revaluated.

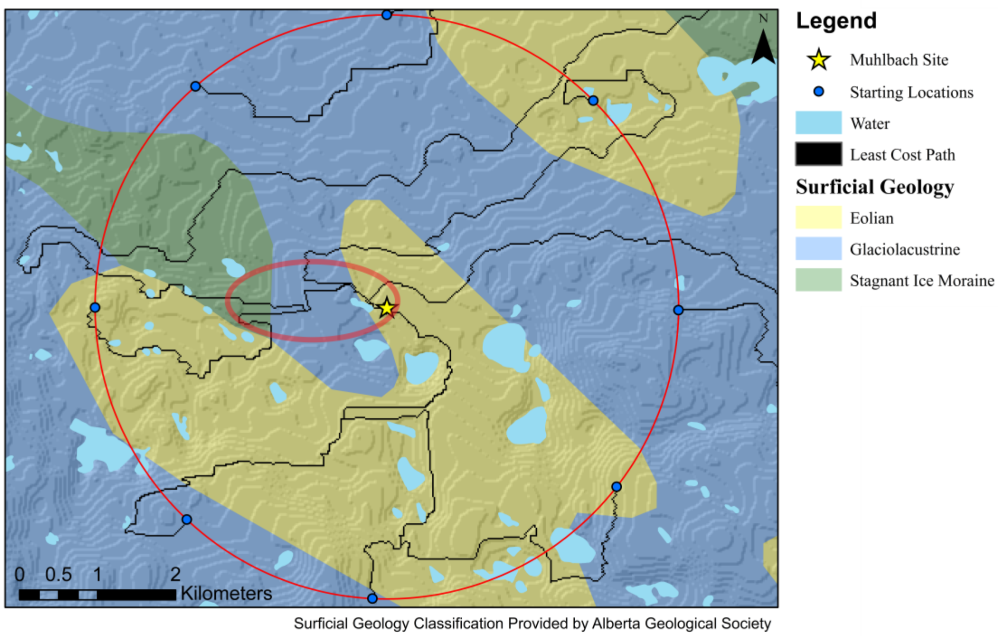

Figure 5.16: Least Cost Path Analysis from eight starting locations towards the centre of the bone bed. Small red oval indicates area of convergence for analysis and likely catchment basin and drive area.

The results from the Least Cost Path analysis are presented in Figure 5.17. When the analysis was run between the eight starting locations and the site, a series of convergences were produced within a two kilometers area west of the site. The low change in slope for this area is significant enough to alter the path from five of the eight starting locations. In terms of cost friction determined by slope, this result suggests that a natural funnel existed on the landscape that could be used to funnel the animals towards the site. This observation fulfills one of Byerly *et al.* (2005:599) conditions: a long flat and relatively direct path connecting the gathering area and the trap. Furthermore, the convergence of paths falls within a two-kilometer area of the site, similar to historical descriptions of pound drive lanes detailed by Verbicky-Todd (1984). These historic pounds typically had a circular corral structure with long divergent wings running out from the entrance (Verbicky-Todd 1984). The remain three of eight starting locations also converged to the south of the site, but this route seemed improbable as it involved navigating around water bodies and driving the animals through the undulating sand dune terrain. These results seem to indicate a possible western orientation of the trap, but we need to consider other factors to affirm this hypothesis.

An important variable for a successful drive is the gathering basin. This area needs to attract game animals through superior forage productivity and sources of permanent drinking water; this characteristic will allow the hunters to gather a large enough herd to maintain cohesion while driving the animals (Byerly *et al.* 2005:599). Two indications of forage productivity are soil type and surficial geology. Soil type is normally determined by annual precipitation, the parent material of the sediment, and the ecological community established on the soil (Soil Classification Working Group 1998). Since the area of interest around the site is relatively small, annual precipitation will affect all the soils the same and not be an influencing factor on overall forage productivity. Certainly, without a significant change in climate there is no reason to suspect that modern soils around the site would have changed much from their ancient counterparts.

The Muhlbach site is located in a Chernozemic soil zone, typically formed under a stable prairie ecosystem that has been established for a considerable amount of time (see Figure 3.1 in Chapter 3 for classification of soils around Muhlbach). This feature is unusual, as most sand dune areas are classified as regolithic soils, as the eolian sand deposits have not stabilized long enough to allow a thick organic soil horizon to form. The sand dunes around Muhlbach have been stable long enough to allow the formation of a thick Ah horizon and a chernozemic soil. Also nearby Muhlbach are some Luvisolic soil zones that form under a deciduous forest environment, and the large swaths of Solonetzic soils east of the site. Solonetzic soils typically form when the parent materials are high in sodium, causing the soil to become dry, hard, and difficult for roots to penetrate (Soil Classification Working Group 1998:11). These two soil types would have significantly lower forage production than the Chernozemic soil in the proposed gathering basin, meaning that there would be sufficient forage to attract bison to the Muhlbach site locale as opposed to the surrounding landscape.

On a finer scale, the surficial geology and topography will also affect the amount of available forage in a gathering basin. The site lies in a deposit of coarse sand, but the proposed gathering basin has a base of lacustrine sediments. These lacustrine sediments would provide superior forage quantity as compared to the eolian sand deposits around the site (Figure 3.2), as the finer sediments in the lacustrine deposits would be able to retain moisture for longer than the coarse eolian sand deposits, leading to an increased forage production.

The shape of the eolian deposits also appears to factor into the kill mechanics of the Muhlbach site, as it is situated on the northern lobe of this surficial deposit, on the western edge of the entire deposit (Figure 3.1). Areas with sand dunes were often utilized for pounds, taking advantage of the natural hollows and dells with structures augmenting the existing topography to trap the animals inside the pound (Verbicky-Todd 1984). Trying to drive the bison through a sand dune environment would be more difficult, since changes in topography and slope would work against the hunters rather than with them; the cost friction for travel would be significantly higher than the surrounding landscape. The fact that the Muhlbach site is right on the edge of the eolian deposits suggest that the animals were driven into it from the west, where the terrain is flatter and more regular, rather than from inside the dune complex. The hunters could take advantage of the natural declivities on the edge of the sand dune complex, without driving animals against the rolling topography of the sand dunes

Another important aspect for a bison drive is the visibility of the trap upon approach. Verbicky-Todd (1984) highlighted the importance of hiding a pound from view, and preventing the bison from seeing the trap until it is too late; Brink (2008:144) noted that at Head-Smashed-In, the cliff was obscured from view upon approach, giving the impression that the distant prairie on the horizon merged with the land at the edge of the cliff. To demonstrate this facet of Bonfire Shelter, Byerly *et al.* (2005) used Viewshed analysis to determine the visibility of the trap along the approach. This analysis evaluates the visibility of individual raster cells from a single point or series of points on the landscape, and can be useful for understanding the view from particular positions on the landscape without physically visiting the site, and any impediments like vegetation or modern structures.

Viewshed analysis uses several different variables to determine visibility of cells from a location, but the most important for this analysis is the offset of the observer, which represents the observer's height above the ground surface. To simulate the estimated eye level of *Bison antiquus*, Byerly *et al.* (2005:601) applied an offset of 1.7 m in their analysis. This study needs the offset of modern bison, which range in height between 1.52 and 1.86 at the shoulder (Meagher 1986), but the actual eye level is probably closer to one meter. For this analysis, an offset of 1 m was applied to all observer points to simulate the terrain visible for an approaching bison. It is important to note that bison have poor sight, and rely more heavily on their sense of smell to detect threats (Brink 2008). Therefore, even if the analysis demonstrates visibility for a location, it does not mean the bison would be able to see it. Viewshed analysis will produce all the cells that are visible at any distance, even if it would be physically impossible to see that far. It is possible to account for maximum distance when completing the analysis, but it is difficult to determine what the maximum visibility for a bison would be. At the least, the maximum visibility for bison would be lower than that of a human (roughly 5 km); so any cells that are visible from a human observer at 1m height could be visible for the bison.

Using the 0.5 m DEM produced from Gruhn's (1969) contour map, a series of Viewshed analyses were conducted at points along the projected path of approach to the site (Figure 5.18). The Viewshed analysis produces a binary raster displaying cells separated into visible and not visible, based on a 1 m offset from the observer's elevation. Four observer locations were selected along this path, at approximately 10 m, 30 m, 60 m, and 100 m from the estimated edge of the bone bed. Interestingly, as the observer moves along the path, the landform on which the bone bed rests on never becomes visible. Even at 10 m from the kill site, the site is not visible from the path (Figure 5.18). Due to a slight rise in elevation in the last few meters, the observers are effectively blocked from seeing the trap until they are almost on top of it.

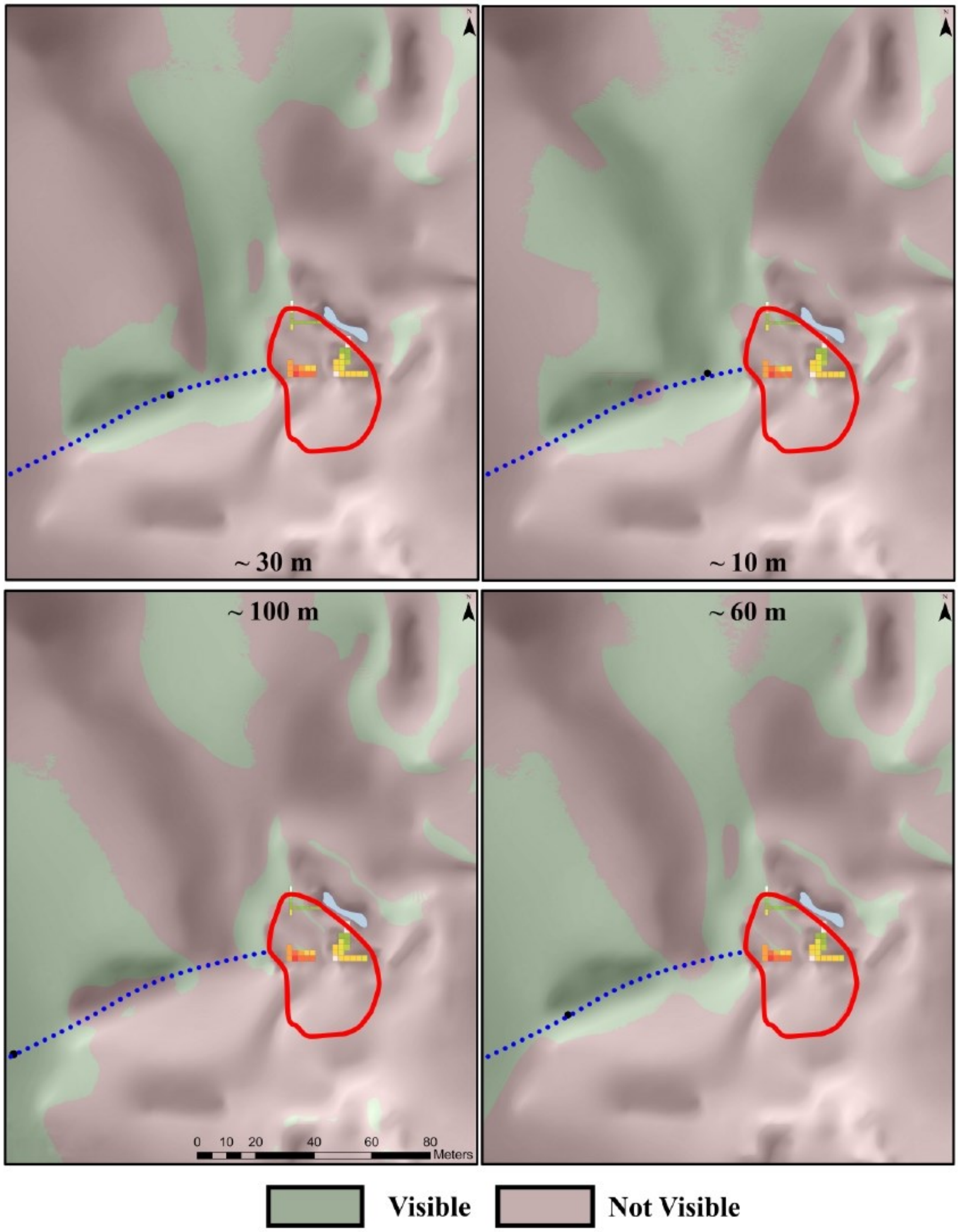

Figure 5.17: Viewshed analysis along projected path at ~100 m, 60 m, 30 m, and 10 m from the extent of the bone bed.

This rise in elevation is also important for trapping the animals in the pound, as pounds required a precipice to prevent the bison from jumping back out through the entrance (Verbicky-Todd 1984:37); alternatively, pits could be dug to ensure that the animals could not jump over the fences once they entered the pound. The kill at Muhlbach occurred in a natural wetland declivity between sand dunes. It is possible that the gentle rise in elevation along this proposed approach could have been altered and deepened on the inside to facilitate trapping the animals in the pound; though detecting evidence of such alteration would be difficult without extensive excavations.

In conclusion, all of the aforementioned variables support a western orientation for the pound structure at Muhlbach. Therefore, any associated secondary processing area and camp should be located somewhere behind the site to the east and south. Other contemporary bison kill sites have associated processing camps within a few hundred meters: the kill and camp at the Fitzgerald site are separated by approximately 50 m (Hjermstad 1996), the Richard's Village and Kill site in Manitoba are separated by 400 m (Hlady 1967). Additionally, portions of the bone bed at Muhlbach were burned; a practiced thought to be associated with cleaning up a kill site and removing the smell of rotting bison carcasses (Brink 2008:166). If the smell from the kill site was bad enough to warrant action, then the camp should be close and downwind of the kill site. Prevailing winds for this area of Alberta fluctuate throughout the year, but generally come from the west and south during the summer (Agriculture, Food, and Rural Development 2003). While not conclusive, this information can direct future research and excavations at the site.

Summary

The comparison of faunal remains from different areas of the Muhlbach site demonstrates that significant primary butchery activities occurred at the site, with the transportation of high ranked elements from the site, and some evidence of secondary butchery locales on the peripheries of the excavation. Least Cost Path and Viewshed analysis demonstrate that the gathering basin for the kill was likely west of the site, and that the animals were driven along a travel corridor into the pound. Further work at the site can explore the relationships between the kill site and any associated processing camp, which should be located towards the east and south of the bone bed.

Chapter 6 – New Analysis and Interpretations of the Stelzer Site

Neuman (1975) defined the Sonota Complex based on his work at the Stelzer site and the nearby associated burial mounds, bringing to light significant patterns occurring within the Besant Phase in the Middle Missouri region. What Sonota signified as an archaeological culture, and how it related to other phases continued as a topic of fascination and curiosity for many northern Plains researchers (see Clark 1984; Peck 2011; Reeves 1983; Syms 1977; Vickers 1994), but much was still unknown. Neuman (1975) had successfully illustrated the material culture from the key sites, but there were still many unanswered questions about the occupation at sites like Stelzer. In the half century since the Smithsonian excavations, large surface collections have been amassed from the Stelzer site, providing an untapped dataset for additional analysis. Likewise, advances in radiocarbon dating allow us to produce large populations of dates from Stelzer to further refine its place in the precontact chronology. Developments in spatial analytical methods and technology also allow the occupation at Stelzer to be illustrated and explored in a manner that was not possible during the late 1960s. In this chapter, I will revisit Neuman's (1975) work at the Stelzer site using a combination of original field notes, maps, and photographs, as well as incorporating previously unpublished data from surface collections, to detail the nature of the Stelzer occupation. The results of this review and analysis will provide a foundation that will be used to explore the framework of Sonota and how it relates to Muhlbach.

Stelzer Site Locale and Environment

The Stelzer site (39DW242) is located in Dewey County, south of Mobridge, South Dakota, on the west bank of the Missouri River. The site was first discovered by William T. Stelzer, who was serving in Robert Neuman's field crew as they surveyed the Missouri River basin in 1962. Neuman was leading an archaeological expedition as part of the Smithsonian River Basin Survey, a large scale survey along the length of the Missouri, undertaken to document archaeological sites that would be impacted by rising water from an impending dam construction.

Currently, the site is situated on the banks of the Oahe Reservoir that would have formed the upper terrace of the Missouri River valley (Figure 6.1). The area directly surrounding the site is relatively flat, sloping slowly up towards the southwest. The landscape directly west is rugged and steeply eroded from intermittent streams. It is bordered on the north and west edge by a large gully, and on the east by the Missouri River bank. Within the Missouri River lies a series of large islands that were heavily timbered prior to the building of the dam; these islands likely would have been a draw to the region, as they could provide a ready source of wood in an otherwise treeless environment.

The Stelzer site locality is ringed with contemporary burial mound complexes; these include five unexcavated burial mounds directly southwest of the site, the Grover Hand Mound site which lies across a ravine directly north of the Stelzer site, the Arpan Mound site located 0.69 km to the south along the edge of the terrace, and the Swift Bird Mound site which is a distance of 1.5 km upstream from Stelzer. There is another mound cluster, Aycock (39DW255), that was also excavated by Oscar Mallory during this period, but little material was recovered and they were not investigated further.

Once it had been confirmed that the material culture at Stelzer was connected to the surrounding burial mounds, Neuman (1975:3) began work on Excavation Units 1 and 2 near the close of the 1962 field season (Figure 6.3), placing the first excavation trenches at the terrace edge and extending them back into the landform. During the 1963 field season, Oscar L. Mallory joined Neuman in the region to test sites farther downstream of Stelzer. While testing at what Mallory thought was 39DW231, they discovered that it was a continuation of the Stelzer site. These Excavation Units 1, 2, and 3 were labelled as Area 2 in order to integrate this area of the site with Neuman's previous excavations. Mallory returned alone in 1964 to finish Neuman's work in Area 1, completing Excavation Unit 1 and 3; unfortunately by this time, Excavation Unit 2 in Area 1 had been eroded away by the rising river. The final phase of excavations at the site took place in June of 1965, when Neuman returned to test seven surface depressions around Area 1.

The site was excavated in a five foot grid oriented on a north-south axis. The units were shoveled in 15.2 cm levels (0.5 ft) until cultural material was exposed, and then the remainder was dug by hand. The occupation layer ranged between 0.15 to 0.49 m beneath the surface, and was approximately 9 cm thick (Neuman 1975:6). There are five separate stratigraphic layers noted at the site, with colours ranging from light to dark grey, but all of the soil textures were described as clayey and gumbo-like (Figure 6.2). Mallory concluded that the heavy clay sediment is likely due to the Pierre Shale bedrock that lies directly beneath the occupation layer.

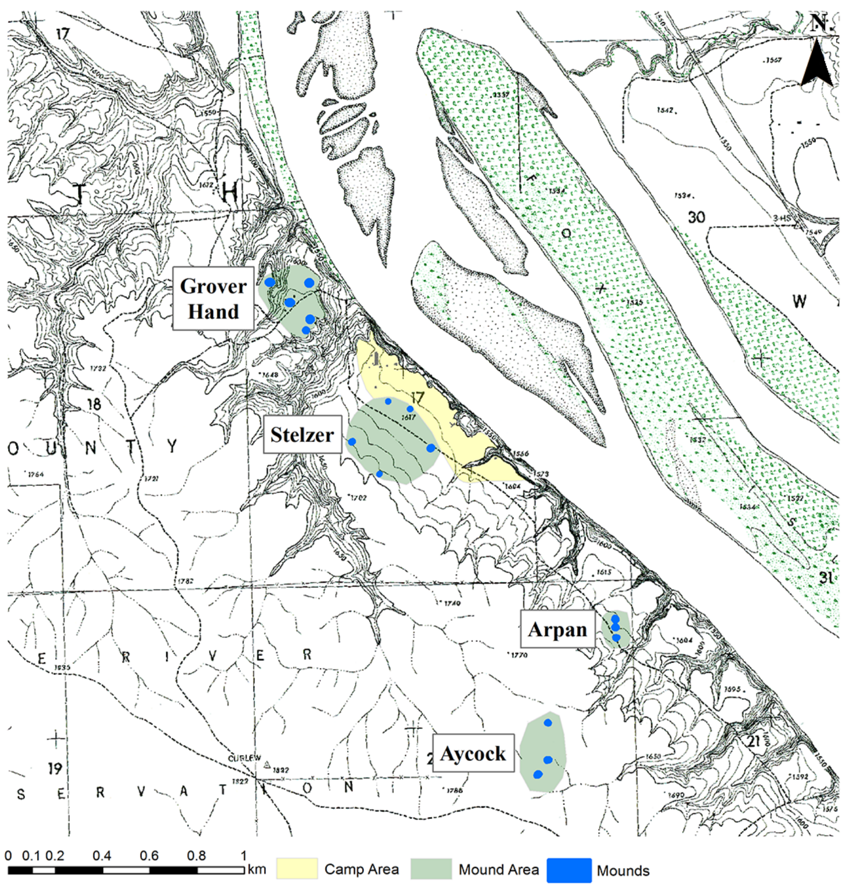

Figure 6.1: Stelzer landscape and the surrounding burial mound complexes, Grover Hand, Arpan, and Aycock. Base map provided by the South Dakota State Historical Society.

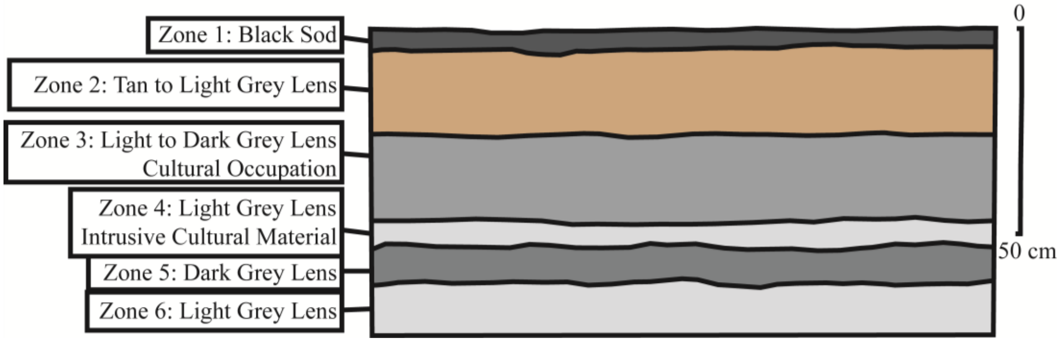

Figure 6.2: Schematic profile adapted from Neuman (1975:5).

An excavation plan map of the Stelzer site was recreated based on the original field notes provided by the South Dakota State Historical Society, and the original site maps on record with the National Anthropological Archives at the Smithsonian Institution. This material was used to create a diagram of the 1962-1965 excavation units and the associated mound sites, a plan which was then laid over a 1947 topographic map of the area provided by the Archaeological Research Centre of the South Dakota State Historical Society. Neuman and Mallory had mapped the location of the trenches and the mounds relative to a site datum, but unfortunately the erosional effects from the reservoir have washed away most of the site and the original datum is lost, making it difficult to accurately situate the site. The excavation areas were positioned using the original form of the landform, the known position of the terrace edge in the 1960s, and the excavation trench's position. This "eyeball" approach is not ideal, but is the best of a poor situation; there is no way to accurately reconstruct the 1960s excavations with the current damage to the site. The position of the trenches and mounds are internally accurate as these are based on original site maps measured using a theodolite; it is only the position of the site relative to the terrace edge that remains unknown.

Based on this site reconstruction, a total of 1 135.5 m^2 was excavated over a four year period. Neuman estimated that the site extended 0.85 km along the valley edge. The distance from the valley wall was never fully determined; archaeological material was recovered in tests 137 m from the edge, and Newman (1975:3) placed the farthest burial mound 500 m from the edge. Considering the estimates provided by Neuman and the position of the terrace edge based on a

1947 topographic map, I propose that the camp covered over 120 000 m^2 (Figure 6.3), and the mound area of the site encompassed just over 100 000 m^2, meaning that Neuman and Mallory sampled only 0.5% of the 220 000 m^2 site.

The proximity to the reservoir led to considerable impacts from flooding and erosion to the site. Satellite imagery from 1997 demonstrates the extent of inundation and erosion from flood damage (Figure 6.5), and these erosional effects were apparent during the initial excavation of the site (Figure 6.4). Neuman placed his trenches at the edge of the valley wall, but this would not have been the original edge of the landform. Aerial photographs from 1938 and the 1947 topographic map indicate that the terrace edge would have been farther east than when Neuman and Mallory conducted their excavations.

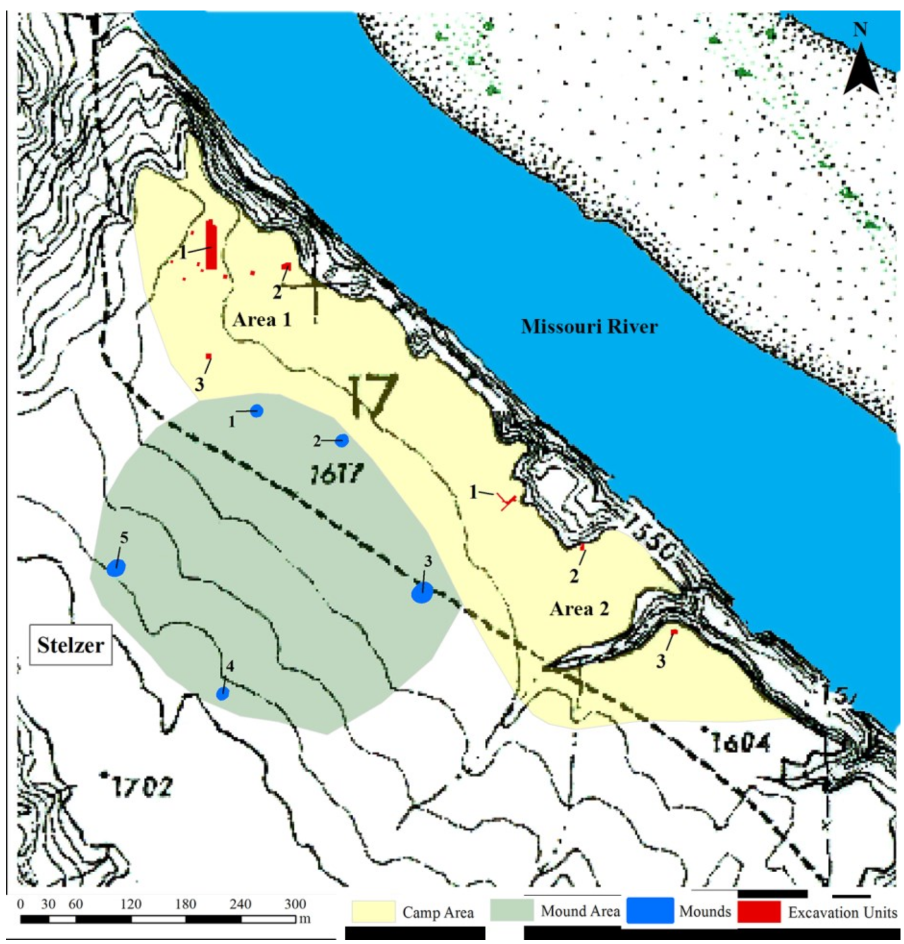

Figure 6.3: Excavation areas and burial mounds at the Stelzer site.

Figure 6.4: Sediments slumping from reservoir erosion during the 1962-1965 excavations at the Stelzer site. Photograph courtesy of John Brumley.

In 1986, a cultural resource inventory of Lake Oahe was undertaken by Larson-Tibesar Associates for the U.S. Army Corps of Engineers in order to assess the reservoir impacts on cultural resources (Sanders *et al.* 1988). The field crews in this survey revisited Swift Bird, Grover Hand, and Stelzer, among other sites in the region, and observed that the erosion had damaged large portions of these sites, leaving artefacts and features exposed on the surface. At the Stelzer site the water had stripped away the sediment to the occupation layer, exposing the tops of several uprights and other features, and the surveyors determined that only two of the Stelzer mounds remained unaffected by the water (Sanders *et al.* 1988:98).

The site remains in this state today, with the entire site except the western-most two of the five unexcavated burial mounds impacted by flooding and erosion. The Arpan mounds have been completely washed away, and were not located in the 1986 revisit (Sanders *et al.* 1988). The Grover Hand and the Swift Bird Sites have also been impacted by the flooding; interestingly, Sander *et al.* (1988:95) noted large quantities of Sonota cultural material eroding out of the northeast bank of the Grover Hand site, originating from another Sonota occupation at the site. This observation is not surprising, as the scatter of features noted in 1986 at the Stelzer site lay among the five burial mounds; it implies that the Sonota occupation extended around and beyond the mounds, farther than was previously thought. Finding an occupation around other burial mound sites is predictable under the circumstances.

Figure 6.5: Satellite imagery showing 1997 flooding of site area.

In 1988, Haberman and Travis (1995) took advantage of the erosion to sample exposed features at Stelzer for radiocarbon dating. They excavated an upright and a pit feature, in which they recovered a large number of charred and uncharred seeds; from a total of 174 identified seeds, 121 were attributed to a minor cultigen known as goosefoot (*Chenopodium sp.*) (Haberman and Travis 1995:74). The dates provided by their study and subsequent radiocarbon dates will be discussed later in this chapter. Additionally, the site has been a popular target for local collectors, producing large surface collections that are housed at the South Dakota State Historical Society. The contents of these surface collections and the features at the site will be reviewed in this chapter, alongside the assemblage from Neuman's (1975) original excavation.

Radiocarbon Dates

Despite collecting samples for radiocarbon dating from the Stelzer site, Neuman did not submitted any material for dating. The associated burial mound complexes were dated using timbers and charcoal from the burial pits, and were used to infer an age of 0 to A.D. 600 for the Stelzer site (Neuman 1975:37). During their visits to the site, Haberman and Travis (1995:75) obtained radiocarbon samples of charred wood and bone from exposed features, which yielded uncalibrated ages of 1800 ± 50 ^{14}C yrs BP (Beta-38267) and 1600 ± 60 ^{14}C yrs BP (Beta-38266). These dates generally align with the estimated age provided by Neuman, as well as the published dates from the nearby burial mound complexes (Figure 6.6). Advances in radiocarbon dating with Accelerator Mass Spectrometry (AMS) have made it possible to obtain increasingly precise and accurate dates from archaeological sites; given the critical relationship between Stelzer and the associated burial mound complexes, it is necessary to develop a finer chronology for Stelzer.

I employed a targeted sampling strategy to assess the age of the largest excavation area at the site, Excavation Unit 1 in Area 1 (Figure 6.7). The samples were drawn from a faunal collection from Stelzer housed at the University of Alberta, largely collected from the numerous Stelzer upright features, as well as various middens, pits, and hearth features. A second round of four radiocarbon samples was selected from the faunal collection housed at the South Dakota State Historical Society Archaeological Research Centre. I submitted a total of 12 samples from Stelzer to the University of California Irvine Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory, where they were demineralized, ultrafiltered, combusted, and counted in the AMS. The results were calibrated using the OxCal 4.2 Calibration Program and IntCal 13 calibration curve (Bronk Ramsey 2009; Reimer *et al.* 2013), and are summarized in Table 6.1 and Figure 6.6. Results are calibrated using two sigmas.

Table 6.1: Calibrated and uncalibrated radiocarbon dates from the Stelzer site.

Sample ID	Feature	Sample Type	14C Date (BP)	Sigma	δ13C	Date calBP	C/N (wt%)
Beta-38267	/	Wood Charcoal	1800	50	/	1865-1605	N/A
Beta-38266	/	Bone	1600	60	-21.4	1703-1412	N/A
UCIAMS-114945	91	Bison right tibia	1715	15	-15.5	1694-1563	2.78
UCIAMS-114946	96	Bison left humerus	1745	20	-16.7	1712-1573	2.75
UCIAMS-114947	77	Bison left tibia	1750	15	-14.9	1709-1614	2.75
UCIAMS-114948	77	Bison left tibia	1775	15	-18.1	1733-1619	2.74
UCIAMS-114949	44	Bison molar	1755	15	-16.7	1710-1617	2.73
UCIAMS-114950	22	Bison right tibia	1710	15	-16.4	1693-1561	2.80
UCIAMS-114951	80	Bison right femur	1775	15	-15.5	1733-1619	2.81
UCIAMS-114952	42	Bison metapodial	1700	15	-14.4	1690-1556	2.77
UCIAMS-143668	112	Bison distal tibia	1775	20	-15.9	1810-1622	2.72
UCIAMS-143669	119	Bison pelvis	1785	20	-14.3	1727-1571	2.78
UCIAMS-143670	75	Bison proximal metatarsal	1755	25	-15.6	1780-1615	2.74

The results from the Stelzer site were surprising; given the large, dense occupation at the site, it was expected that there would be a considerable range in the dates. It was hypothesized that there would have been multiple occupations spread out over time at the site, associated with the burial mounds nearby; this was the scenario envisioned by Neuman (1975:35). Instead the dates were closely clustered, even between the two activity areas in Area 1, Excavation Unit 1, and the larger site area; the median ages of the Stelzer dates all fall between 1810 and 1556 years cal BP. The dates obtained by Haberman and Travis bracket the new dates from the Stelzer site; given the wider error range of those dates, it is likely that the features sampled by them were associated with the occupation in Neuman's excavations. While the error ranges on the new dates are low, it is not possible to separate out different occupations at the site using these dates, as at two standard deviations all the dates overlap within a hundred year period. It now appears more likely that the site was extensively occupied between ca. 1800 and 1550 cal years BP.

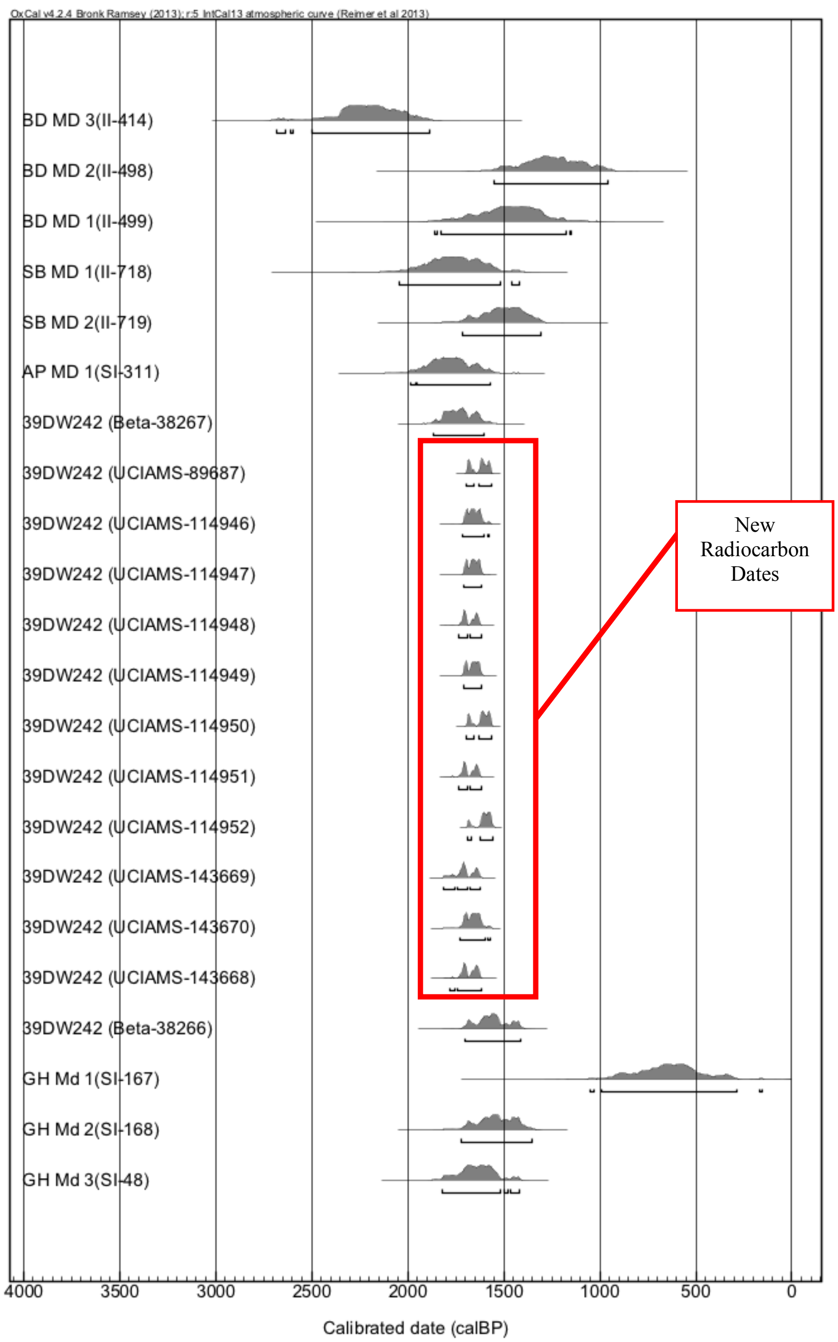

Figure 6.6: Calibrated dates from Stelzer (39DW242) and Boundary (BD), Swift Bird (SB), Arpan (AP), and Grover Hand (GH).

The radiocarbon dates of the surrounding burial mound complexes are broadly contemporaneous. While these are early conventional dates, the results from Arpan Mound 1 (1850 ± 90 ^{14}C yrs BP), both Swift Bird Mounds (1825 ± 120 ^{14}C yrs BP, 1600 ± 100 ^{14}C yrs BP), and Grover Hand Mound 2 (1640 ± 80 ^{14}C yrs BP), and Mound 3 (1720 ± 75 ^{14}C yrs BP) cluster closely around the 200 year period in which the Stelzer site was occupied. Further dating would refine this correlation, but given the cultural association and proximity of the mounds to the Stelzer site, it is likely all these sites were occupied at the same time. Grover Hand Mound 1 deviates from this pattern, with an age of 1049 to 155 yrs cal BP (Neuman 1975:53). At two standard deviations, this range for this date falls outside the Sonota interval and extends almost to the Historic Period. Nevertheless, the contents of Grover Hand Mound 1 are similar to every other excavated Sonota Mound, with a rectangular burial pit containing several secondary human interments covered by timber, whole articulated bison skeletons, typologically similar ceramic sherds, and projectile points (Neuman 1975). This assemblage suggests that Grover Hand Mound 1 is of similar age to the rest of the burial mound complexes, and should be dated again to clarify its placement into the chronology.

The dates from Boundary Mound site also do not align with the Stelzer occupation, but these mounds are 60 km away and were likely not made by people living at Stelzer. Neuman (1975) suggested that the Porcupine Component of 32SI6 in North Dakota was the home base of the people who built the Boundary Mounds. Indeed, this campsite site shares many characteristics with the Stelzer site; notably broad and shallowly side notched projectile points, cord roughened pottery, and upright features (Scheans 1957). A radiocarbon date of 1545 ± 80 ^{14}C yrs BP (GAK-1505) was obtained from the Porcupine component at 32SI6, an age which places the site occupation close to the presumed construction of the Boundary Mounds (Reeves 1983:262). In addition, 32SI6 is only 25 kilometers away from the Boundary Mounds, making it a more likely candidate for the home base of the Boundary Mound builders than Stelzer.

It is important to consider that the Boundary Mounds have a more complicated history and a longer duration than the other mound sites. Dates for these mounds stretch from 2 200 to 1250 ^{14}C yrs BP (Neuman 1975). It is likely that another unknown Sonota camp was closer to the Boundary mounds, and that the Porcupine Component represents a different population. The 1986 survey of the region demonstrated that there was a previously unknown cultural occupation in and around the mounds at Stelzer and Grover Hand that was outside of the main camp area (Sanders *et al.* 1988). There was likely a similar occupation around the Boundary mounds that has since been destroyed.

Features

There are several different types of features that Neuman uncovered and described at the Stelzer site, including bone middens and pits, bone uprights, post holes, and hearths, but many of these features were not adequately described or included in the final list of features. In total, at the site there are 16 hearths, 26 middens, 26 pits, 3 post holes, and 58 upright features. Upon reviewing the features, it is apparent that the collecting from the excavation was not as rigorous as modern projects. Only the readily identifiable portions of the faunal remains were kept, and FCR was often discarded without being weighed or quantified. However, the scale of the site and project was enormous and time was limited; the rising waters of the reservoir were eroding the banks while the excavation was still in progress. Even though the methodology and collecting decisions have biased the material culture sample from the site, meaningful interpretations can be teased out of this dataset once biases and problems are recognized. A review of features from the site is presented in Appendix C, taken largely from Neuman's report (1975), the original site records, maps, and photographs of the excavation.

Area 1, Excavation Unit 1

Covering 634 m^2, the Excavation Unit 1 from Area 1 was the largest continuous excavation unit in the site, revealing two large concentrations of artefacts and features (Figure 6.7). A summary of these features, their contents, and in situ photographs are included in Appendix C, but the relationship between these two large concentrations ought to be explored, as the radiocarbon dates demonstrated that these two clusters were contemporary with one another. Neuman (1975:35) considered a variety of socio-economic factors that led to formation of these two separate concentrations, such as separate activity areas, remnants of lodges, family units, or ethnic divisions within the camp. After exploring differences between these two areas, Newman (1975:35) discovered that there were no distinctions between the tool and feature types between the two areas. He concluded that the same activities were being conducted in both regions of the site, and the separation must be related to band or tribal differences. With advances in spatial analytical techniques, new approaches are possible to tease out the significance of this spatial separation and test Neuman's conclusions.

One possible avenue of exploration is the presence of gendered roles and work areas within hunter-gather societies. In her analysis of the Mini-Moon Besant campsite in Montana, Hughes (1991) explored gendered activities within a northern Plains hunter gather camp setting, and modeled male and female work areas within the site based, on ethnographic examples. Ethnographic and historical comparisons of tasks associated with men and women were drawn from a variety of bison-hunting Plains First Nations groups, as well as the caribou-hunting Alaskan Nunamiut populations. Hughes (1991:28) endeavoured to overcome issues with ethnographic analogy by restricting the comparisons to cases with similar economic orientations, cultural adaptations, and environments. Most Plains aboriginal groups share a similar bison-focused economy, and the focus on migratory caribou was thought to be similar enough to include the Nunamiut in her study.

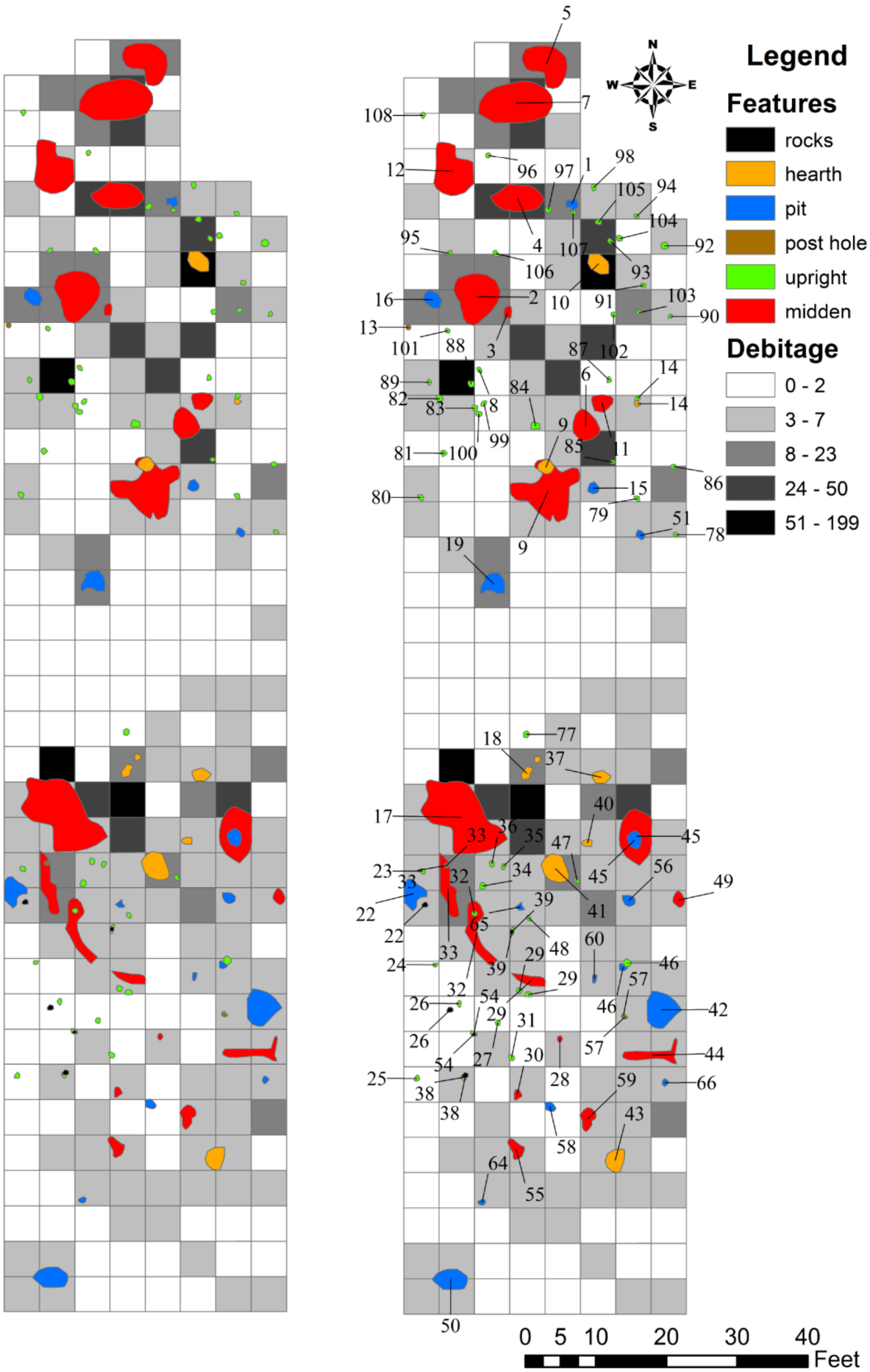

Figure 6.7: Stelzer Area 1, Excavation Unit 1 with and without feature numbers.

Hughes (1991:30) outlined several gender- oriented activities that were similar across all sampled cultural groups; men were mainly associated with tasks surrounding hunting, warfare, and the manufacturing of specialized tools. Women, on the other hand, were responsible for almost all other tasks in camp life: food processing and preparation, hide tanning, sewing, maintenance of the lodging, firewood, and hauling water. There was greater variability in some aspects of life, as the responsibility for tool manufacturing, transport, and initial butchery of animals was more context-specific. The tools and debitage associated with each these aforementioned activities would have been produced by the gender responsible for the activity in question. In the context of the northern Plains, the fabrication of projectile points would have been the responsibility of the men, and endscrapers or sidescrapers would have been made by women. Primary butchery of animals would have been dependent on a variety of factors, such as size of kill and proximity to camp. As hunting was principally a male responsibility, primary carcass processing of a small kill far away from camp would have been carried out by men. If the kill was close to camp, or was the result of a large communal kill, women would have also participated in the initial butchery stages. Later stages of butchery were completed exclusively by the women.

Hughes (1991) also drew heavily upon Binford's (1983) study of Nunamiut camp life and site formation, focusing on the formation of two types of gendered work areas. The first is a men’s outdoor hearth; an exterior hearth around which men would have been seated while carrying out most of their activities, including eating, conversation, and craft manufacturing (Hughes 1991:33, Figure 6.8). A drop zone would typically form around the immediate sitting area in which smaller bone/food fragments and debitage from their crafts would have fallen. A forward and backwards toss zone was also often created; in which larger bone fragments and waste were thrown in order to keep the immediate site area clear (Binford 1983:292), creating a donut shaped midden feature with a hearth in the centre. The midden would contain material culture associated with male-orientated tasks, such as projectile points and specialized tools.

The second gendered work area is a kitchen hearth (Figure 6.9), which Hughes (1990) associated with woman's tasks around cooking and processing various foodstuffs on the northern Plains. Women would have sat obliquely to a hearth while working on a variety of tasks like cooking, slicing meat for drying, marrow extraction, and grease rendering (Hughes 1991:33-34). Periodically, the work area was cleaned by tossing larger bone fragments across the hearth, forming a characteristic butterfly-shaped midden, with the density of bone increasing with distance from the hearth. Considering the kitchen hearth area was the focus of socializing and activities for women as the outdoor hearth was for men, Binford (1983:181) proposed that the artefact distributions around this feature would reflect a female-oriented work area; i.e., a prevalence of scrapers and other tools associated with women's work would be expected.

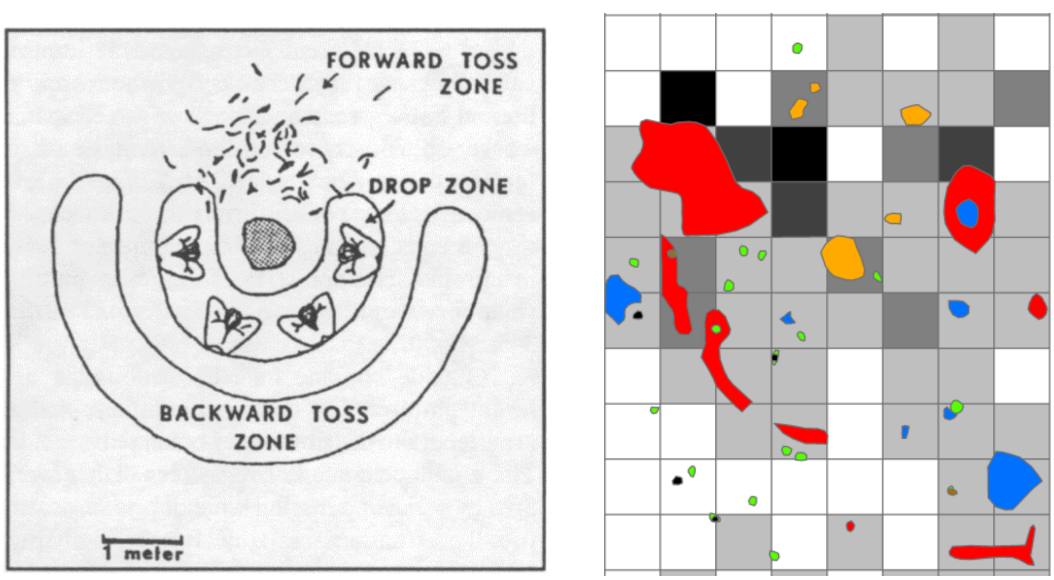

Figure 6.8: Men's outdoor hearth (Binford 1983:153) and Feature 41 locale. Red represents middens, blue indicates pit features, green for upright features, and hearths are orange.

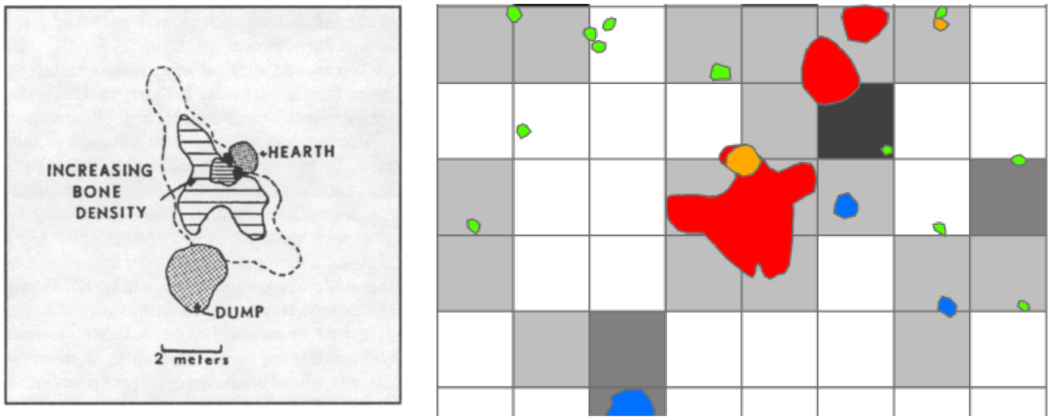

Figure 6.9: Kitchen hearth (Hughes 1991:34) and Feature 9 locale. Red represents middens, blue indicates pit features, green for upright features, and hearths are orange

Other gender roles and tasks would also form distinct features. Hughes (1991:34) ethnographic analysis found that aboriginal women would consistently gather the articular ends of faunal elements, either to save for grease extraction or to place them into waste middens. This observation suggests that middens composed of high-ranked grease-bearing elements (e.g., Brink 1997; Emerson 1990) would be the result of this type of behaviour, and therefore, could be interpreted as food caches for exploitation at a later date. Bone grease is a food resource which can be stored without fear of spoilage for a relatively long time compared to fresh meat. Similarly, women were responsible for extracting the bone grease by using heated rocks to boil water in pits (Hughes 1981:34). The bone was pulverized into small fragments and then added to the boiling water; fats imbedded in the bone would be leeched out and skimmed off the surface of the water. This activity should result in middens or pits filled with small bone fragments and FCR.

Hughes' (1991) study of gender work areas at the Mini-Moon site is relevant to the distribution of features and artefacts at Stelzer, as the sites are contemporary Besant Phase campsites and Hughes' (1991:46) work attested to the importance of specific gender roles in northern Plains aboriginal societies as an essential specialization tied to environmental adaptation. Therefore, it ought to be expected that Stelzer would show similar patterns of gendered work areas.

Unfortunately, the sample available from the Stelzer site has limited the capabilities to identify these gendered areas; collection of faunal remains was limited to readily identifiable elements, eliminating the small pulverized bone fragments associated with grease rendering. Similarly, FCR was noted during excavation, but was neither mapped nor quantified, making it difficult to identify different work areas based on the distribution of FCR.

Despite these problems, there are patterns within Area 1, Excavation Unit 1 that closely match the gendered work areas described by Hughes. Feature 9 (Figure 6.9, Figure C:13) is a large, irregularly shaped midden with a circular hearth on the edge of the midden. Only one piece of debitage and 11 bone fragments were collected from this feature, but a photograph of the feature shows that small fine bone fragments throughout the feature (Figure C:13). The shape and orientation of this hearth-midden feature correspond similarly to the women's kitchen hearth model proposed by Hughes (1991:34), as it strongly resembles the characteristic butterfly shape formed by tossing bone and food scraps over the fire. The general dearth of artefacts around this feature also supports the notion that Feature 9 represents a kitchen hearth, as Hughes (1991:33) enthnographic analysis indicated that women would often cleaned their work and cooking areas, meaning that if this behaviour occurred in the past, there should be little material in this particular area of a site. Figure 6.10 further demonstrates that the concentration of different artefact types is relatively low around the hearth area.

The other locale of interest is focused around Feature 41 (Figure 6.8, C.42). This basin-shaped hearth was filled with a layer of bone fragments and debitage, a piece of fired clay with fingerprint impressions, and a scraper. By itself this feature is not remarkable, but it is associated with a larger general midden at the site. The central hearth (Feature 41) is closely associated with four other smaller hearths (Features 18, 37, and 40), and is surrounded by a ring of middens and refuse pits (Features 17, 29, 32, 33, and 45). The long linear middens, Features 29, 32, and 33, are filled with bifaces, scrapers, gravers, drills, large bone fragments, broken mauls, and FCR. Also near this context is Feature 17, a large midden overlying two pits filled with a variety of artefacts and bones (see Appendix C, Figure C.26, C.27, and Table C.1). The faunal assemblage within this feature is predominantly bison (MNI is 9), but white tail deer and canid remains were also noted.

All of these features are part of a large general midden area that is similar to the men's hearth described by Binford (1983:153), in which a central hearth area has a midden ring around it. The immediate areas around the hearths represent the drop zones in which smaller bone fragments and debitage would have accumulated, and the middens surrounding these areas would have formed the toss-back zones. Unfortunately, there is little information on faunal remains around the hearth areas, but the high concentration of debitage around the hearths is supportive of this notion. This area is among the highest concentrations of debitage at the site, and represents an area of more intensive flint knapping and tool manufacturing that is situated around several hearths. Furthermore, the middens around this locale are filled with large fragments of bone, FCR, and other larger debris that appears to have been tossed away from the sitting area around the hearths.

Another avenue for investigation around these two locales within the site is to analyze the concentration of different tools associated with different gender roles, using Hughes' (1991) detailed list of the gender responsibilities and the tools associated with each task. Artefacts such as projectile points and knives would be associated with activity areas for men, and scrapers, awls, and any tools associated with hiding processing, meat processing, and cooking were linked with an area oriented around women's tasks (Hughes 1991:35). Ceramics can be associated with the latter group, as they can be associated with cooking. Many of the sherds in the Stelzer collection had carbonized food residue adhering to the surface. Looking at the densities of these various artefacts in association with the previously described locales can assist in determining if they are in fact gendered.

A KDE was produced in ArcGIS 10.1 on the quantities of projectile points, knives, scrapers, and ceramics presented at the site, using tool counts per unit provided by Neuman (1975:34). A discussion of KDE and its biases can be found in Chapter 5, and care should be taken to achieve the best representation of the data. For the Stelzer site, the KDE was calculated using tool counts derived from unit polygons, as three point spatial data of each artefact were not collected from the site, only the contents of each 5x5 foot unit. KDE can be run only on points or polylines, so each unit was converted into a centroid, a point at the centre of each unit. The KDE was then run using the values contained in this centroid.

One major issue with using KDE on this type of spatial data is that instead of being distributed across a site based on cultural or natural processes, every data point is equidistant from one another. This result can lead to an artificially even spatial pattern in the analysis. In her spatial analysis of the Fincastle site in Southern Alberta, Mills (2009:61) applied KDE to the artefact and faunal assemblage using a search radius of 0.25 m; the density evaluation would consider every point within 25 cm of the original point. The analysis of the Muhlbach site used a search radius of 0.2 m (see Chapter 5). Using a search radius of 0.25 m at the Stelzer site would produce a KDE surface density with a series of clusters isolated within their units, as 0.25 m is not far enough to incorporate neighbouring points into the KDE. To counteract the even spacing of the unit centroids, the smallest search radius possible with these data was used. A search radius of 1.905 m (6.25 feet) would include all units adjacent to the initial one, but nothing further. This approach will create discrete concentrations within the data without smoothing over the larger pattern. The analysis produced a measurement of artefacts per square foot, overlain with the distribution of features and debitage (Figure 6.10). Working with the assumption that artefacts like projectile points and scrapers are associated with a specific gender, we can compare the concentrations of these tools with the previously described feature locales that were similar to the ethnographic examples as described by Hughes (1991).

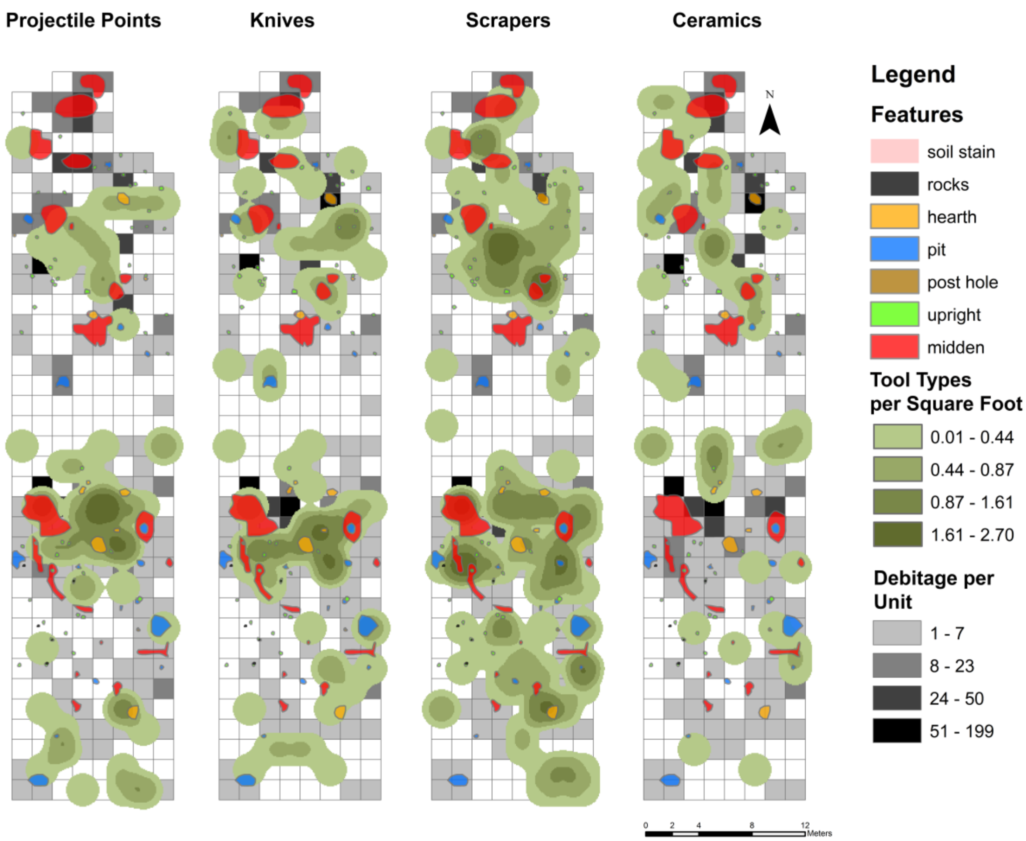

Figure 6.10: Kernel Density Estimation of projectile points, knives/bifaces, scrapers, and ceramics.

Focusing on the Feature 41 locale, there is a dense concentration of projectile points around the central hearths in this region that subsequently drops off towards the surrounding midden. This area has the high concentration of projectile points, as other concentrations of projectile points around the site do not achieve the same level of intensity as around the Feature 41 locale, suggesting that this area was utilized primarily by men. Similarly, there is a concentration of scrapers around the periphery of the Feature 41 locale. Although there are some scrapers within the projectile point concentration, the density of scrapers increases as distance increases from the centre of the Feature 41 locale. This patterning indicates a slight spatial separation between women and men work areas, although the two do largely overlap.

Table 6.2: Correlation Coefficient (r) for each KDE, with the layers on the left as the independent variable and the layers on the top as the dependant variable.

KDE	Points	Scrapers	Knives	Ceramics
Points	1.00	0.57	0.61	0.15
Scrapers	0.57	1.00	0.58	0.19
Knives	0.61	0.58	1.00	0.27
Ceramics	0.15	0.19	0.27	1.00

As previously mentioned, artefacts are largely absent from the Feature 9 locale, but there is a concentration of scrapers and pot sherds just to the north of this area. Assuming that these artefact types would be discarded in work areas where women were, the results of this analysis suggest that the northern cluster was dominated by women's activities. In conclusion, there are locales within each of these larger clusters that can be potentially attributed to gendered work areas in the site. However, as with the distribution of artefact and feature types, both male and female work areas can be identified in both the north and south concentrations of the site. This coincides with Neuman (1975) analysis of the material, but fails to bring any further illumination as to the origin of the two activity clusters at the site. Since this division is not related to work areas or gendered activities, it leaves the possibility of laterally stratified occupations within the short temporal occupation of the site, or possibly that the division is tied to either social or ethnic divisions within the site.

Projectile Point Assemblage

Over the course of Neuman and Mallory's excavations, they recovered 98 projectile points from the site, with 12 complete specimens in the collection. Neuman (1975:17-18) grouped the characteristics of these points into ten categories based on overall morphology, basal shape, and notching. He used these projectile points to define the Sonota Complex as "an archaeological expression representing a regional segment of a cultural tradition…" (Neuman 1975:96). Ensuing surface collecting at the site has yielded an even larger assemblage of projectile points, producing an additional 187 projectile points, bringing the total count of projectile points from Stelzer to 277 (Figure 6.11, 6.12, 6.13, 6.14, and 6.15). If the number of projectile points recovered from the excavation is scaled to the size of the whole site, there may have been over 17 000 points present at the site.

Typological classification of projectile points is a technique that is often used to delineate age and culture type of different archaeological sites, but as discussed in Chapter 2, this approach is problematic for this particular time period. Besant and Sonota projectile points are by definition generalized side-notched points, a form that is commonly found throughout the archaeological record. There is no consensus on the relationship between these two phases. Attempts to separate these two traditions metrically and typologically have proven problematic and inconclusive (c.f. Hamza 2013; Hughes 1981; Peck 2011; Reeves 1983; Syms 1977; Varsakis 2006), and for these reasons, a complete typological analysis will not be conducted. The majority of the points in the Stelzer assemblage do fit within the range of variation seen for Besant sites; the notches are broad and shallow, and the bases range from slightly concave to slightly convex but are largely straight. There are a few points that fall outside the Besant range in the surface collections: six small side notch points typical of later series projectile points (Peck 2011, Figure 6.13). These artefacts suggest that there is a later, albeit brief reoccupation of the site that has contributed to the assemblage.

In addition to the later side-notched points, there are several specimens in the surface collection with slight to complete barbs at the shoulders and corner notches (Figure 6.15). This is a characteristic common with the earlier Pelican Lake Phase, more specifically the Bracken Phase as described by Peck (2011:256). These broad, corner-notched points with slight barbs are distinguishable from the narrower Pelican Lake points, and seem to occupy a transitional phase between classic Pelican Lake and Besant projectile Points (Peck 2011:275). Their presence could suggest a slightly earlier occupation at the site, prior to the intensive Sonota encampment and mound building activities, but not enough is known about the nature of the Bracken transition, and these points could well be the same age as the rest of the site. Neuman (1975:17) noted corner-notched points recovered in the original excavation that have similar characteristics to Bracken, with barbed shoulders, slight corner notching, and broad bodies (see Figure 6.11, upper left). Syms (1977:89) considered these corner-notched points to be distinctive of Sonota, and it may be that these Bracken points actually fall within the range of variation for Sonota projectile points. The timing of this transition from barbed corner-notched points into broad side-notches could have occurred later on the eastern side of the Plains than the timing in Alberta proposed by Peck (2011).

Figure 6.11: Projectile points collected during the 1960s excavations.

Figure 6.12: Besant points from Stelzer surface collections.

Figure 6.13: Late side-notched projectile points from the Stelzer surface collections.

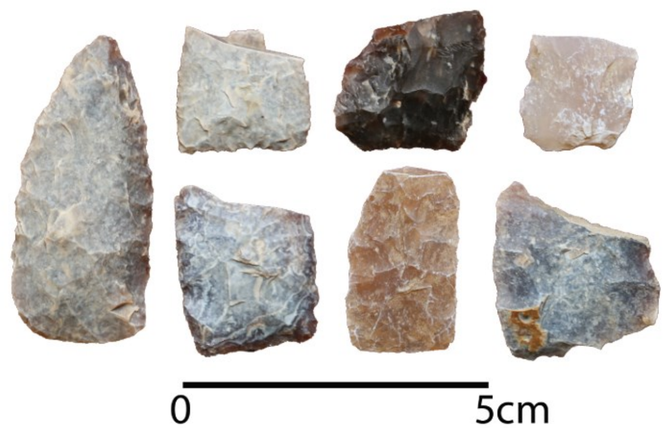

Figure 6.14: Possible point blanks from Stelzer surface collection.

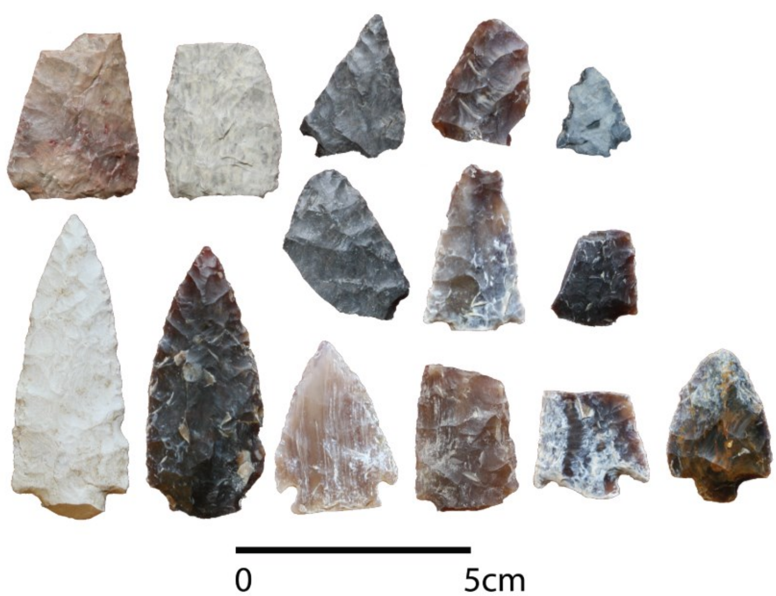

Figure 6.15: Bracken points from Stelzer surface collection.

The raw material counts of the projectile points are summarized in Figure 6.16, and identification was carried out based on macroscopic analysis alone. As previously discussed, there are major limitations for using this technique alone for lithic source identification. However, there are disparities between the raw materials identified by Neuman and those observed by the author. This difference was largely based on changes and refinements of lithic source identification over the past forty years, and it seemed prudent to re-evaluate the material to illustrate a more accurate picture of the lithic assemblage, albeit with some caveats.

Of the 277 projectile points identified at the Stelzer site, the majority are made from KRF (60% of the assemblage). This frequency is lower than expected, given the affinity for KRF associated with Sonota. Contemporary sites with high amounts of KRF, like Muhlbach and Fincastle, have 80 to 90% of the projectile point assemblage made from KRF (Varsakis 2006); so having only 60% of the projectile point assemblage made from KRF is relatively low. Other prominent materials include chalcedony, Tongue River Silicified Sediment (TRSS), and petrified wood. TRSS has sources in the west-central region of the Dakotas, immediately adjacent to Stelzer and the KRF source area (Ahler 1977, see Figure 2.1). It is likely that this material was being incorporated in the tool kit in conjunction with the seasonal visits to the KRF source region. Interestingly, only three points were identified as quartzite, despite Neuman (1975:17) reporting that fine grained mottled grey quartzite was a common material for the projectile points. Ahler (1977:137) stated that TRSS has been described as a type of quartzite in the past; Neuman might possibly have misattributed the raw material of the TRSS points and identified them as quartzite.

One point was made from Bijou Hills Quartzite, a unique green quartzite with sources in small outcrops near the North and South Dakota border, along the Missouri River basin (Ahler 1977, Figure 2.1). The sources of this material could be incorporated easily into a seasonal round that focuses on KRF and TRSS, but there is a limited amount of this material in any component of the lithic assemblage, despite being readily available. This distribution suggests a focus on high quality raw materials like chalcedony, KRF, and TRSS over other common, low quality raw materials. Considering that most of the high quality raw material is from distant sources, transporting whole cobbles or leaving the points unnotched prior to transport from the quarries would reduce the chances of breakage along the way. There are numerous examples of KRF cores at the Stelzer Site, as well as a series of possible projectile point blanks in the collections; these artefacts are usually small, finished bifaces with visible platforms (Figure 6.14). Given their overall morphological similarity to the finished Besant points, these specimens most likely represent point preforms manufactured for easy transport, although they could be bifacial knife fragments as well.

Metrics were taken from the points recovered in Neuman's original excavation, as well as a sample of complete points from the surface collection. A Fisher Scientific digital caliper was used to determine the maximum length, maximum width, basal width, neck width, and thickness for the point, summarized in Table D.1 in Appendix D. Interestingly, when we compare the maximum length and raw material types, a pattern emerges that contradicts conventional thinking about Sonota (Figure 6.17). Despite the assertion that Sonota points tend to be on average longer than Besant points (Reeves 1983; Syms 1977; Varsakis 2006), the majority of points from Stelzer, the Sonota type site, are actually relatively short. This observation does not fit with our understanding of Besant-Sonota typology, as Sonota points are supposed to be long and well-made, while Besant points are short, stubby, and crudely made.

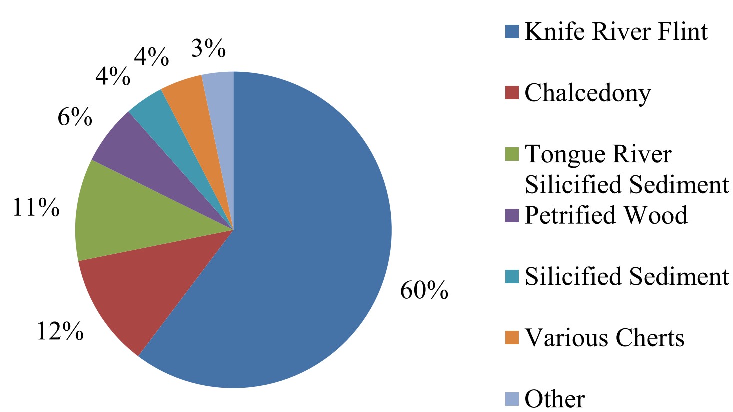

Figure 6.16: Raw material counts for Stelzer site projectile points.

If we consider the projectile point assemblage not from a typological viewpoint, but rather as a reduction sequence, we can gain some significant insights into the dataset. The reworking and reduction of projectile point length is a practice that has been noted at many Besant sites, including Fincastle, Ruby, EdOh-23, and Muddy Creek, and indeed a number of other point forms (e.g., Foreman 2010:107; Hamza 2013; Hughes 1981; Ives *et al.* 2013:156-158). Hughes' (1981) analysis of the Muddy Creek assemblage from Wyoming demonstrated significant reworking of the blade in complete points, and the unmodified points most resembled the idealized lanceolate Besant projectile points. Hamza (2013) further explored this trend with her analysis of Fincastle projectile points, finding that reworking of the blade had more impact on overall point morphology than taxonomic grouping. Based on my observations of the material, the assemblage seen at the Stelzer site can be best characterized as a reduction sequence, in which there are longer "Sonota type specimen" points represented in the assemblage, but the majority are shorter, with substantial reworking. This trend can be demonstrated by the blunted tips and acute blade angles visible on many of the Stelzer projectile points. The idealized long Sonota point is an artificial construct, and is not useful for separating Besant and Sonota assemblages.

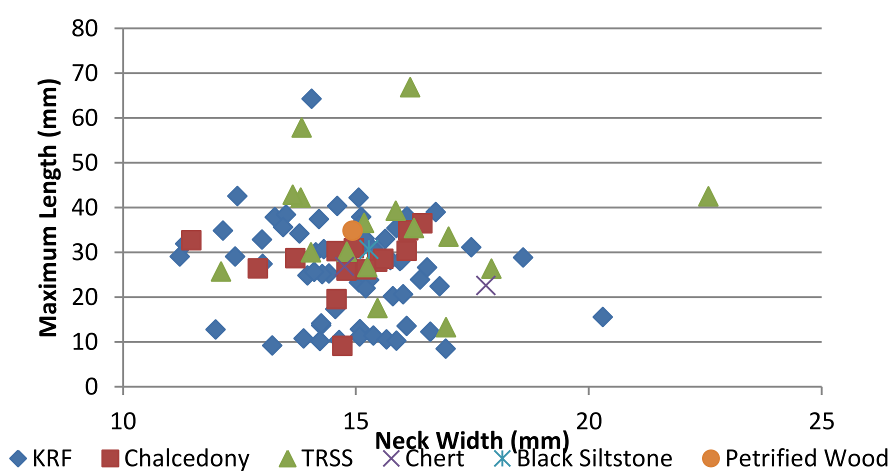

Figure 6.17: Stelzer point metrics compared to raw material type.

Another pattern within the projectile point assemblage is that the points made from KRF tend to be shorter than those made from other material. Almost all of the KRF points from the site fall under 40 mm in length, while there are three relatively long points made from TRSS. The KRF points were more likely to be reworked and sharpened as they were used, while other materials were discarded more frequently in the earlier stages of use; Hamza (2013:174) made a similar observation with her sample of Besant KRF points. There is one exception to this pattern; a single KRF point that is greater than 60 mm in length (Bottom Left of Figure 6.11). However, this point has an impact fracture that runs half the length of the blade, and this steep break would have made it difficult to effectively rework this artefact. The complete points recovered from the Boundary Mounds (N=14) further demonstrate this trend of maximizing the use-life of KRF (Figure 6.18). The elongated typical Sonota Points are made from materials other than KRF, while KRF occupies the lower portion of the projectile point length assemblage. The largest KRF specimen from Boundary is actually a large side-notched knife, almost as wide as it is long. This trend suggests that during these Sonota occupations, KRF was exploited more intensively than other high quality raw materials.

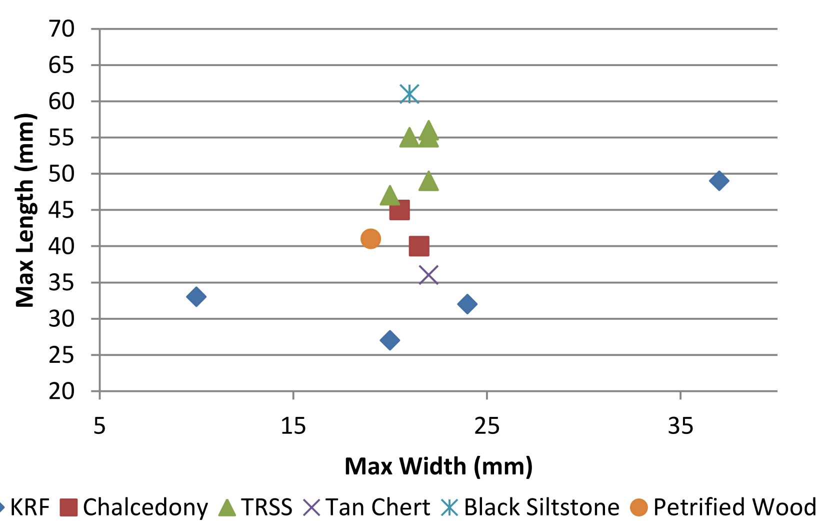

Figure 6.18: Boundary mound point metrics compared to raw materials.

End and Sidescraper Assemblage

Scrapers were another common tool type recovered from the Stelzer site, in which 170 scrapers were collected from the excavations, with 127 complete specimens (Neuman 1975:20). The surface collections from the site also yielded a large number of scrapers: a total of 587 scrapers have been recovered from the Stelzer site, a number of specimens that is unusual even for Plains archaeological sites. Based on the position of a worked beveled edge on the flake, among the 587 scrapers 481 were identified as endscrapers and 106 were sidescrapers. Figure 6.19 and 6.20 depict a small sample of the side and endscrapers from the excavations and surface collections. If the number of scrapers collected from the excavation is extrapolated to the size of the entire site, there could be close to 30 000 scrapers at Stelzer.

Figure 6.19: Sample of Stelzer sidescrapers, oriented with platform down.

Figure 6.20: Sample of Stelzer endscrapers, oriented with platform down.

Using macroscopic techniques to identify raw material for the scrapers, the assemblage demonstrated more homogeneity than did the projectile points. Of the all the endscrapers, 86% were made from KRF, with chalcedony, petrified wood, and TRSS comprising the remaining sample (Figure 6.21). The sidescrapers were more similar to the projectile points, with only 63% of the sample being made from KRF; TRSS, chalcedony, and petrified wood represent 14%, 9%, and 8% of the assemblage respectively (Figure 6.22).

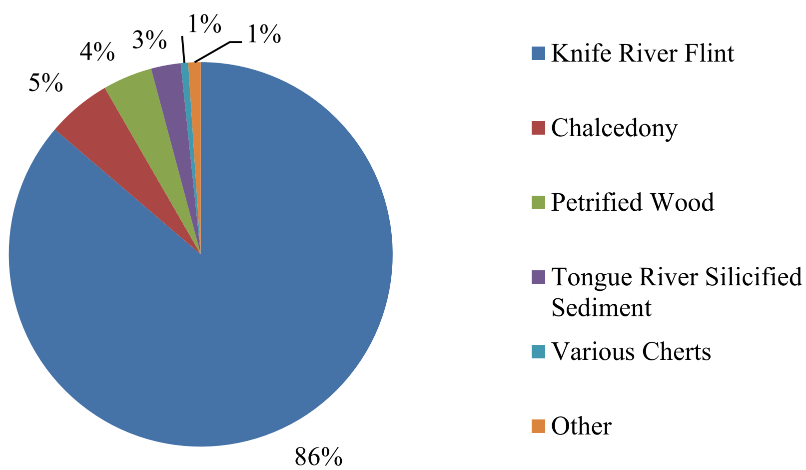

Figure 6.21: Raw material count for Stelzer endscrapers.

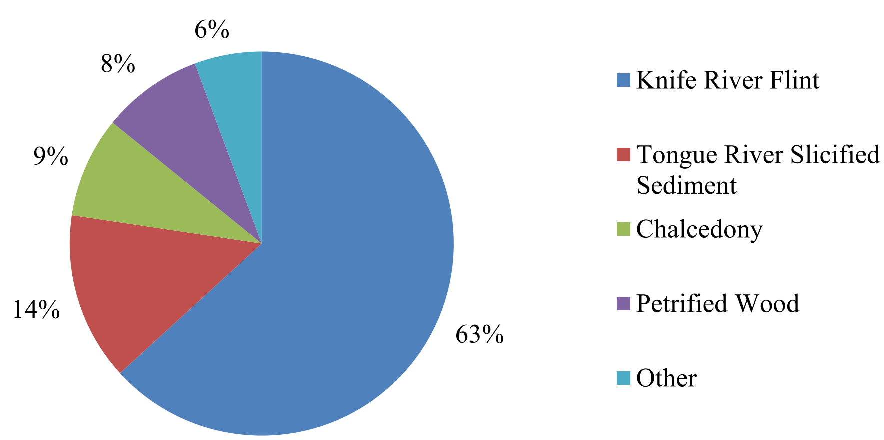

Figure 6.22: Raw material count for Stelzer sidescrapers.

The difference in raw material use illustrates a preference to use KRF for endscrapers over sidescrapers at Stelzer, in addition to illuminating a preference for using KRF to make endscrapers over the projectile points. The material is still popular across all the assemblages, but even more so with the endscrapers. Endscrapers are typically used for hide-processing, but could also be employed for other tasks like wood-working. The association between scrapers and hide-working, normally the task of women (Hughes 1991), could suggest that KRF had specific gender significance at Stelzer. Alternatively, the material could have been preferentially selected as it was high quality, and was well suited for hide scraping. Hide processing is a time-intensive task, and tools would often need to be sharpened (Schultz 1992). A stone that could hold its edge for longer would be a valuable asset.

Most of the endscrapers were relatively short; large proportions of the collection had either broken tips or bases of endscrapers, presumably snapped off during use and discarded. Others were small “thumbnail” scrapers, also at the end of their use life. Through ethnographic research, Shott and Scott (1995:61) demonstrated that during a scraper’s use-life, the length will undergo a 38.8% reduction as compared to an unused scraper blank. Spent endscrapers from that study had a maximum length of less than 40 mm, a pattern that can be observed with the Stelzer assemblage. The majority of the endscrapers were significantly shorter than 40 mm, supporting the notion that they were at the end of their use-lives. The sidescrapers tended to be considerably longer than the endscrapers, a feature which could indicate that some of the sidescrapers had not reached the end of their use-life. Nevertheless, the widths of the sidescrapers (i.e., the working edge) were similar to the lengths of the endscrapers. With their working edges reduced down to the disposal threshold, many of the sidescrapers were likely near the end of their use-life.

An analysis of edge wear suggested that the Stelzer endscrapers were primarily used during hide processing. Due to the size of the collection and the limited amount of time with the material, I limited the analysis to 10 representative specimens from the Stelzer assemblage. While not an exhaustive study, it does illustrate some of the scraper use-wear at the site. Edge photographs of 10 endscrapers were taken using a Dino-Light Digital Microscope, and were compared to descriptions and photographs of experimentally produced wear and polish (Schultz 1992). Three main characteristics indicative of hide processing are polish and rounding of edges, step fractures along the dorsal surface, and linear striations perpendicular to the tool edge (Schultz 1992), and these features could be observed on the Stelzer endscrapers. Some exhibited marked rounding and polish that was continuous along the working edge of the tool (Figure 6.23), a characteristic associated with the dehairing and fleshing of hides (Schultz 1992:346). The dorsal surface of the endscraper edges also showed numerous step fractures, and the ventral surface exhibited linear striations, traits associated with wear from hide scraping, although Schultz (1992:348) indicated that these characteristics may not always manifest during use. It is possible that these tools were also used for other purposes; the ways in which a tool is used does not always result in wear being produced (Schultz 1992). Nevertheless, the wear noted on the artefacts is largely consistent with hide processing activities.

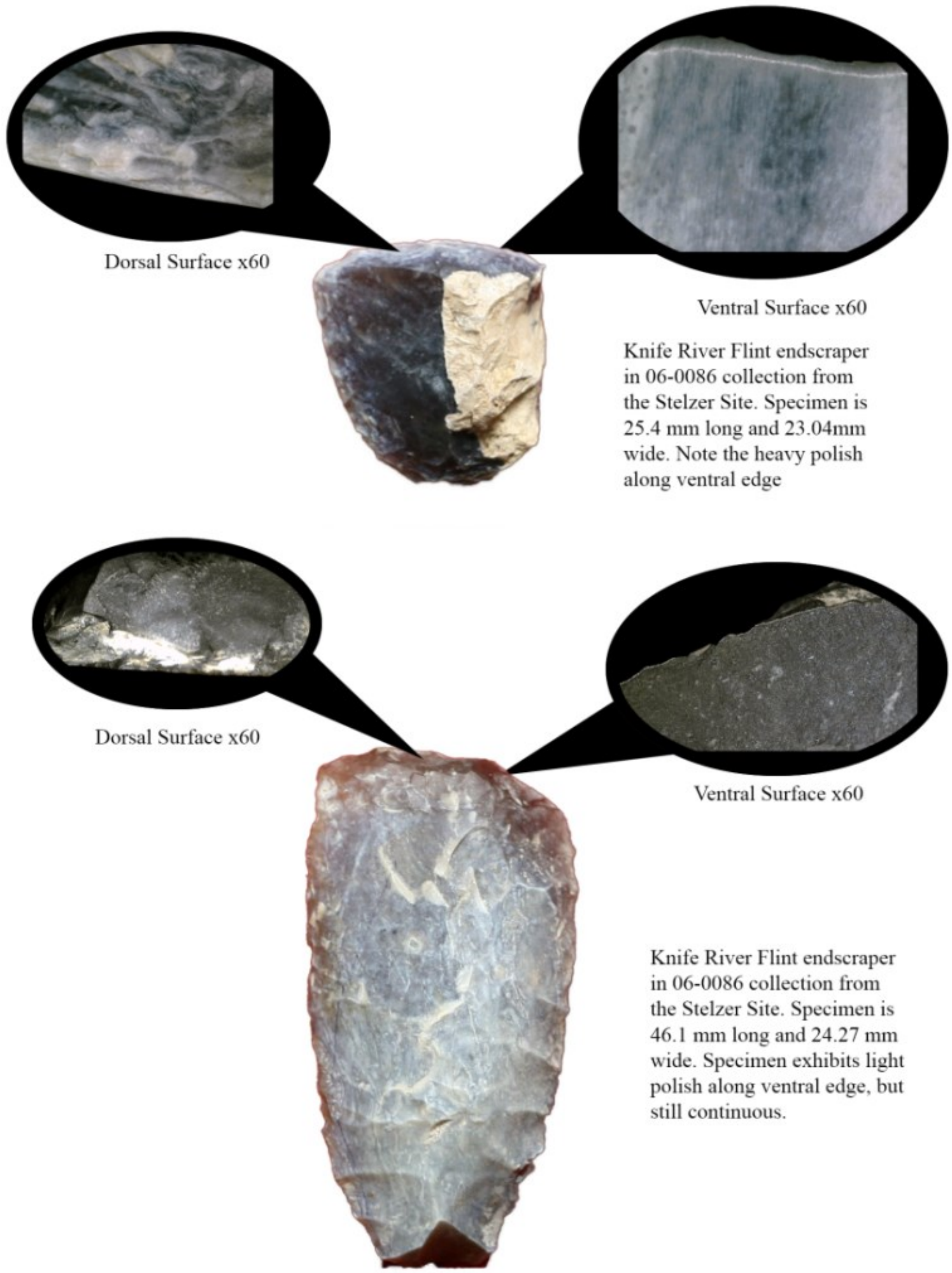

Figure 6.23: Use wear exhibited by endscraper specimens.

Bifaces, Spokeshaves, Gravers, and Drills

Figure 6.24: Sample of Stelzer knives, spokeshaves, gravers, and drills.

There were several other tool types recovered at the Stelzer site, both in the excavations and from the surface collection. A variety of bifacial and unifacial knives were recovered, as well as several gravers and drill specimens. Due to the limited amount of time available with the collection, only a cursory analysis was conducted with this material.

Neuman identified 98 bifacial knives from the site, and separated them into seven different categories based on size, shape, and symmetry; there were also several bifacial knife specimens observed in the surface collections. Also noted in the surface collections were a unifacially worked graver, a bowtie shaped spokeshave, and several "T" shaped drills (Figure 6.24), two of which were made from reworked projectile points. One specimen was fashioned from a KRF side-notched base consistent with Besant, and the second was made from the midsection of a KRF point (the tops of the side notches were still visible in this specimen). Neuman (1975:22-23) collected seven drills from the site; three "T" drills, two triangular drills, and two drills fashioned from projectile point midsections. He also recovered 20 gravers from the site, although none of these specimens fit the classic morphology of gravers. The majority of these specimens are large unifacially worked flakes, shaped with a fine, sharp tip (Figure 6.24, bottom centre). These specimens would be classified as retouched, unifacially worked flakes, but they likely had a similar function to gravers. Although no attempt to quantify the raw material types of these artefacts was made, they continue to follow the pattern observed in the projectile points and scrapers. The majority of the specimens examined were made from KRF, with smaller amounts of petrified wood, chalcedony, TRSS, and some varieties of cherts.

Cores and Debitage

Throughout the course of the excavations, Neuman (1975:25) collected 2 794 pieces of debitage and 29 cores, but since the sediments were not screened; it is difficult to know if this number is an accurate representation of the debitage. The debitage received limited analysis, but cores were divided in five groups based on size, shape, and platform preparation. The surface collections have produced an enormous quantity of debitage and cores from the site, a dataset that would be suitable for its own thesis (Figure 6.25). Due to the massive amount of material and the time constraints with the collection, these aspects of the assemblage were not analyzed in depth, but some general trends were noted.

Figure 6.25: Debitage from Stelzer site surface collection.

The raw material for debitage and cores mirrored what was seen in other parts of the lithic assemblage, primarily KRF with chalcedony, petrified wood, and TRSS. Neuman (1975:25) noted similar raw material patterns, but also reported five pieces of plate chalcedony. This material was popular for making naturally backed unimarginal bifacial knives in later periods (Ahler 1977:148), but it is not present in any other tool category at the site. The debitage seemed to represent the entire reduction sequence, with primary, secondary, and tertiary flakes in abundant quantities. There were a large number of KRF cores, but these were all relatively small compared to the cores of other materials (Figure 6.26).

It appears that the occupants of the site were bringing large quantities of KRF nodules to the site, and completing the entire reduction sequence at Stelzer, with an emphasis on maximizing the amount of useable material from the KRF cores, by reducing the cores down to almost nothing. This practice is in stark contrast with cores of other raw materials, which were often discarded at a much larger, useable size than the KRF (Figure 6.26). This is a pattern that is mirrored in the projectile points, in which the projectile points made from KRF tended to be shorter and reworked more frequently than those made from other materials.

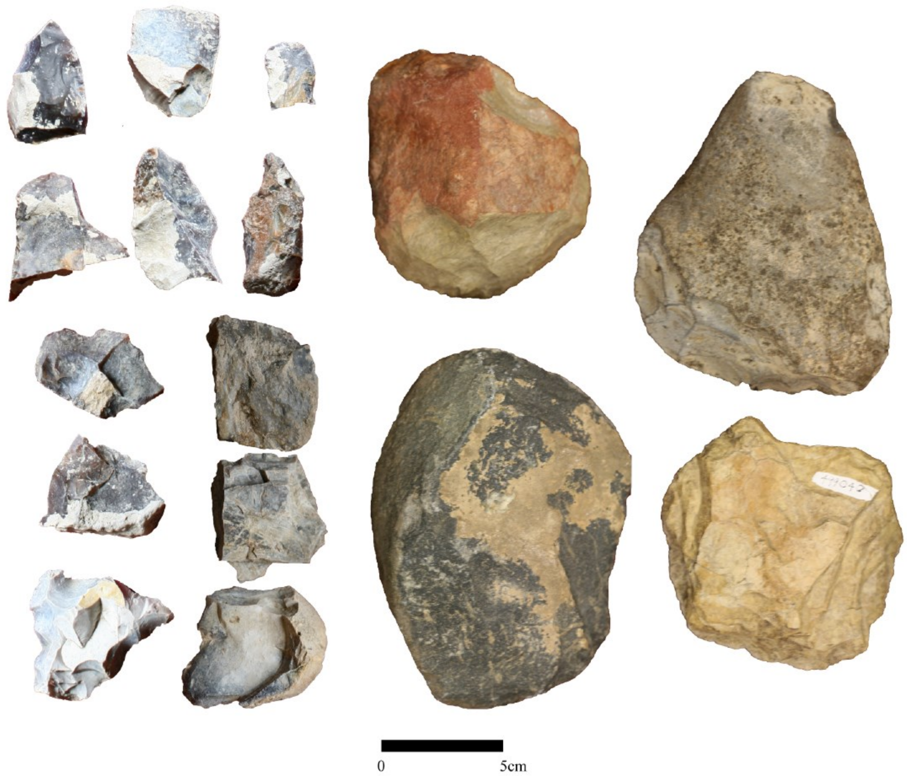

Figure 6.26: Cores from excavations and surface collections

Ceramics

A limited amount of ceramics was recovered from the site; the majority of the ceramic assemblage were small body sherd fragments. There were 16 rim segments from the 1960s excavation, as well as one rim fragment in the surface collections. The pottery is typical of Plains Woodland ceramics, with elongated, conical profiles, thick walls, a cord-roughened exterior, and limited decoration (Walde *et al.* 1995:18). The rim decorations consist of interior and exterior punctates and bosses near the edge of the rim (Figure 6.27), with some specimens exhibiting cord-wrapped object impressions running diagonally or perpendicular to the lip of the vessel. The body sherds typically exhibit a cord-roughened exterior, but some specimens have been smoothed. Neuman separated the ceramics into seven groups based on slight differences in form and decoration; however, large grains of a crushed granitic material that was readily available in the environment were used as temper for all sherds (Neuman 1975:13). The vessels were formed either through coiling or paddle and anvil technique.

The only vessel reconstructed from the site was a surface find from a private collector. Based on 75 sherds, Neuman determined that the vessel mouth was 30.4 cm in diameter, had a maximum circumference of 119.3 cm, and a height of 42 cm. Based on these dimensions, Neuman (1975:16) estimated that the pot had a volume of 33 litres. This estimation had seemed a little high, and a new volume was calculated by using two truncated cones, applying the metrics described by Neuman and measurements from photographs. This method produced a volume of 25.71 L. While smaller than originally estimated, this vessel is still large, and raises the question of whether or not a nomadic hunting-gathering society would transport such a large and unwieldy container that stood nearly half a meter tall. It is possible that large vessels such as this were a form of camp furniture, created for use in only one camp, rather than transported in the seasonal round.

Stelzer pottery is similar to several early Woodland decoration styles, but this similarity is largely because of the generalized and limited decorative motifs present during this time period. Neuman (1975:62) defined his own ceramic tradition based on a vessel recovered from the Arpan Mound, which he termed "Arpan Punctate", in which the defining characteristic of this type was the smoothed interior and exterior surfaces of a conical pot. Other sherds at Stelzer resembled Valley Phase Ware, a contemporary ceramic tradition present south of the Stelzer site in the Missouri River valley, as well as Havana Hopewell ware from the Illinois valley (Neuman 1975). Valley Phase ware is a Plains Woodland tradition exhibiting cord-roughened exteriors, as well as punctates and bosses along the rim; this tradition was influenced by the Middle Woodland cultures like the Havana Hopewellian tradition, but not closely related to them (Hall and Hall 2004:95). It is likely that the ceramics at the Stelzer site represent a similar relationship that is seen between the Hopewellian Interaction Sphere and Valley Phase Ware, in which ceramic style at Stelzer is influenced by Hopewell cultures, but is not closely related to them.

Figure 6.27: Exterior decoration on Stelzer rim sherds.

Groundstone Tools

There were several groundstone tools collected from the Stelzer site: four grooved mauls, six pecking stones, and 22 mealing stones (Neuman 1975:26-27). The mauls and pecking stones are typical of Late Precontact sites, in which mauls are often associated with the pounding of meat for the production of pemmican (Brink 2008), and pecking stones are commonly used for flint knapping and working stone. The mealing stones are interesting, as this is not a tool type typically associated with Sonota and nomadic hunter-gathering societies. Neuman describes these artefacts as "…rounded, hand-sized boulders that have one or more flattish surfaces worn smooth from use….they have obviously seen service, none are finished enough to be complimented with the name metate" (Neuman 1975:27)

My review of these artefacts confirmed the accuracy of Newman's description, as the specimens exhibit a high degree of polish and wear on a small portion of the cobble, but are not nearly finished enough to be classified as a mano or metate. The presence of these mealing stones suggests some type of plant processing occurred at Stelzer, but further research is needed to explore this aspect. As previously discussed in this chapter, a large amount of goosefoot was recovered from a feature at the site. Goosefoot (*Chenopodium sp.*) is a minor cultigen that was domesticated in eastern North America around 3700 yrs cal BP (B. Smith 2006). Haberman and Travis (1995:74) dismiss these seeds as being modern and intrusive, and while this is possible, the dominance of a minor cultigen over all other species in this feature seems more likely to be the result of human action rather than being intrusive.

Other Besant sites have produced *Chenopodium*. The Besant tipi ring site 32OL270 in North Dakota produced charred *Chenopodium* seeds in many of the features at the site (Fredlund *et al.* 1985:136), suggesting that inhabitants were collecting and consuming this cultigen, although it is not clear if they were actively engaged in growing it. A comparison of seed size would illuminate whether the archaeological samples derived from domesticated or wild varieties (B. Smith 2006), and an analysis of ceramic residue from the site would assist in resolving this issue. The ceramic vessels at Stelzer could conceivably be connected with major cultigens; recent research has demonstrated widespread maize use during the Avonlea Phase (Lints 2012). However, the ceramic vessels are limited in number and poorly made compared to later examples, suggesting a restricted use of ceramics for Besant and Sonota.

Stelzer Faunal Assemblage and Analysis

The faunal assemblage recovered from the Stelzer site was predominantly bison, with a total MNI of 43 for the entire excavation area, and an MNI of 34 bison for the Excavation Unit 1, Area 1 (Neuman 1975). An adult and subadult of both white tail deer and elk were recovered, and at least five canids. Other species recovered included prairie dog and rabbit, as well as a portion of a fish skeleton and turtle carapace (Neuman 1975:104). Based on estimations that roughly 0.5% of the total site area was excavated, the faunal remains reflect but a small sample from the site. A rough extrapolation from the bison MNI determined by Neuman suggests that there could be some 8 300 bison represented for the entire area of the site, as well as roughly 400 deer and elk, and almost 1 000 canids. This extrapolation does assume that the concentration of faunal remains would have been consistent across the site, which is unlikely. It is a rough approximation at best, based on uncertain dimensions of the site, but it does illustrate that the scale of the occupation present at the site must have been large in absolute terms.

Neuman (1975:101) presented the counts of faunal remains as MNI per element, as opposed to an MNE or NISP count. This method is problematic as it does not accurately reflect the total number of different elements in the assemblage (see discussion of NISP, MNE, MAU, and MNI in Chapter 4). In order to work around this issue, MNE was determined based on the known contents of the various features in the site (Table 6.2). This information was then evaluated in terms of Emerson's (1990) indices to structure the data and characterize patterns in the faunal assemblage in relation to subsistence strategies (see Chapter 4 for discussion of utility indices, Figures 6.28, 6.29, and 6.30 in this chapter). As I am working with a subset of the faunal remains from Stelzer, this sample limits what can be conclusively stated. Collection practices have biased the representation in the faunal assemblage, as certain elements were less likely to be retained. The review of the features (Appendix C.) demonstrated that while excavators noted abundant faunal remains in each feature, little was actually collected. Additionally, it is my assessment that most of the bone fragments from upright features were retained, while only large, identifiable elements were collected from middens and pits. These factors have influenced the counts of faunal remains, and need to be considered while interpreting the site.

Table 6.3: MNE from Stelzer faunal sample separated by features, MAU, and MNI as identified by Neuman (1975).

Element	Midden	Pit	Upright	Total MNE	MAU	MNI
MOLARS	12	10	1	23	/	/
OCCIPITAL	5	1	0	6	6.0	10
HORN	4	0	0	4	2.0	2
MAX	2	0	0	2	4.0	/
MAND	6	6	1	13	6.5	10
VERT	0	0	2	2	/	/
CER	4	1	1	6	0.9	2
THOR	4	2	4	10	0.7	2
LUM	4	0	0	4	0.8	3
PEL	2	1	2	5	2.5	1
CAU	4	7	0	11	1.6	2
RIB	0	2	15	17	0.9	/
SCAP	20	20	13	53	27.0	28
HUMP	3	0	3	6	3.0	5
HUMD	18	2	28	48	24.0	38
RADP	5	1	6	12	6.0	22
RADD	7	1	4	12	6.0	17
ULNP	4	0	2	6	9.0	8
ULND	0	2	1	3	5.0	/
CARP	0	8	26	34	6.3	/
MCP	6	3	9	18	9.0	18
MCD	4	4	2	10	5.0	7
FEMP	7	5	8	20	10.0	11
FEMD	3	0	1	4	2.0	5
PAT	2	4	1	7	3.5	4
TIBP	4	0	5	9	4.5	7
TIBD	27	7	20	54	27.0	41
TAR	23	10	10	43	10.8	/
MTP	10	1	1	12	6.0	15
MTD	3	1	0	4	2.0	16
PHAX1	26	3	0	29	3.6	39
PHAX2	26	6	2	34	4.3	43
PHAX3	9	7	0	16	2.0	23

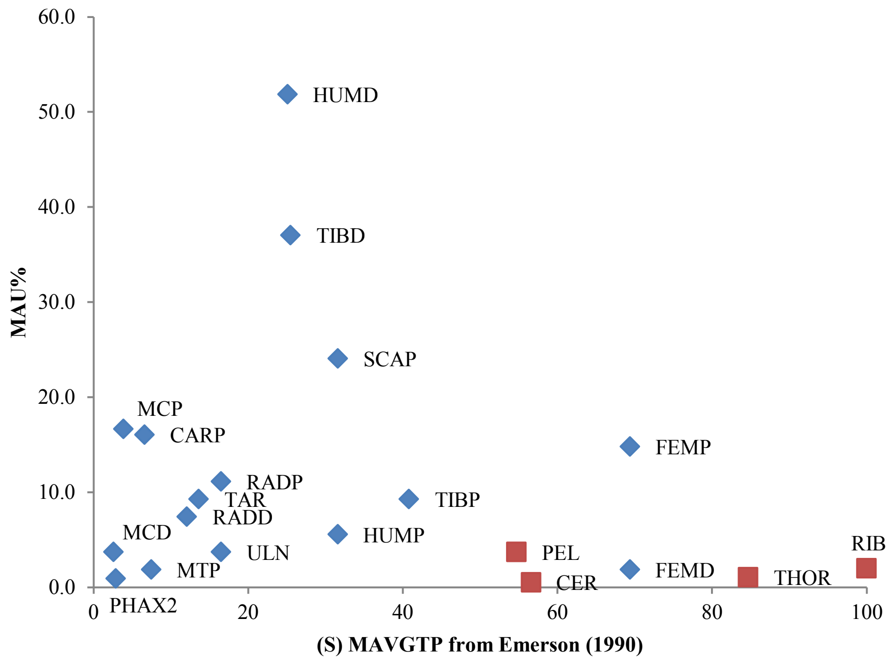

Figure 6.28: %MAU plotted against Total Products Index (Emerson (1990) for Stelzer upright features.

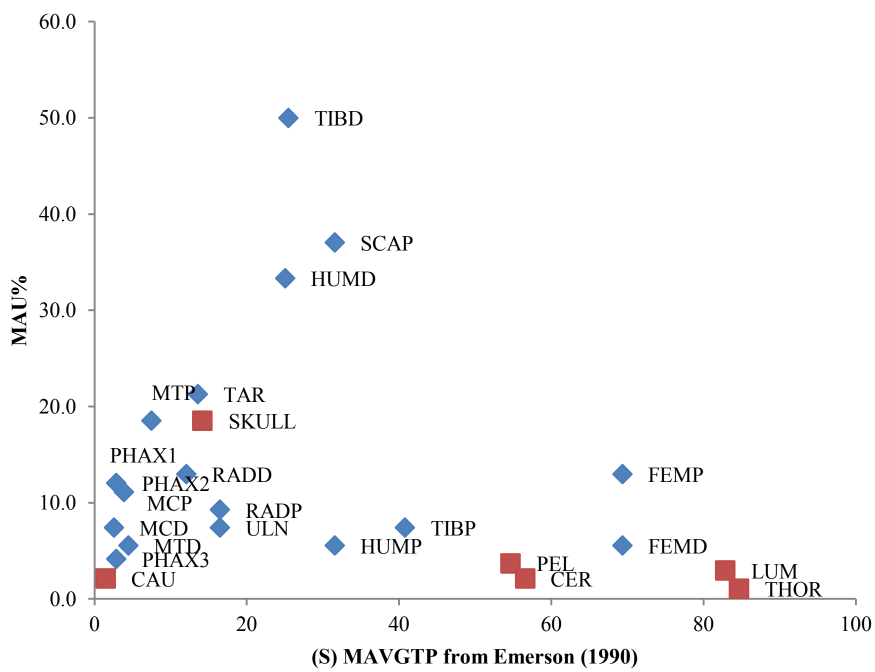

Figure 6.29: %MAU plotted against Total Products Index (Emerson (1990) for Stelzer midden features.

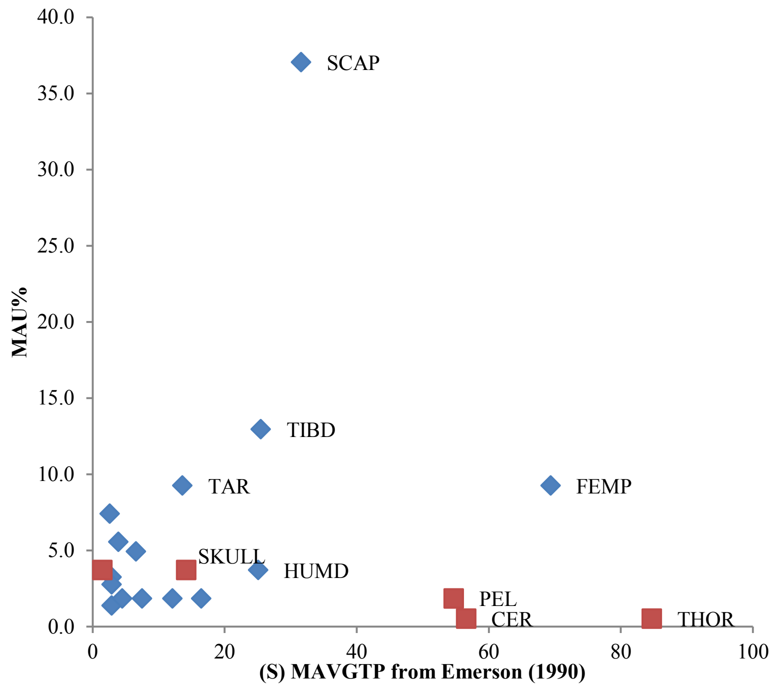

Figure 6.30: %MAU plotted against Total Products Index (Emerson (1990) for Stelzer pit features.

One pattern apparent from the faunal assemblage, based on all of these indices, is that there are more low-ranked elements in the collection than would be expected for a campsite. The expectation is that the lower ranking elements would have been left behind at the kill and only the higher ranking and quality elements would have been taken back to camp (Binford 1978; Emerson 1990), but this is not observed. The low ranking elements, like carpals, tarsals, first, second, and third phalanges, are relatively abundant as compared to high ranking ones, and even the most frequent limb elements present at the site are among the lowest ranking; scapulae, humerii, and tibiae are the most common limb bones, but are lower in rank compared to the femur, ribs, and vertebrae. Compared with Emerson (1990) and as well as Brink's (1997) grease ranking and limb abundance, the lower ranked portion is always more common than the higher ranking portion of the same element (Figure 6.31). The proximal humerus is ranked higher for grease production as compared to the distal portion, but the distal portion is eight times more common than the proximal; this pattern repeats for femora, tibiae, and metapodials. The absence of high grease ranked elements in the assemblage, in conjunction with the abundant FCR, and pit features thought to be associated with stone boiling, suggests that grease rendering occurred at Stelzer.

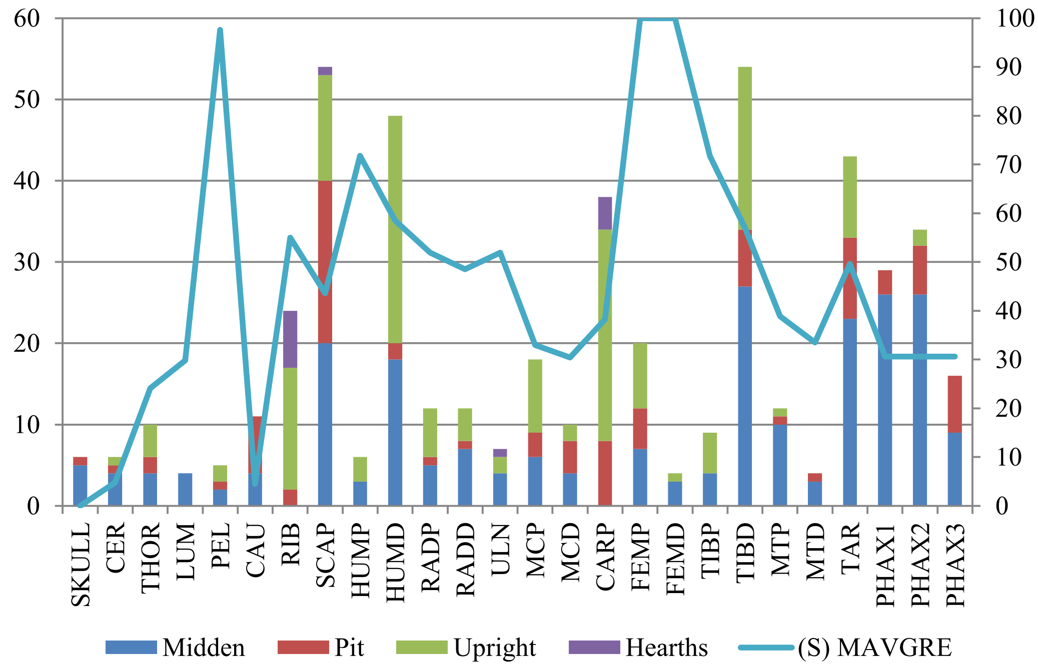

Figure 6.31: Feature type MNE compared to Emerson's (1990) grease indices.

The abundance of low utility elements in the Stelzer faunal assemblage is more typical of a primary butchery location, like a bison kill site rather than a camp. This interpretation is further demonstrated by several articulated or partially articulated bison elements; Features 2, 8, 17, 23, 26, 27, 47, and 49 (see Appendix C.) all had articulated bison elements. This is a characteristic that is more common with a kill site, in which undesirable elements were discarded with minimum alteration and butchery. Similarly, a common characteristic of the Sonota Mounds is the inclusion of whole or articulated bison carcasses; the transportation of low utility and articulated elements would likely not occur unless the kill site was close by. To date, there are no contemporary kill sites known near the Stelzer site, and large communal kill sites are not common in the

Middle Missouri region (Cooper 2008). It is possible that the Sonota hunters engaged in a similar pedestrian hunting style to that described by Buffalo Bird Woman (Brink 2004; Wilson 1924), but this practice would not fully explain the strange element selection pattern appearing at the site, or the inclusion of whole articulated bison skeletons into the Sonota burial mounds. In the excursion described by Buffalo Bird Woman, the hunting party were gone for roughly three weeks, and only returned with the best meat portions of the animals (Brink 2004; Wilson 1924). This type of behaviour if practiced at Stelzer would not produce the abundance low utility elements or the volume of faunal material seen. There should be a nearby kill site that has yet to be uncovered.

Summary

The Stelzer site is a large Sonota occupation, covering approximately 220 000 m^2 along the upper terrace of the Missouri River Valley. It produced a large assemblage of broadly side-notched projectile points, an abundance of scrapers, and a wide range of other stone tools largely made from KRF. The ceramics from the site are consistent with Middle Woodland traditions, and indicate a relationship with cultures further east and south, like Havana Hopewell and Valley Phase. Contrary to Neuman's (1975) original hypothesis that the site was occupied by small groups over a long period of time, radiocarbon dating demonstrated that the extremely dense Sonota occupation at the site occurred over a short period between 1705 and 1594 yrs cal BP, and likely resulted from a large occupation in association with the construction of nearby burial mounds. The distribution of artefacts within the site involved separate clusters of artefacts and features, with gendered work areas within each cluster. The separation between different concentrations of artefacts may be related to different groups occupying the site at the same time. A large number of upright features were uncovered at the site, the purpose of which will be explored subsequently.

Chapter 7 – Revisiting Besant and Sonota Era Bone Uprights

Bone uprights are one of the unique features that were found at both the Muhlbach and Stelzer sites. These features were enigmatic for both Gruhn (1969) and Neuman (1975), who corresponded with one another to try and understand the purpose of these features (records on file at the Royal Alberta Museum). Bone uprights were long noted by avocational archaeologists in the early 1900s (Kehoe and Swanson 1967:33), and they have continued to be found at an assortment of Besant and Sonota sites on the northern Plains. There is considerable variability in the appearance and contents of these features, and this variability has complicated the development of a single widely-accepted interpretation of bone upright features in the discipline. Several explanations concerning the purpose of uprights have been put forward, including proposals that they served as anvils (Gruhn 1969; Kehoe and Swanson 1967; Neuman 1975), posts (Foreman 2010; Frison 1971; Hjermstad 1996; Norris and Hamilton 2004), pegs or tie downs for structures (Brink and Dawe 1989; Heitzmann 1983; Wilson 1977), or had ceremonial significance (Bubel 2014; Foremen 2010). It has even been suggested that uprights formed when stampeding bison snapped off their front legs in pits (Kehoe and Swanson 1967:33). By examining uprights from the Stelzer and Muhlbach sites, and a review of a variety of sites on the northern Plains that exhibit these features, I will develop a model for interpreting these unusual features.

Upright Features

Upright features, alternatively called vertical bone features, bison bone upright features, or vertical upright features, are typically designated when bone is recovered in a vertical position relative to the occupation level of a site. As the majority of the bones at an archaeological site are deposited horizontally, these features stand out, positioned vertically in the occupation horizon. Part of the reason that no single definition has emerged to explain these features is that how the uprights are made varies between sites and between features. At the Fincastle site, the bones were pushed directly into the clay stratum beneath the eolian sand stratum in which the occupation occurred (Foreman 2010). In contrast, the uprights at the Ruby site (Frison 1971) and the Muhlbach site (Gruhn 1969) were placed into pre-existing holes. As will be demonstrated, uprights are more common where the subsurface sediment was saturated, but they can be found in drier contexts as well. Typically, upright features are found beneath the occupation horizon, extending into the sterile sediment below the site. The uprights at Fincastle (Foreman 2010) and Muhlbach (Gruhn 1969) were not encountered until the bone bed had been completely removed. This position suggests that upright features are formed prior to the large scale butchering activities at these sites.

Upright features are most common in Besant and Sonota sites on the northern Plains. Head-Smashed-In (Brink and Dawe 1989), Ruby (Frison 1971), Muhlbach (Gruhn 1969), Fincastle (Bubel 2014; Foremen 2010), Fitzgerald (Hjermstad 1996), Melhagen (Ramsey 1991), and Stelzer (Haberman and Travis 1995; Neuman 1975) all have Besant components with upright features. However, upright features are also found in other periods and places in North America. The Hokanson site (Norris and Hamilton 2004), the Stott site (Hamilton *et al.* 1981), and the Brockinton site (Syms 2014) are all Late Woodland sites with multiple upright features underneath the occupation horizon. At the La Sena Mammoth site in Nebraska, a heavily battered mammoth vertebra was found surrounded by flakes of bone and pushed into the original ground surface of the site. Holen (2006:41) interpreted this feature as an anvil used to strike flakes of bone off larger elements, and as evidence of tool manufacturing. So while uprights are often associated with Besant and Sonota, they are not a conclusive marker of the period.

Contents

To enable the development of interpretative models for upright features, a broad review of upright features and their contents was conducted. Included in this study are the contents and characteristics of upright features from the Stelzer site, Fincastle, Head-Smashed-In, Fitzgerald, Stott, and Muhlbach, as the upright features from these sites had sufficient documentation to allow comparisons between sites. This information will be supplemented with data from other sites, like Ruby and Brockinton, which had upright features, but were not adequately documented in the archaeological literature.

Of the 58 upright features from the Stelzer site, I examined the contents of 29 uprights, summarizing the MNE for each type of bone in the features in Figure 7.1, alongside the MNE for the pit, midden, and hearth features. As discussed in Chapter 6, there are significant collection biases for this site that influence the representation of different elements. Archaeologists tended to collect elements from uprights more often than other features. Ribs, for instance, are prevalent in upright features when compared with middens and pits, but excavators were not consistent with collecting this element from the other features at the site; the same can be said about the vertebrae. It is important to keep this fact in mind while interpreting the ratio of elements in upright features.

The uprights at the Stelzer site contain almost every skeletal element, but in varying ratios, dominated by ribs, scapulae, distal humeri, distal tibiae, tarsals, and carpals. Smaller in number are proximal humeri, proximal and distal radii, and the metapodials. Overall, scapulae, distal humeri, and distal tibiae are the most abundant bison elements of the sample available from the Stelzer site, not just in the upright features; this evidence suggests that their selection and placement into the upright features were based simply on their overall high frequency at the site.

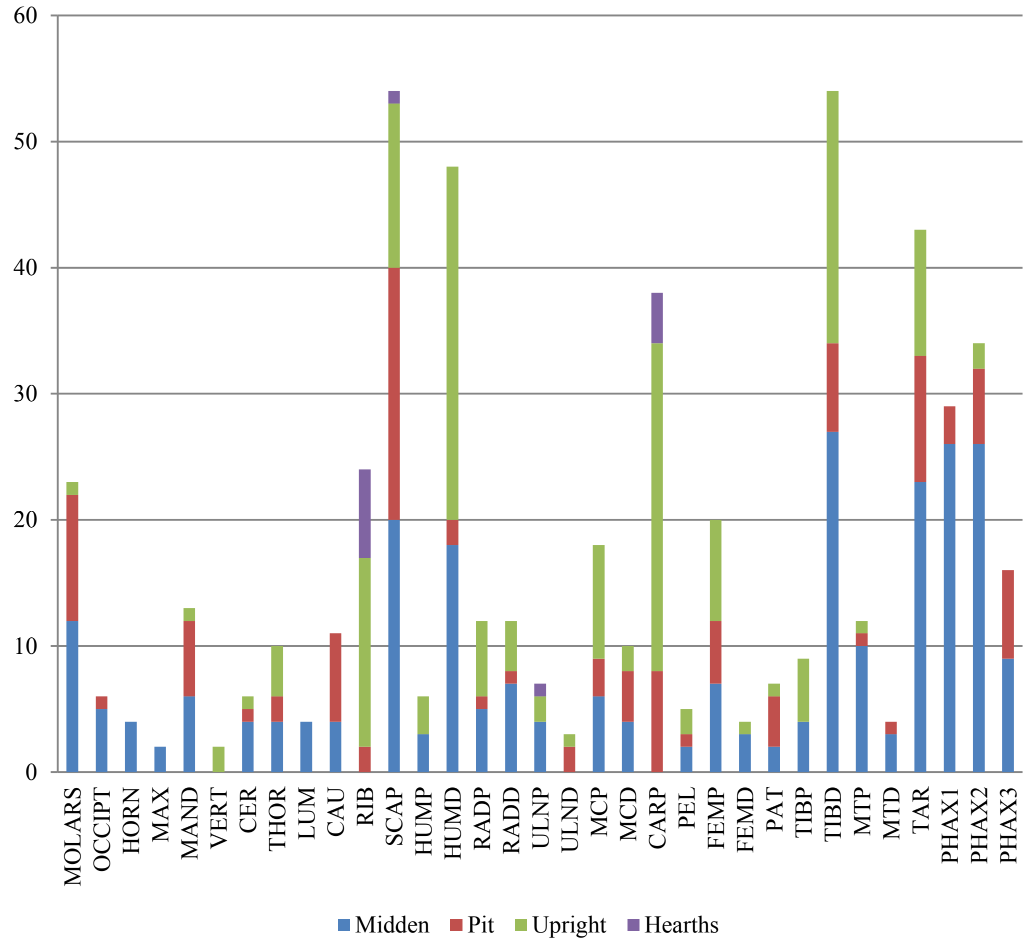

Figure 7.1: Bison MNE for Stelzer, divided by feature type.

At the Stelzer site, most of the elements in the uprights were separated, but some features had articulated limb segments. Excavators reported that Features 8, 23, 26, and 27 had articulated bison limb bones inside the upright feature. Feature 8 contained tightly packed bison bone with some articulated elements, but the field records do not indicate what elements were present. Feature 23 had an articulated distal tibia and astragalus near the base of the upright (Appendix A, Figures A.29-31). Feature 26 contained 16 bison limb bones and ribs, placed into a previously existing pit. Some of the limb bones were articulated, but it is not clear what elements were in the upright. Feature 27 was coated in wood glue and removed as a unit (Neuman 1975:Plate 4). This upright contained a variety of tightly packed humeri, radii, and other bison elements. At least three of the elements in this upright articulated with bone fragments overlying the feature. The presence of articulated elements in the uprights suggests that these elements were placed into the feature while there was remaining connective tissue on the bone.

Unlike other sites, the top of the uprights from Stelzer extend a few centimeters into the occupation layer. This trait means that the uprights at Stelzer would have been visible during the occupation rather than buried like uprights at other sites. With Feature 27, the articulated elements at the top would have likely been erect in the air until the connective tissues decomposed. The tops of other upright features would have been noticeable as well. The articulated elements in the uprights also indicate that these features were being created using fresh bone from the occupation rather than scavenging old bone.

The upright sample from Fincastle is smaller than Stelzer, as there were only eight upright features found at the site (Foreman 2010; Varsakis 2006). The contents of the Fincastle upright features are summarized in Figure 7.2. Like the Stelzer site, there is a broad representation of skeletal elements. The Fincastle uprights have mandibles, maxillae, ribs, scapulae, radii, and metapodial elements, as well as some carpals and phalanges. Unlike the Stelzer site, the uprights at Fincastle are dominated by complete and near-complete mandibles and whole scapulae rather than distal tibiae and humeri. The selection of elements in the Fincastle uprights still seems to be dictated by overall abundance. There are at least 87 mandibles and 59 scapulae recovered from the Fincastle site, which comprise 74 and 50 of the %MAU respectively (Bubel 2014). These elements are abundant at the site in overall number, and in their proportional representation relative to the %MAU from the site. Foreman (2010:134) noted that the complete mandibles were all found in one area of the site, near the Feature 7 upright that contained four complete mandibles and a distal tibia. The other limb bones from the site occur in relatively high numbers as well. The smaller number of these limb elements in the uprights could be a bias from the smaller sample. Carpal and tarsal elements appeared in smaller quantities as well. All the carpals came from Feature 8, and were found in a tight cluster at the bottom of the feature alongside a distal radius fragment (Foreman 2010:54). The association between elements suggests that there still was connective tissue joining the carpals to the radius, and that the upright was made using fresh bone.

Features 2, 3, 4, 5, 7, and 8 from Fincastle were found in the clay deposits underneath the eolian deposits, and are thought to have been pushed into the soft sediment during the occupation (Foreman 2010). Features 1 and 6 were narrow pits with sandy fill and jammed with bone. One of the more intriguing aspects of Fincastle was the vertically-oriented canid skull underneath Feature 1. This skull had been carefully removed from the rest of the skeleton and placed at the bottom of a narrow pit, at which time upright elements were placed above it (Foreman 2010:131). Feature 6 is a pit dug into the clay and filled with at least 28 different elements. Most of the elements were in the upper portion of the feature, but the bottom of the upright had a complete scapula that was distally modified to form a sharp edge (Foreman 2010:134). Presumably, this sharp edge would have assisted with pushing the element into the soft clay.

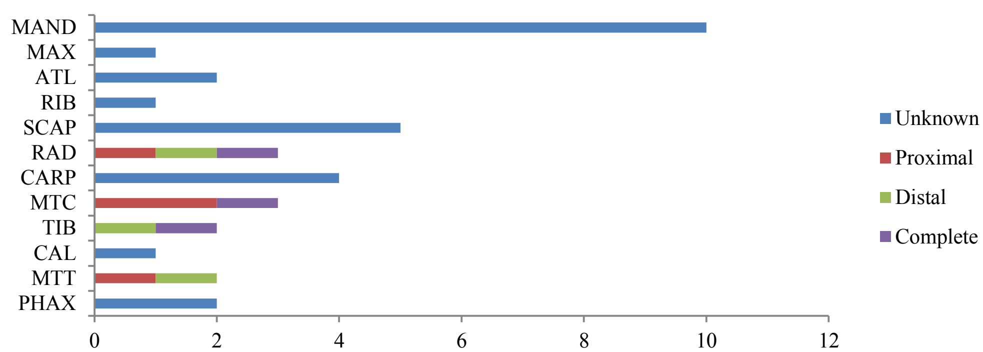

Figure 7.2: Upright contents from Fincastle, adapted from Foreman (2010) and Varsakis (2006).

The handful of upright features found at Head-Smashed-In exhibited a variety of characteristics, ranging from single elements to multiple bone uprights. The contents of uprights from the site are summarized in Figure 7.3 by element portion, and Figure 7.4 by carcass portion. Again, the sample of uprights and overall count of bone is low. The uprights here tended to have distal portions, like Stelzer, but complete scapulae remain abundant. The uprights with a handful of elements were typically driven into the sediment, while larger uprights (over 10 elements per feature) were placed into existing pits. It has been noted by several researchers that the sediment at Head-Smashed-In is extremely hard-packed and difficult to excavate (Brink *et al.* 1985; Brink and Dawe 1989), and the characteristics of the upright features reflect this situation. For example, Feature 23-2 was a single thoracic vertebra spinous process that had been sharpened distally and driven vertically into the hard-packed sediment at a slight angle (Brink *et al.* 1985:55). Feature 85-7 contained two scapulae, 2 metapodials, and a radius that had been pounded into the soil (Brink and Dawe 1989:36). Feature 26-1 contained 30 bison bone elements that had been tightly jammed into a rodent burrow (Brink *et al.* 1985:62). Unfortunately there is not much information about the contents of this feature, but all of the phalanges, carpals, and tarsals in the Head-Smashed-In upright faunal remains were recovered from Feature 26-1. These smaller elements were likely included as packing and stuffing around the larger limb bones (Brink *et al.* 1985:62). The point is that the uprights at Head-Smashed-In were not pushed into soft sediment like Muhlbach or Fincastle, but rather driven into the ground or placed into existing pits.

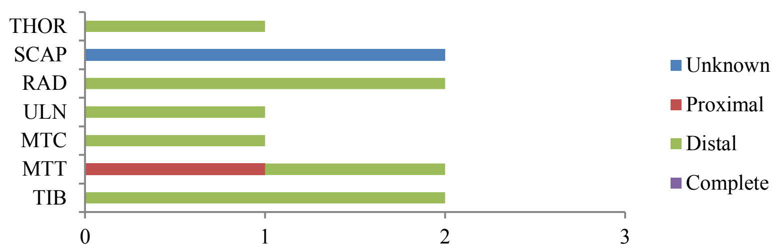

Figure 7.3: Uprights from Head-Smashed-In, by portion, adapted from Brink *et al.* (1985) and Brink and Dawe (1989).

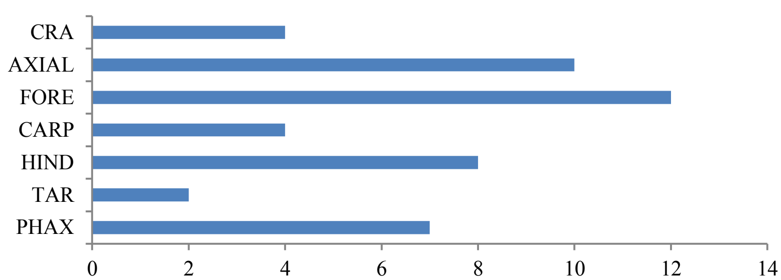

Figure 7.4: Contents of uprights from Head-Smashed-In, by skeleton portion including Feature 26-1, adapted from Brink *et al.* (1985) and Brink and Dawe (1989).

Additionally, several uprights were uncovered at the Fitzgerald site in Saskatchewan. The four uprights found in the kill area of the site consisted of only a handful of elements, but researchers found a larger upright with multiple bones in the processing area (Hjermstad 1996:90-93). This large upright was Feature 16, with several large long bone fragments and two thoracic vertebrae packed tightly into a posthole. Features 2, 5, 6, and 7 were under the bone bed, and each had a few elements jammed alongside or centimeters from a corresponding posthole feature. I summarized the contents of all the uprights in Figure 7.5, and while the sample is small there is still a broad representation of different elements, with the contents closely matching uprights at other sites. The smaller elements, such as carpals and phalanges, all come from the large multiple bone uprights, while the other smaller uprights with a handful of bones consisted only of larger whole elements.

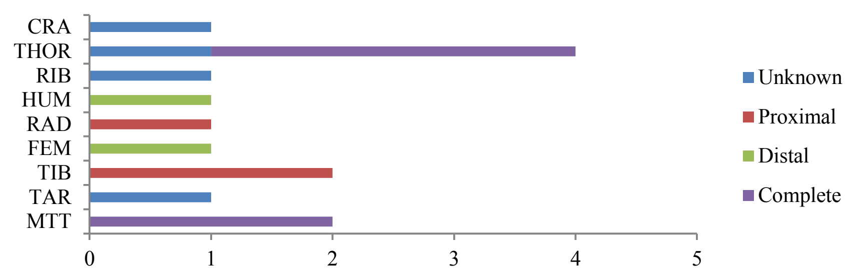

Figure 7.5: Upright features content and portions from Fitzgerald, adapted from Hjermstad (1996).

The Stott site is a Late Precontact Blackduck Phase site near Brandon, Manitoba, with a camp, bison kill, and burial mound nearby (Hamilton *et al.* 1981). Archaeologists found three upright features near several hearths and pit features at the processing and camp area of the site. I summarized the contents of these uprights in Figure 7.6. The most common elements in the uprights at the Stott site were complete or near-complete scapulae (Hamilton *et al.* 1981:44). Feature 1 had three complete scapulae and mandible fragments placed into a narrow pit. Feature 2 also had three complete scapulae along with a complete thoracic vertebra, but excavators did not observe a pit outline for this upright. All the scapulae in Feature 2 were set into the ground and oriented in the same direction at a slight slanting angle. Feature 3 was a narrow pit with a distal tibia and an unidentified long bone shaft fragment positioned vertically.

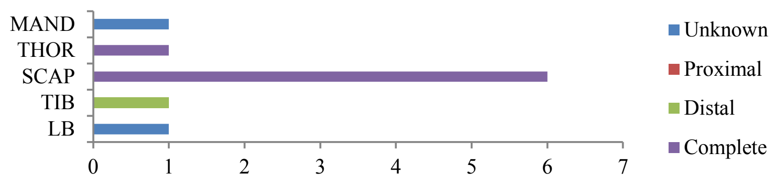

Figure 7.6: Contents of the Stott site upright (Adapted from Hamilton *et al.* 1981:44-45).

There were 12 upright features uncovered from the Muhlbach site. I summarized the contents of these features in Figure 7.7, and detailed descriptions of each can be found in Chapter 3. Archaeologists found the upright features 1, 4, 6, 7, and 17 along the walls of deep postholes filled with the black sand stratum. These features contained a wide variety of elements, including near-complete scapulae, whole radii, ribs, mandibles, pelvic fragments, and metapodials. Feature 6 had a large maxilla segment, two mandibles, an articulated segment of cervical and thoracic vertebrae, several ribs, long bones, and an assortment of carpal and tarsal elements. Feature 8 and 12 contained densely packed upright elements extending into the yellow sand stratum, although it is not clear if these features were filled with the black sand stratum or intruded into the yellow sand. The top of Feature 12 was in line with the top level of the bone bed, suggesting a different formation process than the uprights alongside the postholes. Feature 8 contained 19 bison elements jammed into a pit in the eastern trench at the site.

Features 2 and 9 were pushed into the yellow sand stratum underlying the bone bed, and consisted of only one or two elements each. Feature 2 had a shaft fragment of a right femur and an immature calcaneus, while Feature 9 had a mandible pushed into the yellow sand with the condyle oriented downward (Figure 3.23). Like Feature 12, the top of Feature 9 extended above the bone bed, and would have been exposed during the occupation. Feature 3 was a combination of a cervical vertebra, first phalanx, large rib fragment, a flat bone fragment, and a cobble. The archaeologist did not record the arrangement of these elements and the cobble, but it is similar to some of the uprights from Stelzer. The profiles of Features 5 and 10 are not recorded, but these features are likely similar to the postholes with upright bone along the walls. Feature 10 had two complete radii, a phalanx, two carpals, and an axis resting on top. This element is similar to Feature 6 from the Fincastle site, which had an atlas vertebra resting on the glenoid fossa of a scapula (Foreman 2010:51).

Like other sites, the Muhlbach uprights contain a wide representation of bison skeletal elements (Figure 7.7). Ribs are the most commonly used element, but mandibles, pelvis fragments, scapulae, radii, femora, tibiae, and metapodials are common as well. There does not appear to be intentional selection for elements incorporated into different uprights, as all the features contain a variety of different elements. The selection seems to be based on the overall abundance of elements at the site. Ribs, mandibles, and long bones occur frequently at the kill site.

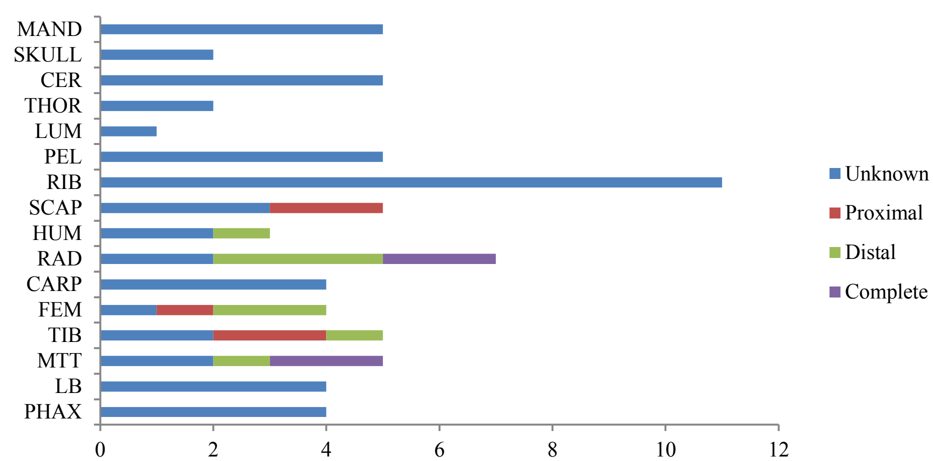

Figure 7.7: Upright contents from Muhlbach site by elements and portion.

Based on this sample of sites, the selection of elements in uprights appears to be dictated by two factors: overall abundance at the site, and size. At all the sites, selection of elements in uprights matches the frequency of elements in the faunal assemblage. The Fincastle uprights are dominated by mandibles and scapulae, two elements that are abundant relative to the overall faunal composition. The Stelzer site uprights are made of distal humeri and tibiae, two abundant elements at the site. Similarly, there is only one upright with a mandible from the Stelzer site (Feature 84), as mandibles are not common at the site. Overall, the abundance of different species in upright features is related to the representation of different species at the sites themselves. Bison are the most common species used to build upright features, likely connected to the dominance of this species in all the sites reviewed here. Other genera like canids or cervids are extremely rare at these sites compared to the NISP of bison. If abundance dictates the selection of elements going into uprights, the chances of another species entering an upright feature are extremely low.

Overall abundance at these sites is not the only determining factor for upright feature composition; otherwise, all uprights would be full of carpals, tarsals, phalanges, vertebrae, and ribs (although these elements do occur regularly). The size of the bone fragment seems to be an important variable. Complete and near complete mandibles, scapulae, radii, and metapodials are common in Fincastle, Muhlbach, and Fitzgerald uprights. The distal humeri and tibiae fragments from Stelzer are somewhat large fragments, usually comprising at least a third of the shaft. The rib fragments and thoracic vertebrae from all the sites tend to be either near-complete or at least longer than 10 centimeters. The only smaller elements in the uprights are the phalanges, carpal, and tarsal elements, and these elements usually occur either within a larger multi-bone upright as packing around other elements, or they were still articulated with a long bone element. The rarest portion in uprights is the skull, but when this element does appear, it is usually a tiny fragment or a large portion of the crania. For example, Feature 5 from Fincastle was a complete maxilla pushed nose-down into the clay (Foreman 2010:50).

It is interesting to consider where the bone in the uprights is coming from. Many researchers have assumed that since many of the upright features underlie the bone bed at kill sites, they were likely created before the kill and butchery event at the site occured. This conclusion means that they could be utilizing old bone on the surface or scavenging old kills to use as construction material, and that the bone in the uprights could predate the occupation. I dated several of the uprights from the Stelzer site to see if there was an age difference between the bone in other features and the uprights. As discussed in Chapter 4, all of the new radiocarbon dates from the Stelzer site fall between 1800 and 1550 cal years BP, and overlap at two standard deviations. In addition, the samples from uprights did not produce consistently older dates as compared to the other features from the site. This analysis suggests that the uprights were built using bone from recent kills, close to the period of occupation. Researchers have observed this trend at other sites. A metacarpal from one of the Fincastle uprights was dated (Feature 4), producing a date of 2490 ± 60 ^{14}C yrs BP (Beta-201910) (Foreman 2010:48), which falls within the pool of other dates from the Fincastle site (Foreman 2010:29). These results suggest that the bone used in these uprights was from localized camp activities, and not the result of scavenging old kills and bone on the surface.

Dating at the Hokanson site in Manitoba did produce a significantly older date in an upright feature (Norris and Hamilton 2004). This Blackduck/Avonlea site had a large kill site and processing camp in close proximity, with several upright features underlying both areas of the site. In the processing area XU4, two samples from a vertical bone feature produced a date of 966 ± 50 cal BP (TO-9771) and 1288 ± 80 cal BP (TO-9770) (Norris and Hamilton 2004:24). These samples do slightly overlap at two standard deviations, but it is unlikely these two bone fragments are the same age. The element that produced the older date was a bison distal radius that showed considerably more weathering than other specimens from the site (Freeman *et al.* 2006:477). The older element was likely scavenged and incorporated into the upright alongside younger elements. If element selection for uprights was based on overall site abundance and size, then eventually an older element would be placed with younger faunal remains due to random chance.

Function

Researchers have known for a long time about upright features in the archaeological record, but the circumstances around their formation and purpose have not been resolved. The several hypotheses for function all attempt to provide a blanket explanation for all upright features, or interpret only a few uprights on the intra-site level. The problem with interpreting uprights in this fashion is that these features likely had different functions depending on their context and formation. Uprights are generic vertically-positioned bone *by definition*, and this generic nature impedes accurate assessments of the different possible interpretations. I will review the various hypotheses for uprights with context-specific examples that would help to interpret different types of upright features, and develop a framework for future analytical efforts.

Accidental, Incidental, and Pragmatic

When initially musing about the vertically standing bones at the Boarding School site, Kehoe and Swanson (1967:34) suggested that these upright features could have been purely accidental, with the bones positioned vertically as the bone bed was trampled by animals. This action would push the bone downwards into the soft soil, giving the illusion of intentional placement by individuals. With the copious amount of bone at a kill site, one would expect that some bone was pushed down at an angle from the original surface as later animals trampled the site. These incidental occurrences of uprights would appear in randomly distributed patterns within the kill site.

The problem with this conclusion is that the orientation and selection of elements in some upright features appears to be to deliberate. There are single element uprights, but most examples are densely clustered bone positioned vertically in the soil. For example, Feature 7 at the Fincastle site exhibits deliberate selection and arrangement, and is unlikely to be accidental (Figure 7.8). Considering the size of the elements and how deeply below the occupation horizon they extend, these bones were intentionally placed by the occupants at the site. If the bone was driven into the ground by trampling, then there should be evidence of this taphonomic factor on the bone. The faunal remains from Muhlbach and Stelzer show few taphonomic indicators that trampling occurred at these sites. The faunal elements in these upright features are not crushed or broken, as one would expect if the site experienced heavy trampling, and they are densely packed into a small area. Therefore it seems unlikely that these examples could be incidental. One could use the same evidence against the suggestion that uprights formed from stampeding bison breaking their limbs off in pits, leaving their limbs standing upright in the ground. While there are articulated elements in some uprights, these features do not contain an entire lower limb in anatomical position.

Figure 7.8: Feature 7 from the Fincastle Site. (Foreman 2010:53).

Kehoe and Swanson (1967:34) also suggested that the bone was placed into rodent holes to clean up the area and mitigate any risk to pedestrian traffic. Brink and Dawe (1989:40) expanded upon this scenario at Head-Smashed-In, suggesting that children at the sites might have created the upright features. While excavating the Head-Smashed-In Buffalo Jump, they observed local children using FCR to fill the numerous rodent burrows around the site in order to drive the animals to the surface. Uprights at archaeological sites could result from children using bone for this purpose. They further postulated that the bone was stuck into existing holes at the site in order to reduce the risk of accidents from stepping into these holes. While this scenario is not by definition accidental, it is certainly more pragmatic than other scenarios. It should be easy to demonstrate this scenario in the archaeological record, as the bone upright features would appear at the tops of rodent burrows, with the burrow continuing away from the upright. This picture would be evident in the profile of these features, assuming that the original burrow has preserved.

From the sites reviewed, only one of the upright features appears to be in a burrow. At Head-Smashed-In, Feature 22-3 was a concentration of vertical bone in what was determined to be a rodent burrow (Brink and Dawe 1989). The majority of the other upright features were placed into existing pits, which tapered out at the bottom. Still, this one occurance does not demonstrate that Feature 22-3 from Head-Smashed-In was accidental, as the site was riddled with rodent burrows. Animals commonly gnaw on the bones for calcium (O'Connor 2000). In this case the rodents could have burrowed underneath the upright after it was in place, to access the bone for calcium. Unless we can demonstrate contemporaneity for the formation of the burrow and the upright, it will not be clear if the upright was purposeful, incidental, or accidental. This is a factor to keep in mind while interpreting other upright features.

Anvils for Breaking Bone and Working Cores

Both Kehoe and Swanson (1967) and Neuman (1975) put forward the anvil hypothesis for upright features. In his analysis of the upright features from the Stelzer site, Neuman (1975:31-32) concluded that the uprights were being used as anvils to work stone cores and faunal remains. He pointed to Features 23, 25, 33A, 54, and 57 from the Stelzer site as examples, noting the densely packed bone with the articular surfaces rising up slightly into the occupation horizon. Neuman (1975:32) thought that the articular heads would make a useful platform to work cores, or on which to smash bone for marrow. He drew comparisons from Paleolithic sites in Europe, where researchers had concluded from microscopic analysis that vertically positioned mammoth bones were used during pressure flaking (Neuman 1975:33; Semenov 1964). Kehoe and Swanson (1967:34) made similar allusion to the Paleolithic record in discussing the uprights at the Boarding School site, stating that the broad flat distal end of a vertical humerus would make a fine flaking anvil.

If the uprights were used as anvils, there should be damage on the exposed articular portions of the uprights. At the Stelzer site, there was no evidence of trauma to the articular portions, but Neuman (1975:32) suggested that wrapping the top of the upright with hide would prevent any damage from impact. This interpretation seems unlikely, as the hide wrapping on the uprights would not be sufficient to shield the bone from impact. Repeated use of the articular surface would break off flakes of bone, and obliterate the exposed portions of the element. A review of the bone from the Stelzer upright features found only one element that had evidence of blunt force or crushing on the articular surface. This element was the head of a bison femur, an unlikely candidate for an anvil; the alteration likely originated from the initial butchery of the animal to remove the femur from the acetabulum (Watts 2008).

It is unlikely that the Stelzer uprights would have been used like the Paleolithic examples, but there is a different perspective on uprights that is still related to their use as anvils. Some of the anvil uprights Neuman listed from the

Stelzer site had cobbles in the centre of the feature, specifically Features 23, 25, 39, and 54. Feature 23 is an upright feature that measures 30.48 cm long by 24.38 cm wide by 6.91 cm deep (Figure 7.9). Sixteen articulated bison long bones and some additional fragments were used to form a 12.19 cm wide empty ring in the centre of the feature. This upright was in close association with Feature 22, a large irregularly shaped midden filled with highly fragmented bone. Neuman (1975) proposed that a cobble could have been placed in the centre of the upright feature, but it was removed. Feature 25 is an upright feature with a quartzite cobble in the centre (Figure 7.10). This feature measured 25.91 cm long by 13.72 cm wide and 18.90 cm deep. Four bison long bones were tightly packed around a quartzite cobble, and were surrounded by a fill of charred bone fragments, charcoal flecks, and a quartzite flake.

Figure 7.9: Feature 23 from the Stelzer Site, view north. The midden, Feature 22, is visible in the bottom left of the photograph. Courtesy of the South Dakota State Historical Society.

Figure 7.10: Feature 25 from the Stelzer Site, view northwest. Courtesy of the South Dakota State Historical Society.

Feature 39 was an upright feature with two stones in the centre of the feature (Figure 7.11), measuring 21.34 cm long by 12.19 cm wide and 45.72 cm deep. The feature contained two small cobbles surrounded by vertical bison long bone, with bone fragments, flecks of charcoal, and burnt bone at the bottom of the feature. Feature 54 was an upright feature with a granitic cobble in the centre. It measured 24.38 cm long by 21.34 cm wide and 21.34 cm deep, and had a fill of dark brown sediment, broken and burnt bone, FCR, and charcoal. The bones were set into the original occupation surface in a rough triangle arrangement with a granitic cobble in the centre.

Figure 7.11: Feature 39 in cross-section, view north. Courtesy of the South Dakota State Historical Society.

These features could still be anvils, but not as Neuman envisioned. The cobble could be used as the anvil platform instead of the articular surfaces of the bone. The bone would have been placed upon the cobble anvil and smashed open with a hammerstone to extract the marrow. This set-up would work under normal circumstances, but sediments at the Stelzer site were described as clayey and gumbo-like (Neuman 1975:6). If wet, this sediment would become a sticky soft surface, and repeated blows to the top of an anvil would drive the cobble down into the sediment. To correct this problem, spare long bone could be jammed around the anvil in a ring to give additional support (Figure 7.12). This practice would keep the working surface of the anvil exposed and functional.

In addition, if the cobble was unsteady or uneven, bone could be used to support the sides of the cobble and provide stability. At the Boarding School site in Montana, a rounded boulder measuring 24.38 cm by 12.19 cm was found with three vertical long bones along the sides (Kehoe and Swanson 1967:32). There was a long bone element on the east, west, and south sides of the boulder, and the authors stated that the boulder would not have stood upright without the bone braces. An arrangment like this could function as an anvil for breaking open bone to extract the marrow, or to pulverize the bone for grease rendering.

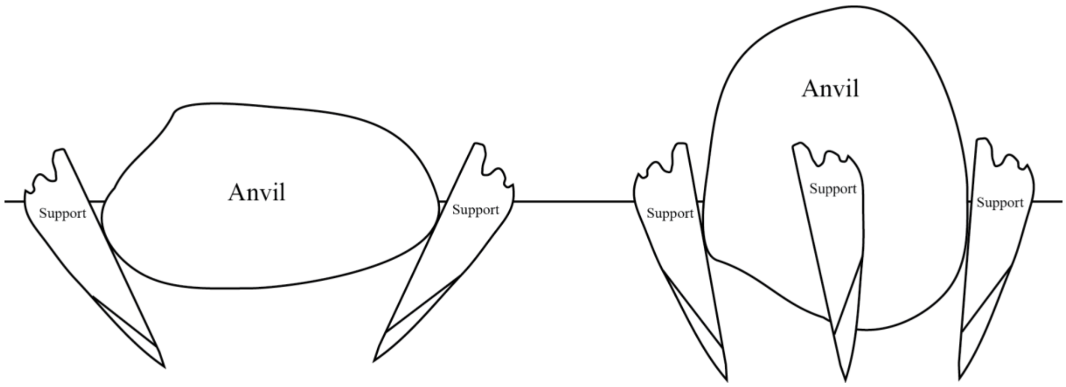

Figure 7.12: Schematic upright and anvil combination. The cobble is supported around the edge by upright elements set at an angle to the ground surface.

In the archaeological record, this arrangement would appear as an upright feature with a cobble at the top and a ring of vertically placed bone around it (Figure 7.12). Additional bone could be placed directly underneath the anvil to give further stability and support. The upright should also be wider than it is deep, as the emphasis is to get the upright bone lateral to the base of the anvil, and this placement will cause the feature to become wide relative to its depth. Finally, any evidence of battering or crushing should occur along the shaft of the long bone that is in contact with the anvil. Unfortunately, evidence of the latter characteristic would be difficult to separate from the flake scars and spiral fractures produced during the initial butchering of the animals.

An anvil upright should also have assoicated middens or pits filled with comminuted bone. Right next to the upright Feature 23 is the pit feature, Feature 22. This irregularly shaped pit measured 124.97 cm long by 91.44 cm wide and 9.14 cm deep. It was filled with highly fragmented large mammal ribs and long bones, as well as several pieces of presumably fire-cracked quartzite. Figure 7.14 shows the close association of this pit feature and the Feature 23 upright feature, as well as a pile of cobbles that could have been used as an anvil. The shape of the pit and the association with the anvil suggests that this was a processing area in which long bones were cracked open for marrow and thrown into the pit for disposal. Feature 39 also has large midden deposits associated with it. Interestingly, all of the anvil upright features discussed from the Stelzer site are found in one area of the site (Figure 7.13). While not all the uprights reviewed have middens associated with them, their proximity to one another does indicate a bone-processing work area.

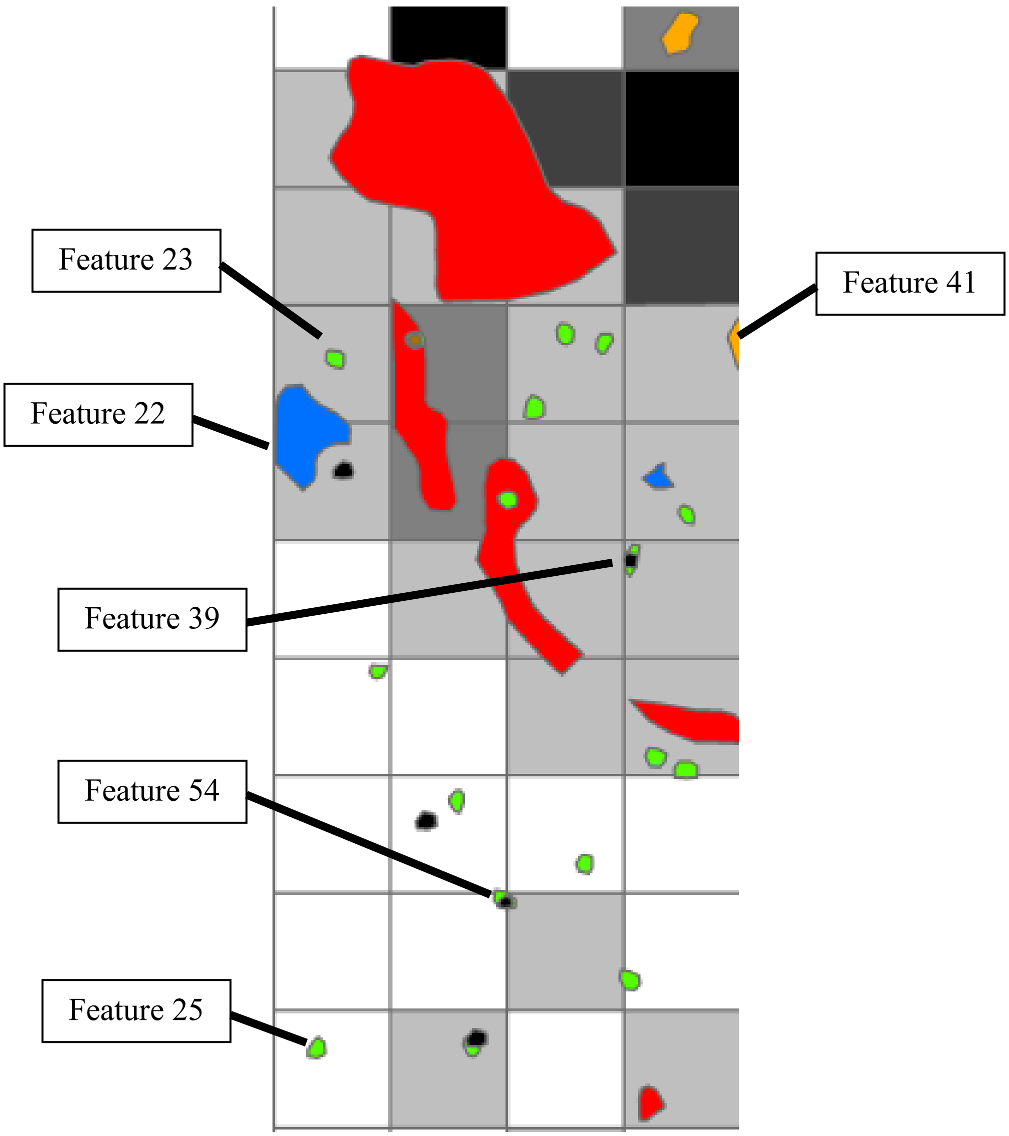

Figure 7.13: Location of anvil uprights from Stelzer. There are also several clusters of cobbles (Black) and uprights (Green) from this area, as well as hearths (Orange), middens (Red), and pits (Blue).

Figure 7.14: Feature 22 (pit) and Feature 23 (upright) in background. The pile of cobbles in foreground was likely used as anvils. Courtesy of John Brumley.

Similar types of uprights can be seen at the Muhlbach site (Figure 7.15). Site records described Feature 3 as a four-bone upright with a large rock. It is not clear what the arrangement was, but it is similar to the anvil uprights at Stelzer. Feature 3 is decidedly different compared to the other upright features from the Muhlbach site. Feature 18 contained several cobbles surrounded by bone flakes, suggesting that the cobbles were used as an anvil to break up the bone. Both of these features were adjacent to the small Feature 13 hearth. Overall, the bone density between these three features is low when compared to the rest of the Muhlbach site; it is on the edge of the arc of bone through the site. It appears that this was a work area for processing the bison carcasses after the kill, with a small hearth for either cooking or simply making a smudge to keep the insects away.

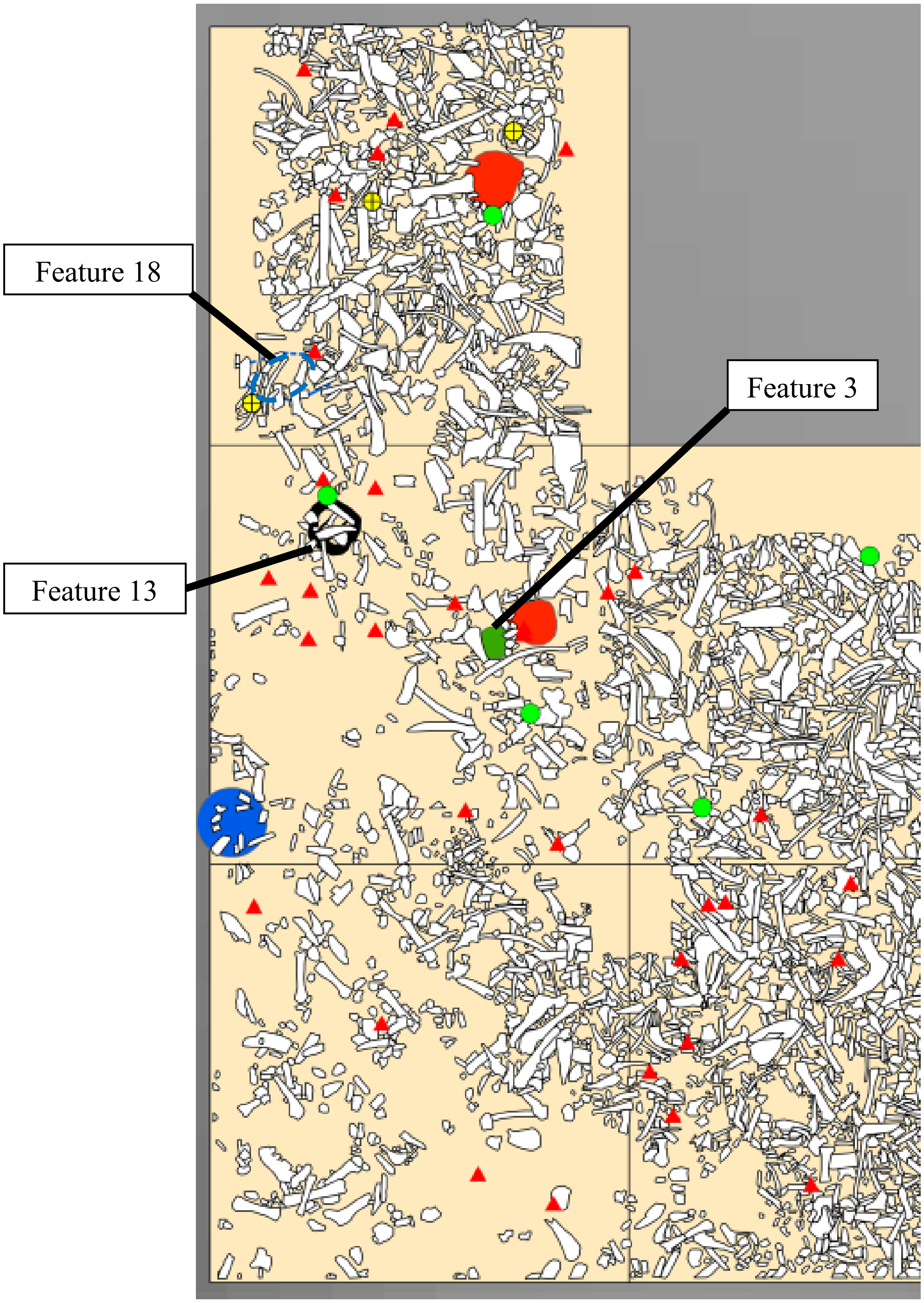

Figure 7.15: Proposed upright anvils and work area at the Muhlbach site.

Postholes and Shims

One of the most popular hypotheses regarding uprights is that they are from posts. This idea originated from interpretation of the Ruby site, a Besant bison pound in Wyoming. Frison (1971) uncovered an extensive series of postholes around a dense bison bone bed, forming an encircling pound structure with part of a drive lane. East of the drive lane there was an ellipsoidal posthole structure with preserved juniper timber and several bison skulls (Figure 7.16). This site provides one of the best examples of a Precontact pound structure in the archaeological record. While he did not identify them as uprights, Frison (1971:80) noted that many of the postholes had a variety of bison bones and flat stones along the walls of the features. He postulated that the posts had been tightened by pushing bison scapulae, mandibles, ribs, humeri, and other long bones alongside the posts to give added stability. Bison pounds would often be built from posts and a latticework of wood between each post, or a double row of posts with timber wedged between (Verbicky-Todd 1984). Two wings would run out from the mouth of the pound, and these fences would be used to control the animals inside the drive lane until they reached the pound. The pound walls did not need to be strong enough to stop a bison; just solid enough to hide any gaps that the animals might perceive as an opening. If the bison could see a hole, they would attempt to break out through the fence. Building a sturdy wall would be an integral part of making the pound, and shimming up the posts would ensure that the wall would not collapse during use.

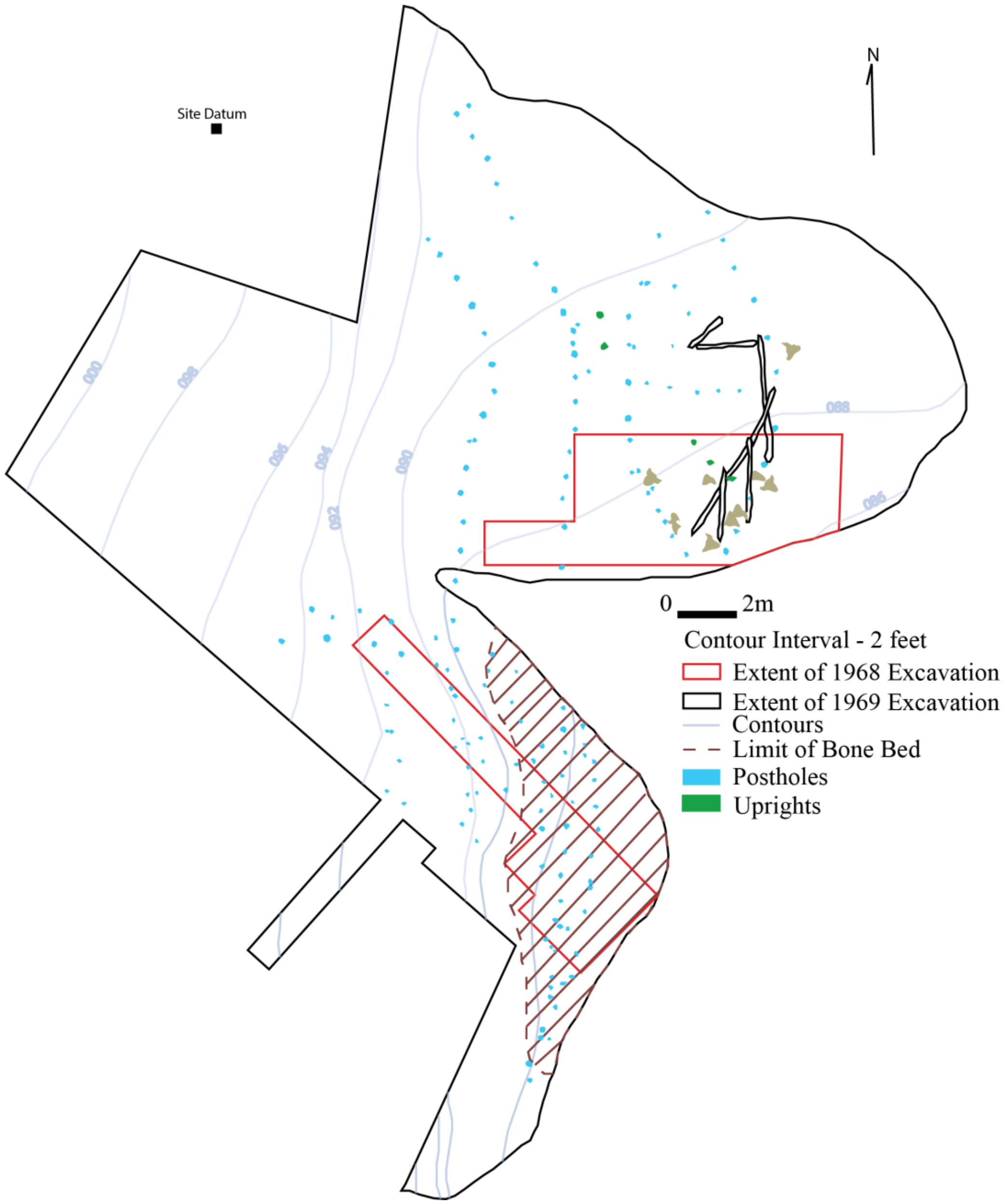

Figure 7.16: Ruby site excavations with associated features, with the uprights marked in green (Adapted from Frison 1971:78)

Researchers have noted similar upright features at other sites as well. The Muhlbach site has several upright features that are in existing postholes, such as Features 1, 4, 6, 7, and 17. All of these features have bison bone positioned vertically along one side of a deep straight wall pit. These pits are filled with the black sand stratum from the bone bed, and are intrusive into the yellow sand stratum underneath. All of these features are found in the main trench, forming two parallel lines running in a northwesterly direction (Figure 7.17). This pattern is similar to the arrangement of postholes at the Ruby site (Figure 7.16). These two rows could be part of the wall of the pound or a section of a wing. At roughly two meters apart, these features are not close enough to form a single fence made of double posts. These double rows of postholes and uprights likely represent two separate building events, or a repair in the wall of the pound.

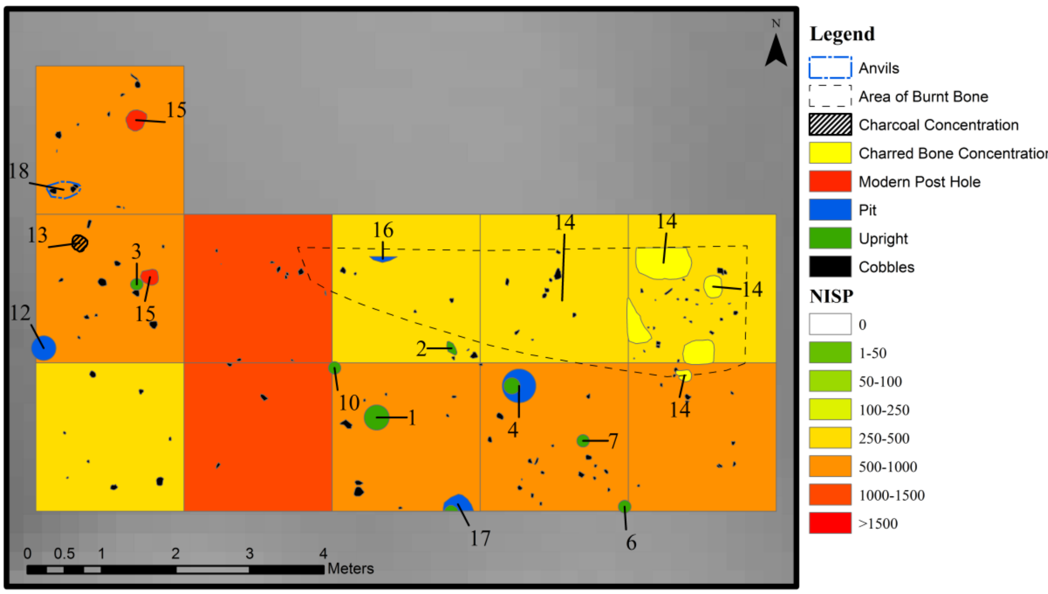

Figure 7.17: Features from the main trench at Muhlbach. Note the two rows of uprights/pit features running northwesterly through the units.

At Stelzer, Features 33A and 57 are postholes with upright animal bone alongside the walls of the feature. Feature 33A is an upright feature found underlying the northern portion of the Feature 33 midden deposit. This feature is in the northern portion of the midden, and measures 24.38 cm long by 15.24 cm wide and 30.48 cm deep. The upright is comprised of seven long bone elements packed around a visible post mold. The base of the post mold is deeper than the bottom of the bone uprights, suggesting that bone was placed around the post after it was erected. Feature 57 was a post mold with two bison ribs and a rock placed vertically along the north wall of the feature, with the rock between the two ribs along the wall. The inclusions in this post mold feature were likely placed alongside an existing post, acting as a shim to stabilize the structure. What these posts would be part of at the site is not clear.

Archaeologists have also found the upright shims in burial mounds. The Elliot Village site in Manitoba is a Late Precontact campsite with some associated burial mound complexes that W. B. Nickerson excavated in the early 1900s (Capes 1963:17). Of interest from this work is the Burial Mound H at the Elliot Village site, in which he uncovered a stake with a bison vertebra pushed alongside of it (Capes 1963:17). Figure 7.18 shows a map of Burial Mound H, with the stake and vertebra near the centre of the burial mound, next to a human humerus and several other artefacts.

The interpretation for uprights used with posts appears to be a clear-cut case for function, but not every upright feature has space for a post. In the ceremonial structure to the east of the drive lane, Frison (1971:85) noted several upright features that were tightly packed with thoracic vertebrae, leaving no space for a post or stake. Foreman (2010:132) also notes a similar pattern at the Fincastle site, as well as at several other sites, including Head-Smashed-In, and the Fitzgerald site. Many of the upright features found at Stelzer were too tightly packed to allow for a stake or post to be inserted into them, yet this arrangement does not necessarily mean that a post was not used with these upright features. Foreman (2010:137) stated that in scenarios in which wood is a scarce resource, it would be necessary to reuse posts after the task was completed, meaning that the postholes could collapse and leave no evidence of the feature in homogeneous sediment. In this scenario, only the bone used to shim up the post would have been left behind. Furthermore, if the bone used to shim up the post was used only on one side of the posthole and the post was removed and/or the posthole did not preserve, the upright feature would appear as if it were too tightly packed for a post inside of the upright feature.

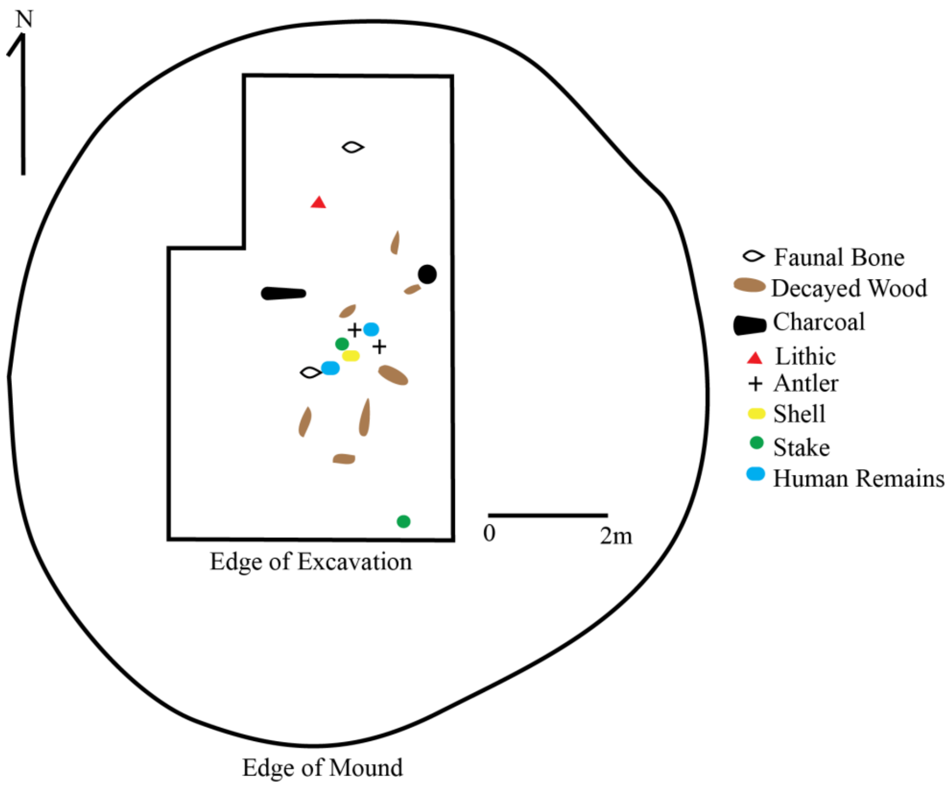

Figure 7.18: Burial Mound H from Elliot Village site in Manitoba. The upright vertebra and stake is indicated by the green circle near the centre of the mound (Adapted from Capes 1963:17).

Norris and Hamilton (2004) proposed a similar hypothesis at the Hokanson site, at which the uprights did not have space for a post, despite having a defined pit outline. The occupants of the Hokanson site might have removed the post for other uses such as fuel, although the authors questioned why the occupants would have felt the need to scavenge wood. The Hokanson site lies in the forested Parkland region of Manitoba (Norris and Hamilton 2004), as opposed to the open prairie around the Fincastle site (Foreman 2010). Readily available sources of timber would not be a concern in Manitoba; there would not be a need to scavenge the old wood from the pound. The scavenging of wood from a pound, even in well-timbered contexts, might be related to the difficulties of gathering enough wood of a suitable size. Stone axes have a notoriously low efficiency for cutting down trees (Mathieu and Meyer 1997:339), although this inefficiency could be mitigated by employing antler wedges (Cinq-Mars and Le Blanc 2008). In either case, building a pound would require a large amount of timber, and therefore a large energy and time investment into these materials. Straight long timber, suitable for use as posts, would have been a valuable resource, and likely would have been reused when possible rather than left to rot in the ground. This factor could explain why posts were removed even in well-timbered environments.

The use of uprights/posts at kill sites is more easily explained, but their application at campsites is less than certain. Most of the uprights at the Ruby, Muhlbach, Fincastle, and Fitzgerald sites are likely related to the building of the pound and any other structures associated with the kill. On the other hand, there are a variety of structures that would require posts at the processing camp, including drying racks for meat or upright hide stretchers. A drying rack needed to be sturdy in order to support the weight of the meat on it, and the posts would have needed to be shimmed up if the ground was soft. The same situation would be true for upright hide stretching frames; many of the hide processing stages required application of considerable physical strength that would put pressure on the hide stretching frame. These structures would have needed bracing in order to prevent them from falling over during use.

The difficulty in interpreting uprights in camps lies in the ability to associate different uprights with each other. There are 58 uprights at the Stelzer site that could be related to structures like drying racks or activities like hide tanning. The number of scrapers found at the Stelzer site clearly indicates that there was intensive hide processing occurring at the site, and it seems likely that there would have been a hide stretcher on the site. However, there is no discernible pattern for the distribution of uprights (see Figure 6.7). The distribution of uprights centered on the two activity areas at the site, near the other midden, pit, and hearth features. It appears that some uprights were used as supports for anvils during bone marrow extraction, and at least two upright features were used to shim up posts. The majority of the upright features defy easy categorization, being full of thickly packed bison bone. It is possible that at one time, all of the uprights had posts that either were removed or did not preserve, but it is equally likely that these uprights have some other unknown purpose.

Another issue with interpreting the uprights as posts is contemporaneity. Despite the Stelzer site having a short occupation, it is not possible to definitively associate uprights with one another and determine if they were part of the same structure. Several of the uprights from the Stelzer site do form straight lines, similar in dimension to a structure like a drying rack, but two uprights could have formed a few years apart and there would be no way to tell if they are related. Furthermore, there are tasks around camps that require the use of only a single post. The fleshing stage of hide processing would require a single short post over which to drape the wet hide (Aileen Reilly, personal communication 2014). This factor means that the uprights could have easily been for a single post structure, and not related to other upright or post features. This consideration complicates interpreting uprights in campsites.

If bone was being used to shim up a post, there are a couple of possible scenarios for how this practice would manifest in the archaeological record (Figure 7.19). The most obvious indicator would be an existing posthole or mold with bone positioned vertically along the wall. The bone could be clustered to one side of the posthole, or encircle the entire post. Alternatively, if the post was removed or did not preserve, the upright would appear as tightly clustered vertical bone, extending deep beneath the occupation layer. There may be a faint pit outline around the upright feature, but this feature may not be observed in every case. This type of upright should contain long and bulky elements, although smaller elements like phalanges would not be uncommon. The objective for building this type of feature is to pack bone into the side of the posthole in order to tighten up the post. Long complete elements like scapulae and mandibles would be the simplest, but several phalanges would suit the purpose just as well. In circumstances during which the post was removed or the posthole did not preserve, the upright elements could have a faint pit outline present, or simply no evidence of a pit. There may even be a cluster of upright elements spaced out in a small area, in which the post was removed and/or the hole did not preserve, but the upright elements that were placed around the post are still in place. Finally, how the original post was oriented will affect the placement of the elements in the upright. Long flat elements like scapulae, pelvic fragments, and mandibles should have been flush against the original wall.

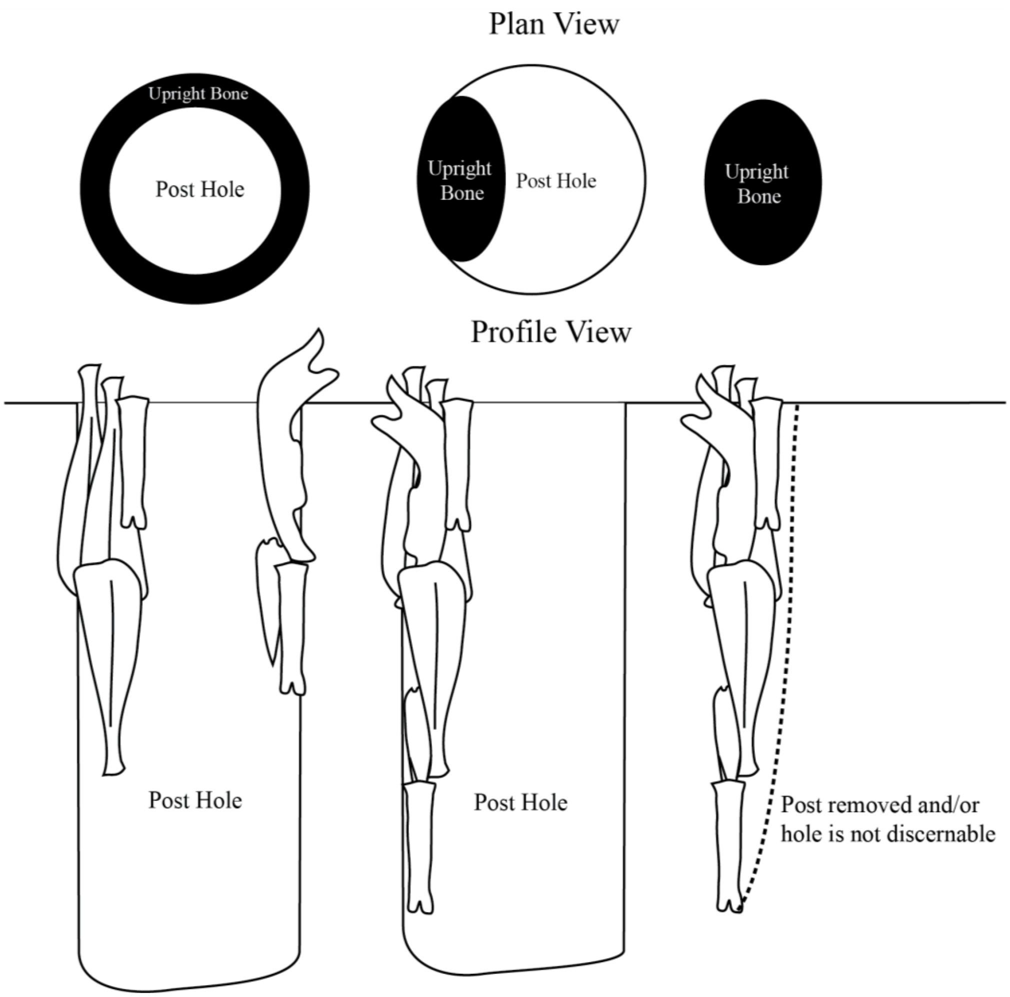

Figure 7.19: Schematic posthole and upright combinations. The bone would be positioned vertically along one wall of the posthole.

Filled-in-Postholes and Marking Space

There are instances in which a posthole is visible in profile, but has been completely filled in with vertically-oriented bone. Excavations at the Brockinton kill site in Manitoba found a series of postholes underlying that bone bed that had been jammed full of upright bison bone (Syms 2014). These postholes were initially from a pound structure, but then the posts had been removed from these holes and completely filled with bone when the occupants abandoned the site. This type of feature can be separated from upright bone that fell into a pit after the post decayed, as a clear pit outline can be delineated, and faunal elements in the pit were packed tightly into all available space in the pit. The Brockinton kill site had lightly butchered animals and was quickly abandoned (Syms 2014), a situation which raises the question as to why the occupants would bother removing the posts and filling them in with bone; I will return to this point further into the discussion.

Several of the uprights from the Stelzer site were also densely packed into pre-existing pits at the site. Feature 27 is a bone upright measuring 21.34 cm in diameter and 27.43 cm deep. The fill of this feature contained grey silt with a granitic stone, as well as articulated and isolated bison limb bone fragments. Three of the bison long bones on the west side of the feature were oriented vertically, and one element appeared to articulate with a lone bone fragment overlying the feature. Two other long bone fragments were similarly arranged, with an overlying articulating element. This feature was tightly packed with bone, but there was no evidence of a pit associated with it. The bone and stone inclusions around the feature suggest that the elements were placed into an existing hole, into which small bone and stone fragments fell. If the feature was created by bones pushed into the ground surface, there ought to be no inclusions around the feature. This possibility is demonstrated by the Fincastle uprights, in which the bone was pushed into the sterile clay beneath the occupation layer. These uprights lack the smaller skeletal elements that are present in uprights placed into existing pits. In this circumstance, the bone displaced the sediment, leaving no space for the small debris to fall around the feature.

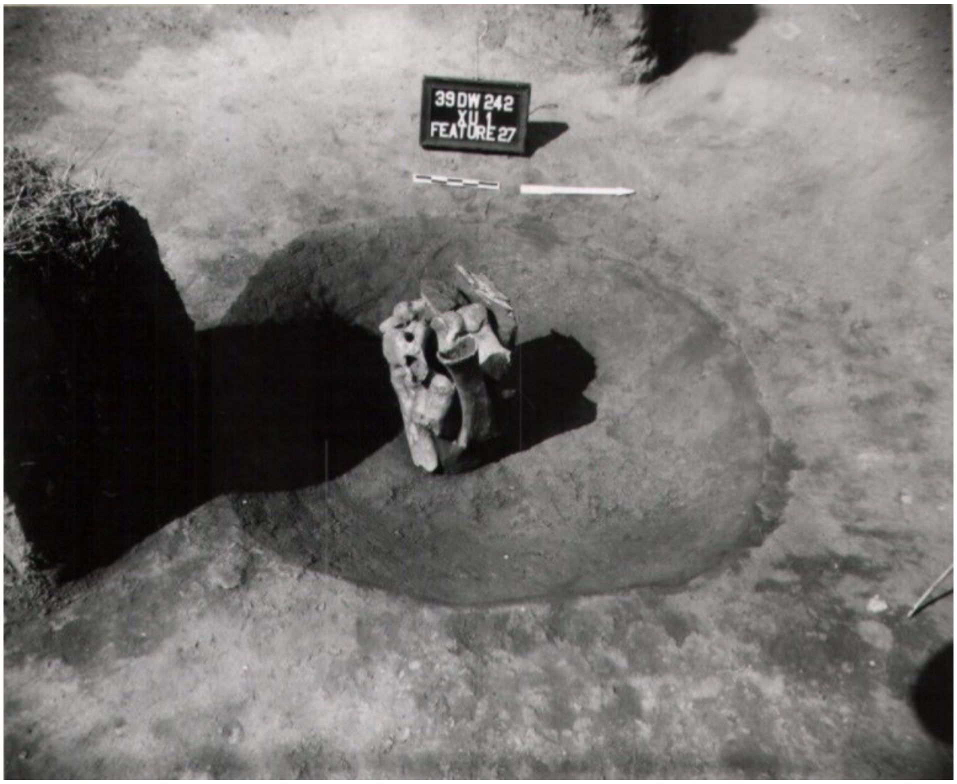

Figure 7.20: Feature 27 from the Stelzer site after pedestaling, view southwest. Photograph courtesy of the South Dakota State Historical Society.

The Ruby site also exhibited several upright features that had been packed into existing postholes. Frison (1971) identified several upright features near the ceremonial structure that contained exclusively complete vertebrae jammed into a posthole (Figure 7.21). One upright feature with four thoracic vertebrae completely filled the posthole. Another upright feature was made of an articulated cervical vertebral segment placed into a hole. Frison (1971:85) noted that neither of these uprights had space for a post. Feature 16 from the Fitzgerald site contained seven tightly packed bison elements in a posthole, leaving no room for a post (Hjermstad 1996:94). Many of the uprights from the Hokanson site were placed into postholes, the bone packed tightly into the feature (Norris and Hamilton 2004). Two of the uprights from the Stott site were placed into pits, completely filling the outline of the feature (Hamilton *et al.* 1981). Feature 12 from the Muhlbach site is a shallow pit packed full of upright bison elements.

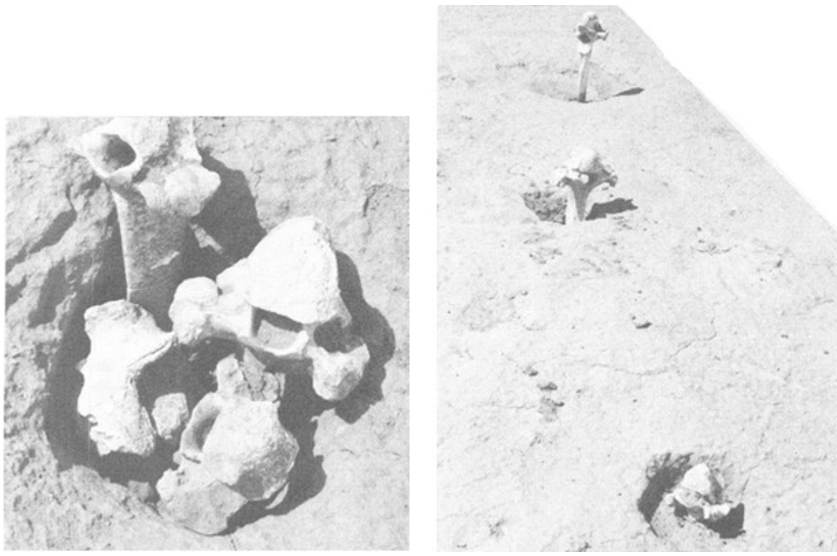

Figure 7.21: Thoracic vertebrae in post holes from the Ruby site. (Adapted from Frison 1971, Figure 3).

These multiple-bone uprights are common at sites, but their purpose is still very poorly understood. Munson (1984) suggested that these packed multiple-bone uprights could have been used as tie downs, stakes, or anchors for tipis. While some upright features could have functioned as tie downs or stakes, there is no logical explanation for why a pit packed full of vertical bone would serve better as a tie down location than a single element driven into the ground. The single thoracic vertebrae driven into the ground at the Ruby site (Figure 7.21) would be better as anchors for tying structures down than a densely packed upright like Feature 27 from the Stelzer site (Figure 7.20). This interpretation also does not address why the post would be removed from a kill site and the holes packed full of bone before abandoning the site.

An important variable to consider for these sites is the duration and frequency of occupation. Historical and ethnographic literature indicates that the large-scale communal hunting usually occurred annually in the fall and into the winter (Brink 2008; Verbicky-Todd 1984). Bison jumps and pounds would have been utilized during this time of year to obtain hides and prepare food stores for the winter (Malainey and Sherriff 1996), and these events would attract groups of people together. Large polyethnic, multilingual communities would have likely occupied sites such as Head-Smashed-In, and would have likely engaged in ceremonies, gambling, trade, marriage, and festivities (Brink and Dawe 1989). Participating in a communal hunt would be an important aspect of social life.

However, these kill sites were not used consistently every year. An excellent example of this inconsistency is the Vore site in the Black Hills, Wyoming. This site is a bison jump into which hunters drove herds of bison into a large sinkhole (Reher and Frison 1980). This site was used frequently, causing a buildup of bison bone at the bottom of the jump. After the jump was used, thinly laminated bands of sediment covered the top of the bone bed. Known as varves, these thin strata form annually in still bodies of water under a cyclical pattern affected by temperature and precipitation (Reher and Frison 1980:53). This cycle means that a distinct layer will form during the summer and winter, and it is possible to determine an accurate timeline for the frequency of bison kills at the site. Reher and Frison (1980:55) recorded 282 varves at the Vore site, indicating a 141 year period of deposition. Within this stratigraphic record, the authors determined that kills were occurring on average once every 25 years. During the initial occupation of the site, kills were spaced 34 years apart, and then every 11 years later in the occupation. By the late 1600s and 1700s there may have been continuous use of the jump site (Reher and Frison 1980:59).

While the tempo of bison kills did increase over time at the Vore site, this frequency of use does not match the annual communal bison hunting model until the historical record. Reher and Frison (1980:59) recognized the possibility that other kill locations could have been used in the intervening years, but they postulate that a band may have a productive kill only once every five to ten years, following cyclical peaks in grassland productivity. Ives (1990:327) and Fawcett (1987) both questioned this deterministic model, as the analysis of the varves demonstrated that were several peaks in precipitation that did not result in a kill. Fawcett (1987:210) proposed that the timing of communal bison kills was linked to socio-political issues, as a means to mitigate tension through redistribution of bison products, to gain prestige amongst several different groups, or occasionally to acquire excess goods for trade. Ives (1990:326-328) correlated the irregular, widely spaced pattern of kills unrelated to climatic changes at the Vore site with a local group growth model, in which communal hunts occurred when the local groups attain a population sufficient enough to carry out a communal hunt, as opposed to a local group alliance system in which different groups could aggregate regularly, meeting the population size required for a communal kill.

The factors that determined the frequency of kill events at Vore could have a bearing on the significance and use of uprights, but the important aspect from this discussion is the timing between kills. If kill sites were being used only once every 10 to 34 years, as the evidence at the Vore site suggests, an individual may have participated in only one or two events in a lifetime. There would have been relatively large gaps between occupations at a kill site, and this gap in time means that important aspects of how the kill site functioned could potentially be forgotten between visits. Driving bison into a trap requires a specialized knowledge of both animal behaviour and how to best utilize a landscape to entrap or trick the animals. There would be considerable time investment and planning around designing a pound, as well as significant trial and error to refine the workings of the kill site. Even if the site was used every five years, there are still demographic stochastic risks that could remove knowledge-carrying individuals from within a society who retain the specific details of how a certain pound was constructed and oriented. It would be important to mark these locations on the landscape to allay these problems.

Researchers have observed this marking at several large bison jump sites including Head-Smashed-In. Above the kill site at Head-Smashed-In are long lines made of small cairns running away from the cliff edge (Brink 2008). These lines of cairns form the drive lanes used to steer the bison towards the cliff. However, the cairns themselves are only markers; these small piles of stones indicate only where the “Dead Men” go. Descriptions of the “Dead Men” vary from piles of dung, to piled brush, or crossed sticks, but men, women, and children would hide behind them during a drive (Verbicky-Todd 1984). The people hiding behind the “Dead Men” would jump out when the bison herd was getting too close to escaping the drive lanes, although the animals sometimes did escape through these lines. Brink (2008) hypothesized that the piles of brush would create a tunnel effect for the running bison, giving the impression of a solid barrier. The stone cairns present at Head-Smashed-In site may have served as markers to assist the returning group in placing these “Dead Men”, as the precise placement of these visual obstacles assisted with driving the bison over the cliff; their placement could not be left to memory alone.

At pound sites like Brockinton, Muhlbach, and Fitzgerald, it would have been important to rebuild the pounds as close to the original successful design as possible to ensure the success of the kill. If a group does not return for several years or decades, they cannot rely on memory alone. Like the “Dead Men” at Head-Smashed-In, the postholes might have been filled with bison bone to mark where the corral was originally constructed. Bone is more resistant to decomposition than wood, and upon returning to the site, the occupants could empty the posthole of bone and put the new post in place. The postholes could have been filled in during the final occupation of a kill site, if the group intended to return to the location. Evidence of this practice can be seen at the Brockinton site. The faunal remains at the Brockinton site were lightly butchered and the site was quickly abandoned after the postholes were jammed full of bone (Syms 2014). In this instance the occupants likely planned to come back to the location for another communal kill, but for unknown reasons did not return.

If a post was removed and the hole was packed with bone, there should be several characteristics present in the feature. The bone in the upright would have been tightly packed into the feature, with a larger variety of elements. Smaller elements like loose carpals, tarsals, and phalanges would have been used as packing to completely fill the space left by the post. Additionally, not all of the elements would have been vertically positioned. The larger, more complete elements would fit only vertically into the posthole, but the smaller articular ends of limb bones could go in horizontally and vertically. For example, Feature 27 from the Stelzer site has several distal humeri elements positioned horizontally inside the feature. The other key characteristic is the presence of a pit around the upright feature. The pit may appear as a definitive feature, or it may only be a faint outline, but the shape of the pit should closely conform to the upright bone. Unfortunately, this possibility becomes difficult to separate from the upright shims scenario when the post was removed or the posthole did not preserve (Figure 7.22). Both of these scenarios will appear similar in the archaeological record, and are dependent upon the preservation of the pit feature to differentiate between the two of them. Fortunately, both types of upright features indicate that there was a post there and it is not necessary to split hairs.

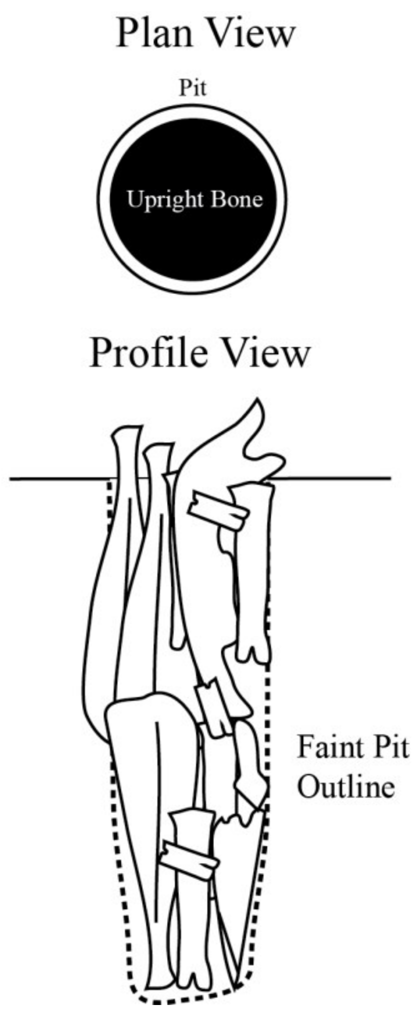

Figure 7.22: Schematic Plan and Profile view of packed-in posthole and upright feature.

Pegs, Tie Downs, and Stakes

Researchers have hypothesized that uprights might have been used as pegs or stakes. Munson (1984) suggested that the multiple bone uprights were used to secure a rope or a tie down. Brink and Dawe (1989) explored this possibility with the upright features uncovered in the camp area at the Head-Smashed-In site. Visible in many of the historical photographs, various types of stakes and pegs were used for tasks in a camp setting, including pinning down the edges of tipi covers, stretching hides, tying down dogs and horses, and as anchors for guy lines used to secure tipis (Brink and Dawe 1989:38-39). Typically, the stakes would be made of wood, but the authors pointed out that in a poorly timbered environment bone could have been used in lieu of wood for stakes (Brink and Dawe 1989:38). They also highlight how the hard ground at Head-Smashed-In caused wooden pegs to split while being driven into the ground, and that fresh bone would be an excellent alternative. This hypothesis fits well with single- or multiple-bone uprights driven into the ground, as these could have served as anchors. However, the tightly packed upright features with a large number of bones would not have functioned as anchors or stakes nearly as well; why use 17 elements when one bone would do? Pounding several long bones in a small area would not provide additional stability, but would rather loosen the sediment and the element that would be serving as an anchor for the rope. It seems that there is a strong functional restriction for this type of upright.

Brink and Dawe (1989:41) interpret Feature 85-7 from Head-Smashed-In as an anchor for a guy line. This upright measured 12 cm by 15 cm across, and extended from 20 to 45 cm below the surface. It contained two scapulae fragments, a distal metacarpal, a distal radius, and proximal metatarsal. The metatarsal had been longitudinally split, and researchers thought that this split occurred when the element was hammered into the ground (Brink and Dawe 1989:36). Shortt (1993:32) noted two ribs stuck vertically into the occupation surface at the Happy Valley Kill site, and proposed that they might have been used to secure hides draped over the pound fence. From the Muhlbach site, Features 2 and 9 were pushed into the yellow sand stratum underlying the black sand and the bone bed. Feature 9 was a mandible with the top extending above the bone bed.

Foreman (2010:132) proposed that Features 2 and 4 from the Fincastle site could have served as guy line anchors for drying racks. Feature 2 contained a metatarsal and radius fragments, and Feature 4 had two distal metacarpals. These two features had been pushed into the underlying clay stratum, as there was no evidence of any pit or inclusions around the uprights. Feature 7 from the Fincastle site could also be an anchor for a tie down. This feature contained a tibia and four near-complete mandibles arranged in an "X" pattern, all pushed into the clay (Figure 7.8). Foreman (2010:134) proposed that there might be a ceremonial connection with this upright feature because the selection and orientation of the mandibles was unique. The condyles on the deeply set mandibles in this feature could also have been used to anchor ropes, but demonstrating this interpretation would be difficult without any noticeable wear.

Upright bone could have been used to stake down the edges of stretched hides and tipis. Hides were usually stretched tightly over the ground using stakes, or on upright hide stretching frames (Brink 2008). The stakes would have been inserted into small holes along the edges of the hide and stretched until taut. If bone was used in lieu of wooden stakes, the presence of single bone uprights in a closely spaced regular pattern could indicate that the uprights were used for this purpose. This type of upright would be distinct from the other upright features. Multiple bone uprights could not be used to stake down tipi covers or hides, as they would create an enormous hole in the leather and waste material. Furthermore, this type of upright would be restricted to narrow elements like the spinous processes from vertebrae and the shafts of ribs. Elements like tibiae or humeri might have been used, but whole elements would create a larger hole in the leather, probably larger than what would be desired; linear long bone fragments or elements from younger animals could be employed, but their identification as stakes or pegs lies in their isolation from other upright elements.

One would expect that single bone uprights used to stake down material should be frequently found at campsites; as tipis would need to be pinned down around all the edges, and stretching hides would require several elements to pull the leather tight. However, this type of upright is not common in the archaeological record. Archaeologists have excavated many sites with stone circles, but very few have such pegs with the stone circles. One stone circle at EgOt-4 in Alberta had a bone peg (Heitzmann 1983); this site had two large stone circles, and one circle had a rib fragment set into the ground at an angle on the outside edge of the circle. The absence of bone pegs at archaeological sites could be attributed to the use of wooden stakes or stones instead of bone, but all three of these materials could have been used simultaneously on one structure (Heitzmann 1983). Another important variable explaining the absence of bone pegs at campsites is that these pegs would have been removed after use. When people moved their camp, they would have pulled these pegs out of the ground, and would have either carried them or discarded them on site. In addition, bone stakes used to stretch hides need to be pulled out of the ground when the hide was finished. This activity would reduce the number of stakes in the archaeological record.

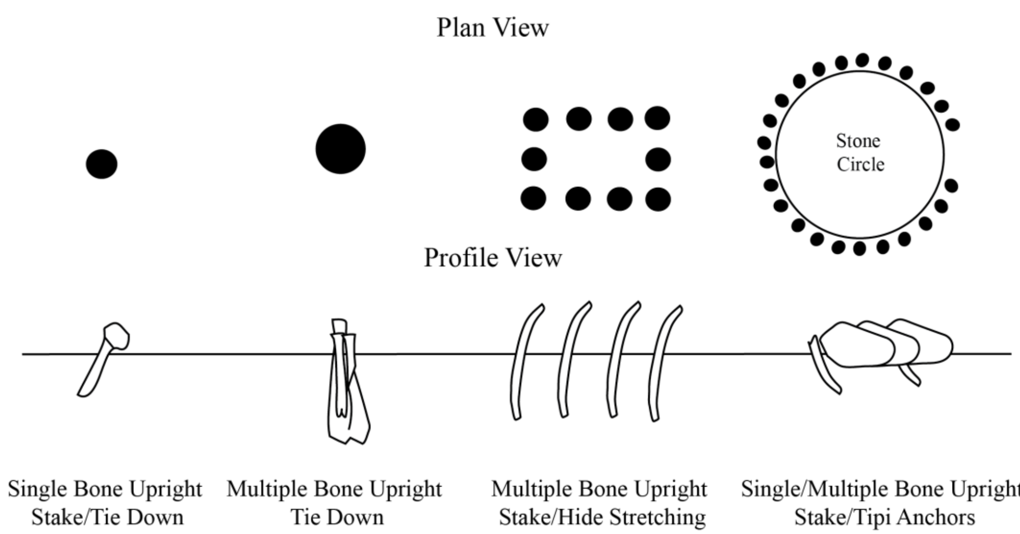

Figure 7.23: Schematic representation of different stake, peg, and tie down upright features.

There are a few characteristics that can be associated with stake and tie down upright features (Figure 7.23). Uprights used as tie downs or stakes should show evidence of being hammered into the ground, or of alteration to assist with this process. Many of the long bones in upright features have been fractured along the shaft, creating a sharp edge. In Feature 6 from the Fincastle site, a near-complete scapula was intentionally fractured on the distal end in order to create a sharp edge (Foreman 2010:52). Alternatively, the elements in the upright could be pushed into the ground if the sediment was soft enough. This type of upright should also be limited in size. Increasing the number of elements used will only weaken the foundation of the tie down, and using more than one element to stake down a segment along the edge of a hide will waste material. The type of element used should be an indication of whether the upright was used as a tie down. The upper portion of the upright elements should be larger than the lower sections. Tying a rope to an inverted thoracic vertebra would be more secure than a rib shaft fragment, as the rope would not be able to pull off as easily. Similarly, the articular ends of long bones would be thick enough to prevent the rope from slipping off. The top of the upright should be above the occupation surface at the site. A stake holding the edge of a lodge would not be effective if it was buried beneath the surface, out of reach. Tie downs might be buried in certain circumstances, if the upright was hammered into place after the rope was tied to the element. The largest difficulty with identifying a tie down upright would be determining if there was a rope present. Preservation at most northern Plains sites simply is too poor to find artefacts like rope. Without a well-understood spatial context of the features at a site, identifying an upright as a tie down is simply a best guess.

Ceremonial Uses

The final possible interpretation for upright features is that they are ceremonial in character. Foreman (2010) and Bubel (2014) alluded to this possibility at the Fincastle site, citing the arrangement of several upright features from the site. Furthermore, some uprights are associated with ceremonial structures. At the Elliot Village site in Manitoba there is an upright made of a single vertebra alongside a wooden stake at the centre of the burial mound floor (Capes 1963:17). Frison (1971) identified several uprights at the Ruby site near the ceremonial structure at the site. These uprights contained only complete thoracic vertebrae jammed into postholes, and were found outside of the elliptical ceremonial structure that also contained several complete bison skulls.

Probably the best candidate for a ceremonial upright is Feature 1 from the Fincastle site. Feature 1 was a narrow pit filled with vertically positioned bone and a downwards facing canid skull at the bottom of the feature (Foreman 2010:130). Excavators uncovered the feature in the western area of the site, in the centre of a two by two meter excavation unit. This upright feature is isolated from all the other uprights uncovered at the site. The presence of the inverted canid skull at the bottom of the upright feature is particularly interesting, as it is hard to explain as the result of functional or incidental actions. Based on absence of chop marks on the occipital region of the skull, the canid cranium was carefully removed from the rest of the axial skeleton (Foreman 2010:131). After the pit was dug, the skull was placed in the bottom and the bison bone was positioned vertically above it. This upright feature does not fit any of the other possible models previously discussed.

Foreman (2010) drew a comparison between the canid skull in the upright at Fincastle and a canid skull found in Mound 1 at the Boundary Mound site in North Dakota. Neuman (1975:66) reported a canid skull on the mound floor in a pile with numerous other bison skulls that were incorporated into the mound. Unfortunately, the plan maps of the Boundary mounds were lost after the excavation, so I am unable to determine the exact context of this skull, but the canid skull and the bison skulls were all aligned towards the same, unspecified direction. Field records indicate that in the same 5 foot unit as the canid skull was found, on the floor of the mound, excavators recovered a human metatarsal, a highly polished bone pendant with two spirally curving grooves carved into it, and approximately 110 bison bone fragments (Figure 7.24). Some of the 110 fragmentary faunal remains from this unit had been identified, and they included seven left and seven right maxillae, three occipital, three right and nine left horn cores, one right mandible, and 29 parietal fragments.

It appears that the canid skull from the Boundary Mound 1 was included with a pile of bison skulls on the mound floor, as well as human remains and at least one grave good. Excavators found this concentration directly northwest of the burial pit. Foreman (2010:131) compared the inclusion of the intact bison skulls in the burial mound and the canid skull, stating that if the bison skull was regarded as sacred, then the skulls of other animals may have been viewed similarly. The canid skull in the Boundary Mound 1 was clearly included in a ceremonial context, along with numerous bison skulls, burial goods, and human remains. There was no evidence of cut or chop marks on the occipital of the Boundary canid skull, suggesting that, like the Fincastle specimen, it was carefully removed from the axial skeleton.

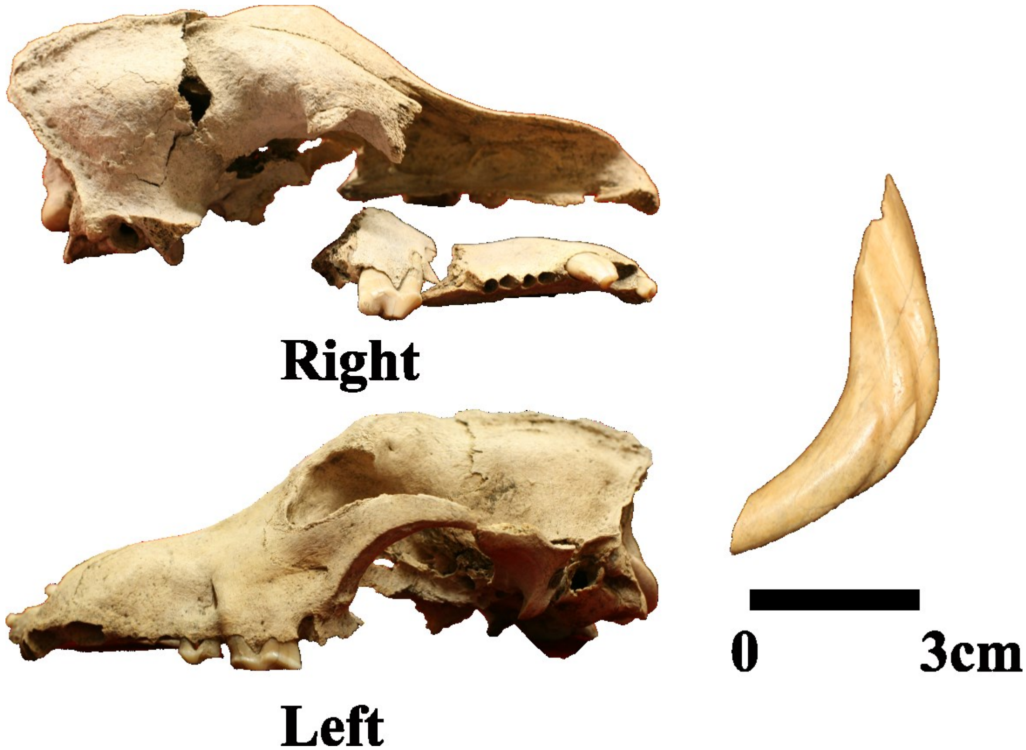

Figure 7.24: Dog skull from Boundary Mound 1, and bone pendant from same area. Scale reference is only for pendant.

Another possibility is that the inclusion of bison skulls in uprights may also indicate ceremonial activities. As previously discussed, whole bison skulls are relatively rare in kill sites, and are usually attributed to cultural or ceremonial purposes. Archaeologists have uncovered whole bison skulls in numerous ceremonial contexts at archaeological sites: there were several intact skulls in the ceremonial structure at the Ruby site (Frison 1971); a circle of inward-facing bison skulls was uncovered in the bone bed at the Vore site (Reher and Frison 1980); the Sonota burial mounds excavated by Neuman (1975) contained piles of bison skulls, as well as whole articulated bison skeletons, and bison skulls were often used as altars during ceremonies, like the Sun Dance (Verbicky-Todd 1984). Researchers found an archaeological example of this pattern in Manitoba, at the Crepeele site (Nicholson and Nicholson 2007). At this site, excavators found a painted inverted bison skull that had fired clay in the brain case and red ocher. A whole, or even partial bison skull placed vertically in the sediment could be indicative of some type of ceremonial activity.

On average, cranial elements in uprights are rare. When they do occur, the cranial elements tend to be small and highly fragmented, and likely were included incidentally with other small bone fragments. However, a few uprights had large skull fragments. Feature 5 from the Fincastle site contained a large portion of a bison maxilla, forced nose down into the clay stratum (Foreman 2010:133). This feature was underneath the densest area of the bone bed in the eastern excavation block. Feature 6 from the Muhlbach site also contained a large maxilla portion positioned vertically in the sediment, as well as a plethora of other elements. This upright feature was placed in a posthole, also under a dense area of the bone bed. There were several uprights at the Hokanson site that had bison skulls associated with them. Upright Feature G in the camp area of the site had cranial elements associated with it, and Feature 12 contained a large number of bison bones packed vertically into the sediment, with a bison skull above it and a large boulder adjacent to it (Norris and Hamilton 2004:29).

These features could have a ceremonial connection with the inclusion of large cranial elements, but there is little to differentiate them from other upright features. The arrangement of the large upright, the bison skull, and the boulder in Upright Feature 12 from the Hokanson site (Norris and Hamilton 2004) is reminiscent of an altar, but there is little proof of this interpretation beyond the spatial association. Since element selection in uprights seems to be largely dependent on abundance and size, one would expect that simply by chance some uprights would be made of cranial elements. Their inclusion in an upright feature, or even the presence of complete skulls at a site, is not an indication that they were gathered for ceremonial purposes; the elements in the upright would have to exhibit purposeful alteration with unique treatment of the skull, such as red ocher or paint, before this purposed could be inferred. An interesting avenue of investigation would be to analyze the soil around the upright features for pollen, starch grains, or phytoliths, to see if any particular plants are being included with the upright features (see Twiss 2006).

Figure 7.25: Plate 96 from Catlin (1973). Painting of Siouan Dog Feast Ceremony.

Uprights themselves may not be inherently ceremonial, but instead associated with ceremonial activities. Brink and Dawe (1989:40) noted the presence of some type of pegs used to wedge poles in two historical paintings by Catlin (1973: Plates 96 and 97). These two paintings depict two Siouan ceremonies that Catlin witnessed during his time traveling on the northern Plains. Plate 96 shows a Siouan ceremony and dog feast, in which a ring of people are seated around a central post with a ribbon tied to it, with several joined tipi covers providing shade in the background (Figure 7.25). Catlin's Plate 97, a sketch of a Sun Dance ceremony, shows an individual with piercings on his chest that are attached by rope to a long pole (Figure 7.26). At the base of both of the poles central to these ceremonies, some type of stake has been wedged around the pole, presumably to help secure the pole in the ground. These examples come from paintings, where they might be subject to artistic licence. The inclusion of the pegs wedged alongside the base of the poles would nevertheless seem unlikely to reflect artistic flair because these would be innocuous details to trouble over. They likely reflect accurate renderings.

The fact that Catlin depicts these two ceremonial contexts with upright-like features suggests that some bone uprights in the archaeological record could have ceremonial connections. Yet these uprights still had a functional use, as the stakes were used to wedge and secure a pole in an upright position. The thoracic bone uprights outside the ceremonial structure at the Ruby site (Frison 1971) could have held poles used for ceremonial purposes. The upright and stake at the centre of Burial Mound H from the Elliot Village site in Manitoba certainly had some sort of ceremonial connection (Capes 1963:17).

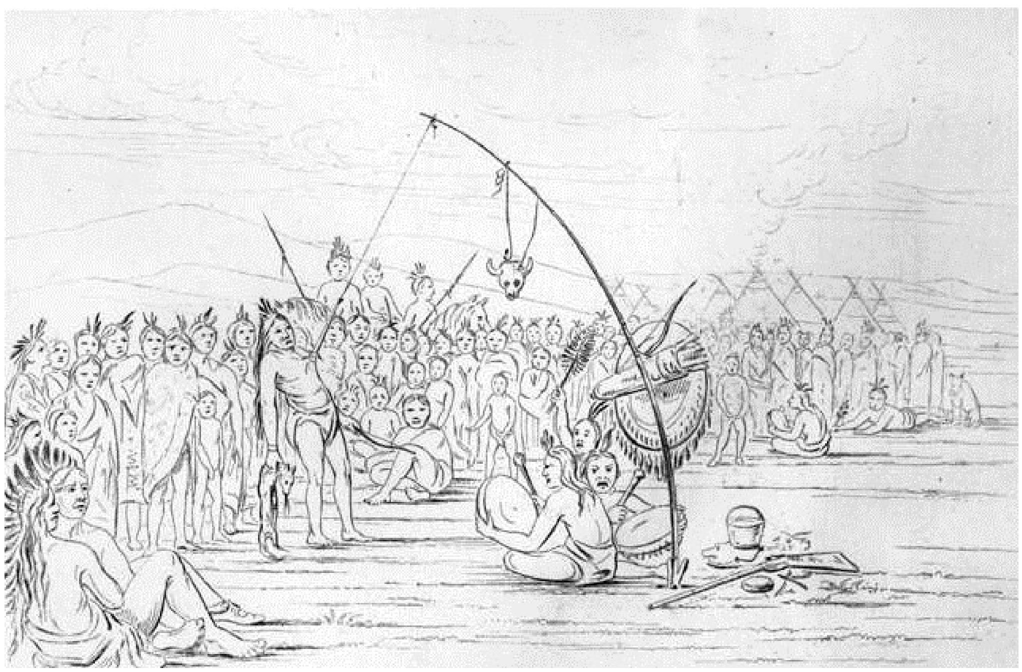

Figure 7.26: Plate 97 from Catlin (1973). A sketch of the Sun Dance ceremony witnessed by Catlin, where an individual is attempting to pull piercings from his chest.

Determining the exact nature of the ceremony is more difficult. There is an incredible depth to the ceremonial life of First Nations groups on the northern Plains, especially around the large communal hunts. Pre-hunt ceremonies could include praying using a medicine bundle, using a buffalo charming stone (*iniskim*), building cairns to entice the bison, and dances including a large number of people (Verbicky-Todd 1984). Offerings to ensure the success of the drive were at times hung on a tall pole or tree at the centre of the pound, and these offerings may have included cloth, bison skulls, tobacco, and important tools (Verbicky-Todd 1984:44). These offerings could also have been placed at the bottom of the pole.

If offerings were placed at the bases of these ceremonial poles, then the association of different artefacts with uprights could be an indication of whether the uprights had a ceremonial connection. Intact bison skulls placed near an upright/post could have been left as offerings. Feature 12 from the Hokanson site had a large multiple-bone upright under the kill area of the site with an inverted bison skull placed on top, adjacent to a boulder (Norris and Hamilton 2004:29). Based on the extrapolated bison pound shape proposed by the authors, this upright feature would be inside the pound structure, near the estimated centre. Therefore, this feature could be associated with ceremonial activities conducted for the communal hunt, similar to the pole placed at the centre of the pound for offerings.

Unlike other types of upright features, there is no clear model for identifying ceremonial uprights. The uprights from the Ruby site contain only thoracic vertebrae, perhaps denoting a ceremonial context. The upright in Burial Mound H at the Elliot Village site also contained a bison vertebra (Capes 1963:17), but many uprights also contain vertebrae, so this element is not exclusive to ceremonial contexts. The presence of intact skulls could also indicate that the upright has a ceremonial significance, but the association between an upright and a skull alone is not enough to be conclusive. The issue of contemporaneity between the upright and the skull complicates the development of any sound interpretation. The canid skull in Feature 1 from Fincastle is certainly suggestive of ceremonial purposes, but the significance of this upright is not clear. Yet, the mysterious attributes of a number of these upright features hints at a greater significance than purely functional purposes. Ethnographic and historical sources do shed some light on potential ceremonial contexts in which uprights could have been utilized, but there is a great deal of variability in the ceremonial traditions between groups. At best, a ceremonial context can be ascribed to some upright features, but the exact nature and purpose of that association is extremely difficult to determine.

Conclusion

Upright features have a variety of purposes and functions that researchers can ascribe based upon the shape, size, and context of each feature. Researchers can differentiate upright anvils by the presence of a cobble at the top of the upright feature, with the upright bone set at an angle around the edges of the anvil. The top of this type of upright should be in line with the occupation level at the site, contain long bone elements, and should be associated with middens of highly fragmented bone. Uprights can also be associated with posts because bone was used to shim up the posts. One would expect this type of upright to be located along the walls of postholes, although this location will depend on the preservation of these features. Postholes could also be jammed full of vertical bone to assist with finding and rebuilding the structure upon returning to the site. These uprights should contain a wider variety of faunal elements, since the posthole was packed tightly with bone. Researchers can identify tie down and stake uprights as a single element has been driven into the ground to provide an anchor. Multiple bone uprights can be tie downs, but too many elements jammed into ground surface in one location will weaken the anchoring point. Uprights can be associated with ceremonial activities, but strong contextual information is needed to reach this conclusion. The inclusion of intact skulls with an upright could indicate a ritual connection, while the spatial relations of uprights to known ceremonial features and activities can be indicative of ritual connections.

Chapter 8 – Interpretations and Integration

The Muhlbach site is an important site in northern Plains archeological literature and is used frequently in comparisons with other contemporary Besant and Sonota sites on the northern Plains. Despite this significance, there has been little published on the site since Gruhn's initial work in 1969, and much that was simply not known about the site. To rectify this situation, I undertook an intensive analysis of the Muhlbach site along with its near contemporary in South Dakota, the Stelzer site, to address significant questions about both assemblages. There were several objectives for this thesis: 1) to review the nature and distribution of Besant and Sonota sites with high frequencies of KRF on the northern Plains; 2) to conduct an in-depth exploration of the landscape surrounding the Muhlbach site and material culture from the site, with an analytical focus on determining seasonality from the faunal assemblage; 3) to revisit Sonota through a review and analysis of the Stelzer site, illuminating a poorly known but enormous archaeological assemblage, and 4) to investigate the upright features that link Besant and Sonota sites. With these threads now in place, we can probe the causal factors that led to the formation of western Canadian archaeological sites containing large amounts of KRF far from the source area, and the relationship of those sites to the Sonota heartland along the Missouri.

To begin, let us review what we can definitively state about the Muhlbach site. The people who occupied the Muhlbach site have some relationship with Sonota and the region now known as the Dakotas, having incorporated large amounts of KRF into their tool kit. This relationship was never in doubt, even from when Gruhn (1969) first excavated the site in 1965, but the exact nature of the relationship has long been debated. The utilization of KRF at Muhlbach is restricted to formal tools, primarily projectile points, but also some flake tools, scrapers, and bifaces. An assemblage restricted to mainly projectile points is not surprising for a kill site, as this type of site would introduce numerous projectile points into the archaeological record. There is limited representation in terms of the different stages of the reduction sequence, and an absence of cores. The evidence of the KRF lithic reduction sequence at Muhlbach is restricted to small tertiary flakes from edge sharpening or blade wastage; other stages of lithic reduction or any expended cores were not found at the site. This aspect is similar to the utilization of KRF at the Fincastle site (Bubel 2014). Given the weight of KRF material found at the site, a single person could easily carry the amount of material at the site from the KRF source area (Speth *et al.* 2013; Spier 1925). It may appear that the Muhlbach site is heavily dominated by KRF, but the entire assemblage has little mass, as compared to other raw materials like quartzite.

The Muhlbach faunal assemblage also illuminates several important facts that can be stated about the occupation. A large number of bison were gathered (likely from west of the site), driven, and entrapped using topography involving a small wetland on the edge of a sand dune complex, augmented by some type of pound structure as determined by the distribution of upright features. An abundance of calcanei from the excavated area indicates that the hunters killed at least 128 bison at the site, although the number of bison killed at the site is likely higher as the bone bed is thought to cover around 1 200 m^2. Metric analyses of different elements demonstrated that the herd killed at the site had a high proportion of cows and calves. Based on the utility indices and the abundance of different bison skeletal elements, the butchers employed a gourmet exploitation pattern, removing the high-quality meat portions from the animals and transporting them away from the kill site. It appears that the few male animals were lightly butchered and exploited as compared to the female specimens. The distribution of faunal remains in the main trench displayed a dense arc of bison bone through the units, and a spatial analysis of different elements demonstrated that this arc of bone formed as axial elements were processed and discarded at the site. It appears that this arc formed on the edge of the pound; as the animals were broken down into butchery units, the waste bone accumulated along the edges of the pound, similar to the distribution observed in the historic photograph of Chief Poundmaker's pound (see Figure 5.7).

Further evidence about the occupation comes from the thick layer of burned bison bone at the site. This layer of burned bison bone was superimposed by unburned bone, indicating that at least two kill events occurred at the site, although there could have been more. The first kill remains were quite possibly burned by the people occupying the site in an attempt to clean up the area, make any nearby habitation areas more comfortable, and allow for successful re-use of the setting. A second kill event covered over the burned bone from the earlier kill. It is difficult to determine how close in time these two kill events occurred, but with a larger population of radiocarbon dates from Muhlbach, we do have more secure information about the duration of occupation. The radiocarbon results indicate that the occupation occurred between ca. 1688 and 1401 years cal BP, providing a three hundred year span in which these two kills could have occurred. Assuming that the bone bed was burned to eliminate the odor, the kill events likely occurred close enough in time that the smell of a rotting bison kill would become unpleasant enough to warrant action–so that it is reasonable to suspect that the timing was likely on the order of weeks or months.

Some inferences can also be made about the season of occupation for Muhlbach. Based on the presence of neonatal bison remains and a herd structure indicating that the kill site was dominated by cow-calf units, it appears that at least part of the occupation occurred sometime in the late spring or early summer, after calving season had begun, but before rut occurred in the late summer. After these large kill events took place, the occupants abandoned the Muhlbach site, and the bone bed was subsequently covered over by the surrounding eolian sand deposits.

Turning now to the Stelzer site, there are many important details about this site that came to light from revisiting the original material and subsequent surface collections. As we have seen, the scale of the Stelzer site occupation dwarfs typical sites observed for the Plains region, covering over 200 000 m^2 along a terrace edge overlooking the Missouri river. In addition to the enormous size of the Stelzer site, the occupation occurred over a short period of time. Further refinement of the occupation's duration was made possible through a population of high-quality AMS radiocarbon dates, demonstrating that this intense occupation occurred between 1800 and 1550 yrs cal BP, a very tight range for such a vast site. These results contradict Neuman's (1975) original hypothesis that the site was repeatedly occupied by small groups over a longer period of time, and it seems likely that the Stelzer site was occupied by a large group over a short interval. The calibrated AMS results for the Muhlbach and Stelzer sites almost overlap, such that the two sites are near-contemporaries.

Similar to Muhlbach, KRF is prolific at the Stelzer site, but the aboriginal inhabitants heavily utilized KRF in all aspects of their tool kits, not just one type of tool. They also drew upon other high quality materials like TRSS, chalcedony, and a variety of cherts, but there was a preference for KRF, as the artefacts made from this material were often reworked and reduced until there was little to no usable material left. This reworking is evident from the large number of exhausted KRF cores from the Stelzer site, as opposed to the much larger cores of TRSS and other raw materials. Quality does not appear to be a factor, as the flintknappers discarded the other high quality materials, like TRSS, in larger forms as compared to artefacts made from KRF.

Most of the projectile points recovered from the Stelzer site fit within the variation seen for the Besant Phase. This variation includes the idealized, long-bladed Sonota projectile points present in the assemblage, as well as some corner-notched and barbed varieties that Syms (1977) associated with Sonota assemblages. However, most of the projectile points from the Stelzer site are short, stubby, side-notched variants, the majority of which are made from KRF. A widely accepted, key characteristic for Sonota projectile points is that they are longer than the Besant forms, but this feature is not observed at this Sonota "type site." Rather, the majority of the projectile points are indistinguishable from the shorter Besant or Samantha forms. Even Neuman (1975) never attempted to separate the projectile points at Sonota sites from other Besant projectile points, citing a lack of rigorous descriptions for comparative material. In fact, most of the attempts to separate Besant and Sonota points typologically took place in later publications (primarily Syms 1977 and Reeves 1983, but more recently Foreman 2010; Peck 2011; Varsakis 2006). Despite efforts to push forward paradigms that split Besant and Sonota into different phases, subphases, or complexes based on point form, research has shown that most of the variations in Besant point shape can be attributed to blade reworking and sharpening of projectile points, and not taxonomic grouping (Hamza 2013; Hughes 1981). It is apparent that Besant and Sonota assemblages cannot readily be separated using projectile point metric data alone, a factor that complicates assessing the relationship between Besant and Sonota.

The faunal assemblage at Stelzer demonstrates a bison-focused subsistence economy, with some elk, deer, and canid remains present. Based on the abundance of low utility bison elements, as well as articulated limb and axial segments, the faunal assemblage has a utilization pattern similar to what would be expected for a kill site rather than a camp. This pattern, along with the whole and partially articulated bison skeletons interred in the nearby burial mounds, suggests that the bison must have been killed near the site. Based on the size of the site, there were likely thousands of bison killed and butchered at or near the camp.

One of the most striking components of the Stelzer assemblage is the abundance of scrapers, far exceeding any other tool type from the site. The implications of this profusion of scrapers is significant, as researchers are increasingly taking into account the importance of hide-working and hide products in northern Plains societies (Cooper 2008:158; Fawcett 1987:203; Muniz 2013:285-286; Aileen Reilly, personal communication 2014; Speth 2013). Fawcett (1987:203) stated that increases in scrapers could be related to the redistribution of hide-based products within groups, as a means of mitigating tensions and to gain prestige. Speth (2013:181) highlighted multiple instances in which the goal of communal hunting was to obtain hides for clothing, shelter, and shields, not for the procurement of food. The sheer volume of hide-working implements from Stelzer implies that substantial hide-working occurred at the site, so that we need to be aware of the importance of hide products even if we do not recover them directly.

Integrating Muhlbach and Stelzer Analyses with Key Issues Concerning the Besant-Sonota Phenomenon

Now equipped with a firm archaeological foundation for Muhlbach and Stelzer, it is possible to explore relationships within the Besant-Sonota phenomenon. Arguably one of the most important characteristics for defining Sonota is the exploitation of KRF, dominating all aspects of the lithic assemblage. The affinity for KRF goes beyond economic or subsistence needs, as there were many suitable alternatives available to the occupants at the Stelzer site. KRF was a prominent toolstone for much of the northern Plains archaeological record, but only during the Cody Complex and Besant-Sonota era do we see such an intense peak and focus on this raw material (Dawe 2013). To explore this trend, we need a clearer understanding of how the material was moved out of the source area to sites like Muhlbach and Stelzer.

Sonota and many other Middle Woodland cultures during this period were influenced by the Hopewell world, demonstrated through the exchange of KRF and obsidian, the construction of burial mounds, the presence of carved and decorated human and animal dental arcades, and marine shell artefacts typical of Hopewellian cultures (Carr 2006; Neuman 1975; Syms 1977). This relationship between Hopewell and other contemporary archaeological cultures has been termed the Hopewell Interaction Sphere (Caldwell 1964; DeBoer 2004; Reeves 1983; Syms 1977). How these mound-building cultures in the Eastern Woodlands affected distant cultures and economies has been of interest to archaeologists for some time, as initial observations of Sonota material culture focused on influences from the Hopewell world (Neuman 1975), suggesting to some authors that Sonota was heavily engaged in trade and exchange with the Hopewell Interaction Sphere (Reeves 1983:156; Syms 1977:90).

In order to explore this relationship, Clark (1984) laid out three models of exchange to interpret the frequency of KRF during this time period in relation to Hopewell and other contemporary cultures in Minnesota and Wisconsin. Specifically, she analyzed the frequency of KRF in Malmo sites, located in Minnesota dating between 2640 and 1065 yrs BP (Clark 1984:182), and the

Havana-Hopewell related Howard Lake Focus sites on the eastern side of Minnesota dating between 2150 and 1650 yrs BP (Gibbon and Anfinson 2008), and contemporary Havana-Hopewell related Laurel sites located in the northern portion of the study area. Using exchange models from Renfrew (1972), Clark (1984) detailed three possible frameworks for interpreting the transference of KRF from the source area to the Hopewell world: "Down the Line Trade," "Directional Trade," and "Prestige Chain."

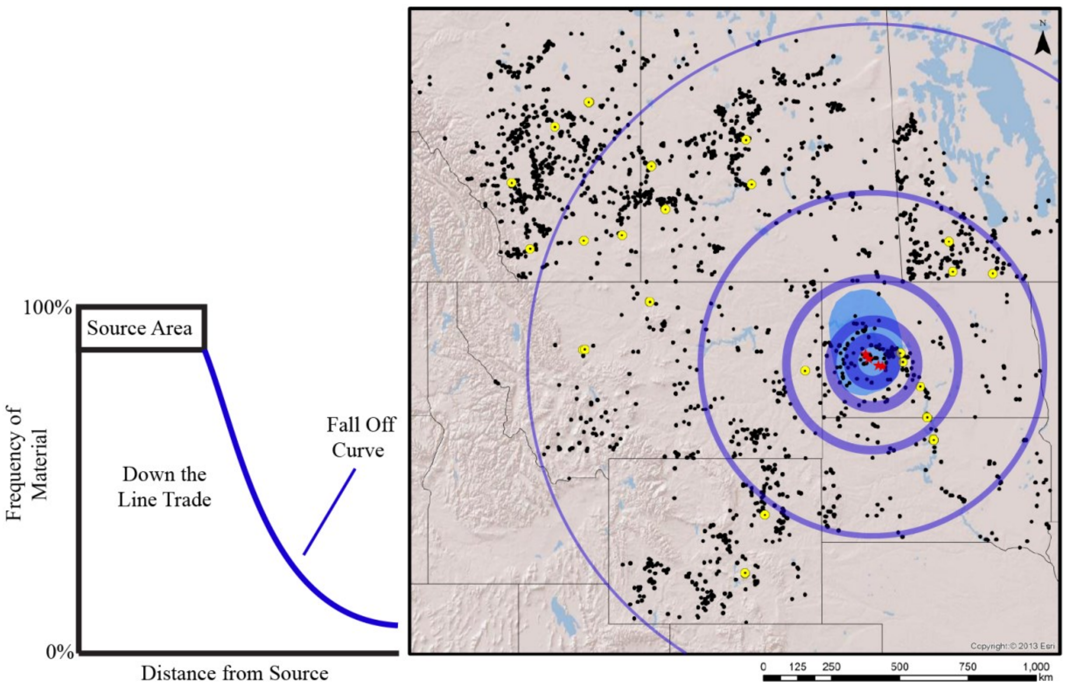

Figure 8.1: "Down the Line Trade" Model adapted from Clark (1984:191). As distance increases from the source area, the amount of material present in archaeological assemblages decreases rapidly

In the "Down the Line Trade" model, an exotic material like KRF is transferred from individual to individual or group to group, quickly decreasing in frequency once leaving the source area as the material was used up (Figure 8.1). Exotic materials with geographically-constrained sources, like obsidian and KRF, would appear in incrementally smaller amounts as distance increased from the source. The rate at which the material appears in the archaeological record is called the "Fall-Off Curve." The mechanisms by which this transfer occurred could include trade, but DeBoer (2001) illustrated how potent a force gambling could be, rapidly carrying exotic materials like shell or metal thousands of kilometers.

The "Directional Trade" model sees the material falling off in a similar pattern to the "Down the Line Trade" pattern, but there are epicentres at a distance from the source at which the material accumulates in larger amounts (Figure 8.2). This pattern is often seen when there are large population centres that can exert influence in order to obtain a certain consumable good (Clark 1984). The raw material would be delivered in large amounts to the secondary centre direct from the source area, altering the gradual loss of material from "Down the Line Trade". Once the raw material reaches the secondary centre, the material is distributed from each epicentre following a "Down the Line Trade" pattern.

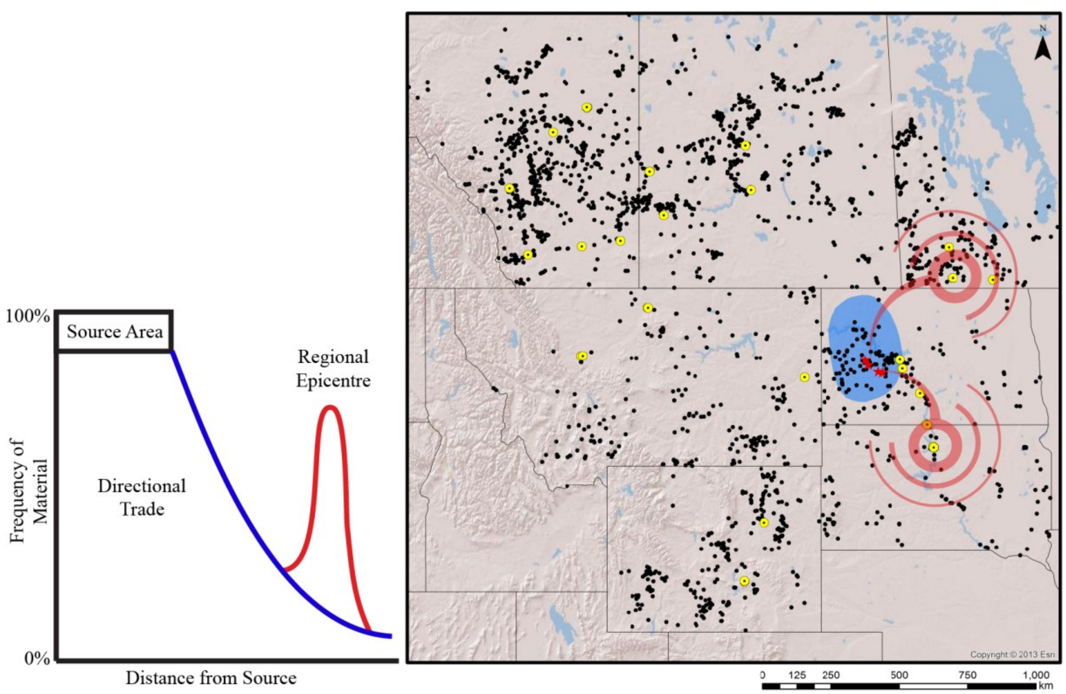

Figure 8.2: "Directional Trade" Model adapted from Clark (1984:191). Large amounts of the valuable material are funnelled to regional centres and distributed from these locations.

The third model is the “Prestige Chain,” in which a high value raw material is traded long distances in small amounts (Figure 8.3). This model is more akin to the pattern seen with the marine shell artefacts or pieces of copper that appear in the Sonota burial mounds; these materials were carried great distances, thousands of kilometers, but only appear in the archaeological record in very small amounts. Artefacts like a copper ram’s horn and obsidian bifaces in Hopewell burial mounds would also reflect a “Prestige Chain” model (DeBoer 2004). Owing to their value, these prestige artefacts rarely enter the archaeological record, and usually only appear either in a burial or by accident (Clark 1984:185). In this way, the pattern is similar to the “Directional Trade” model, but with a considerably smaller increase in frequency and greater distance. However, both models are related to the prestige value of the material. The significance lies in the greater distance and smaller amount present in the archeological record.

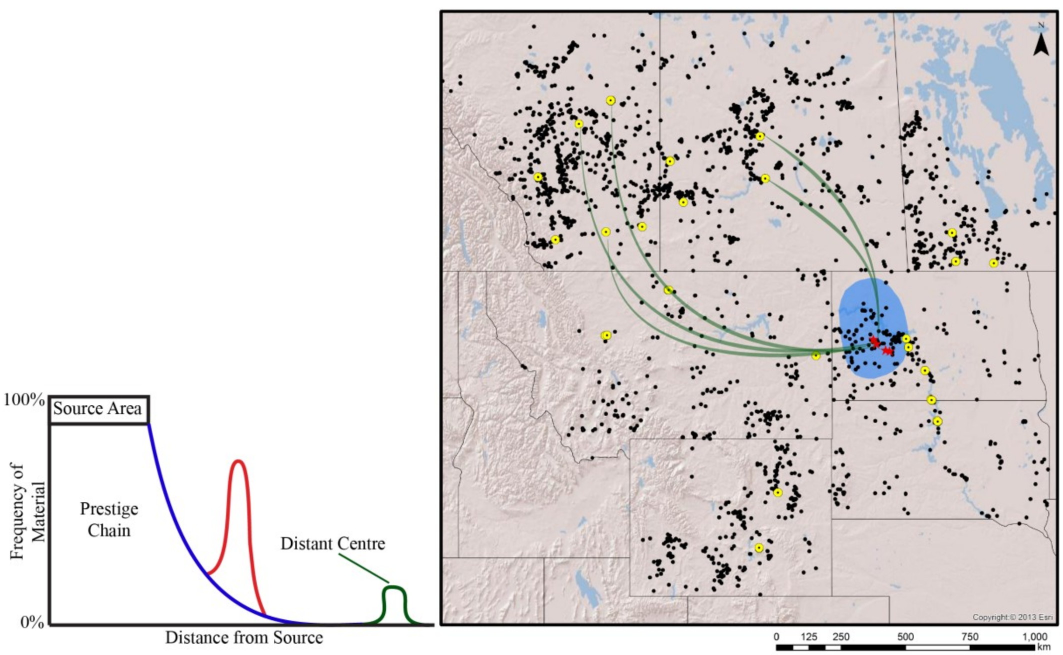

Figure 8.3: “Prestige Chain” Model adapted from Clark (1984:191). The high value material is transported long distances in small amounts with few intermediary steps in between.

Using these models it is possible to explore how KRF was transferred between groups in the Besant and Sonota world. While Clark (1984) presented these as three separate models, all three exchange mechanisms could be in use at the same time. The consumption of KRF seen at the Stelzer site and within Sonota most closely fits with a "Directional Trade" model, in which large amounts of a material were funnelled to certain regional centres. Stelzer is 250 kilometers from the source area, but still contained a large number of KRF cores, as well as the full reduction sequence in the debitage. Syms (1977:89) noted a similar pattern regarding the presence of KRF trade nodules and cores at the Richard's Village Site in Manitoba. This pattern indicates that Sonota populations could exert enough influence to funnel large amounts of raw KRF to these very large campsites in which the material was then extensively worked into formal tools. This could be carried out through direct access and long distance transport by the group, or through specific agents charged with acquiring the material for the greater group.

While KRF was being exchanged using "Directional Trade" within Sonota, Clark (1984:186) concluded that contemporary Middle Woodland cultures to the east received KRF through "Down the Line Trade". Moving east from Sonota territory in the Dakotas towards Minnesota, the amount of KRF in the contemporary Malmo habitation sites decreased from 80% to around 15% of the total assemblage as one moves from west to east. The distance between Malmo sites and the KRF source is roughly 500 km, or approximately twice the distance between Stelzer and the KRF quarries, but the frequency of KRF in the Malmo assemblages decreased exponentially faster than in Sonota assemblages. Farther east from Malmo in contemporary Howard Lake Focus sites, the frequency of KRF in the assemblage decreases to a further 2.3% of the overall lithic assemblage. This pattern of KRF utilization follows a "Down the Line Trade" model, in which the material was transferred between agents and quickly consumed as distance increases following an exponential fall off rate. While the source of the original KRF material involved in this "Down the Line Trade" pattern could come from the quarries in North Dakota, it is entirely plausible that the KRF at Malmo and farther sites was transferred to sites like Stelzer through “Directional Trade” prior to entering into this “Down the Line Trade” fall off pattern.

West of the KRF source area, Besant sites typically follow a “Down the Line Trade” pattern. Aside from the few high-frequency KRF sites, most Besant sites in Alberta and Montana have few KRF tools or debitage present, usually amounting to a few projectile points or flakes. The rest of the lithic assemblage is dominated by locally available quartzite, cherts, and siltstones. The “Down the Line Trade” pattern present in Besant sites could be described as the background pattern of KRF utilization during this phase, with sites like Muhlbach and Fincastle standing as outliers.

The third exchange model, the “Prestige Chain,” can also be observed during this era. For Hopewell, Clark (1984:185) concluded that the appearance of KRF artefacts in the habitation and mound sites best fits a “Prestige Chain” model, as almost all the KRF present in Hopewell sites was recovered from burial mound contexts, typically as large ceremonial bifaces, similar to how obsidian was treated in Hopewell assemblages (DeBoer 2004; Griffin 1965). This pattern indicated that the material had an intrinsic prestige value that made it desirable, similar to the manner in which marine shell and copper were transferred far from their sources.

Like the utilization of KRF (Clark 1984) and obsidian (DeBoer 2004) at Hopewell sites, the KRF utilization at Muhlbach can be characterized as a “Prestige Chain” model, in which the amount of KRF in terms of weight in these assemblages is actually quite low, but occurs at great distances from the source. Acknowledging that no one has located a nearby residential site for Muhlbach, it appears that the formal tools, primarily projectile points, are being made from KRF, rather than the entire lithic assemblage, as is seen at Stelzer. The biggest difference between the utilization of KRF in these select Besant assemblages and Hopewell is the number of artefacts that appear in the archaeological record. The presence of KRF at Hopewell sites is limited to a handful of bifaces (Clark 1984; DeBoer 2004), but high-frequency KRF sites like Muhlbach (Gruhn 1969), Fincastle (Bubel 2014), Fitzgerald (Hjermstad 1996), and Melhagen (Ramsay 1991) have dozens of KRF projectile points in several deposits. One of the key characteristics of a "Prestige Chain" model is that the high-valued material will rarely enter the archaeological record, usually only with a burial or by accident, but this incidence is not true for the aforementioned high-frequency KRF sites: these are large bison kill sites, not burials, and certainly not accidental, and therefore fail to meet one of the key assumptions for a "Prestige Chain" model. This is a point to which I will return, as there are other factors involved at Muhlbach and the kill site context beyond the basic assumptions of the "Prestige Chain" model that warrant exploration.

The Significance of the Sonota Burial Mounds

Since much of the KRF and Besant-Sonota discussion is focused around the construction of burial mounds, it is important that we devote some attention to the prospect of intrinsic connections between the exploitation of KRF and the construction of burial mound complexes. While the burial mounds are related to the Hopewell Interaction Sphere, this connection is a nuanced relationship bearing further exploration. Vehik (1984) compared the mortuary practices of Sonota and Illinois Hopewell, a contemporary mound building society, and illustrated that while there were similarities in general burial mound construction and placement, there were stark differences in individual access to burial mound interment, as well as an absence of "symbol of office" goods in the Sonota mounds. Her analysis demonstrated that while Sonota burial customs were influenced by Hopewell cultures, they were not an extension of them; the Sonota burial mounds were not the transplantation of Hopewellian mounds on to the northern Plains. This interpretation coincides with Clark's (1984) analysis of Hopewell use of KRF, which showed that while KRF was important in the Sonota home world, very little actually entered the Hopewellian realm.

Vehik's (1984) analysis showed that Sonota was a uniquely Plains culture that took up aspects of Hopewell material culture. The inclusion of whole or articulated bison carcasses in the mound fill speaks to a uniquely Plains adaption of an existing tradition, as the bison is an animal that is extremely important both culturally and spiritually across the Plains region. Bison feature prominently in many ceremonies and traditions of Plains groups, and the inclusion of articulated bison in the mound could be interpreted as introducing Plains cultural aspects into this practice of mound building. Another uniquely Plains inclusion into these burial mounds is the presence of ammonite fossils in the mounds. Known as *iniskim* to the Blackfoot, they were important ceremonial objects used in calling bison, tobacco planting and harvest, and as parts of ceremonial bundles (Peck 2002). The earliest known archaeological ammonite comes from a McKean Complex component in the Cactus Flower site from southeastern Alberta, dated between 3800 and 3600 years ago (Brumley 1975; Peck 2002), but Neuman (1975) recovered similar ammonite fossils from the Swift Bird and Arpan burial mounds. It is difficult to determine continuity for ammonite ceremonial use into the past, but the use of ammonite fossils is reported for several modern northern Plains aboriginal groups, particularly for the northwestern Plains and the Middle Missouri regions (Peck 2002). Their presence in the Sonota burial mounds suggests that these objects may already have assumed symbolic importance, and reflect a Plains element among Hopewellian practices.

An important point to consider regarding the Sonota burial mounds is that cemeteries are both rare and unusual in the northern Plains archaeological record. Scaffold burials were the dominant form of burial treatment on the northern Plains, in which an individual body was placed on a raised platform to decompose (Millar 1981:108). After a certain amount of time had passed, the relatives of the individual gathered the bones to carry either with the group or for burial elsewhere. Important and powerful individuals within society could also be buried under a cairn or a medicine wheel. Brumley (1985) demonstrated that certain types of medicine wheels were used as burials during the Old Women's Phase. Known as death lodges, some of these medicine wheels yielded human remains when excavated. These death lodges are not cemeteries in the modern sense, as they do not stem from the cumulative burials of multiple individuals over time, but rather are monuments to important individuals within society. This observation raises the question as to why a nomadic, bison hunting population would engage in the practice of building monumental mortuary architecture for communal graves? Millar (1981:107) argued that the practical constraints of dog-nomadism militate against the concept of a traditional burial ground for primary interments, and suggested that secondary burial practices would better accommodate higher degrees of mobility. If we add burial mound construction to the mortuary complex, this behaviour becomes yet more costly and time consuming, in addition to deviating from the established cultural norms in previous generations. Binford (2004:8) demonstrated that the development of cemeteries can be associated with increases in population size and decreases in residential mobility, but the groups involved with the Sonota burial mounds and the Oxbow-era Gray Site do not fit this model neatly, as they likely had low population densities and high mobility patterns. He also proposed that when foraging groups have larger cemeteries, they are situated within a central space for the greater social unit spread over a large geographical area; or organized within the family level with visitors coming from a larger geographical region (Binford 2004:7). In either case, the ethnographic pattern observed by Binford (2004) indicates that events like the construction of the Sonota burial mounds would draw participants from a regional area, affecting interconnected populations over a larger geographical area.

Arnold (1996:102) stated that as nomadic and semi-sedentary hunter-gatherer societies became more complex, cemeteries were developed as a method of establishing ties to landscape, as well as marking and delineating territory. Earle (2000:52) furthered this line of thought; he indicated that monumental burial mounds focused a group’s attention regionally, carry identity and sacred information, and persist as genealogical markers. This idea is intriguing when compared to the influx of new technologies into Besant and Sonota, but whether changes in material culture and subsistence on the northern Plains can be attributed to increasing social complexity is questionable. Walde (2006b) drew attention to several cases in which the spread of agriculture was halted when the more sedentary groups met complex, mobile hunter-gathers who exploited a concentrated wild food resource. He argued that the Besant hunter-gatherers maintained their bison-focused economy and culture, as they had an equally complex social organization as the Eastern Woodland groups with which they were interacting (Walde 2006b:300). The material culture from the Sonota sites includes new technology like ceramics and rare materials like copper and marine shell, but little of this material actually appears in the archaeological record. If there is a resistance in Besant-Sonota to eastern cultural influences, the adoption of burial mounds in the Middle Missouri region could be seen as an effort to culturally solidify ties to the physical landscape, as neighbouring societal structures and cultures change in response to an influx of new technologies, exotic goods, ideas, and cultural traditions into the region.

Notwithstanding that, the nature of intergroup relationships and large communal gatherings on the northern Plains demonstrates that these congregations were often polyethnic. Attempts to link archaeological cultures with historical ethnic and linguistic groups on the northern Plains have meet with limited success. The difficulty with linking ethnic groups with archaeological cultures can be highlighted by David Thompson's (1916) story of Saukamapee, a Cree man who ended up living with the Blackfoot in Alberta. Brink (1986) found that it was common for multiple ethnic groups to occupy the same camp, commonly during important ceremonial events like the Sun Dance and funerals (see also Peck and Ives [2003:185, 188] on the likelihood of a polyethnic character for the Old Women's Phase). There is a correlation between the Old Women's Phase and the Blackfoot, but other attempts to link older archaeological phases and complexes with modern cultural and biological populations are inconclusive (see Vickers 1994). In what Moore (1994) refers to as "cladistic" models of ethnicities as parent-daughter lineages, cultural identity tends to be conceptualized as rigid constructs. The intermixing of northern Plains languages and cultures demonstrates clearly that Aboriginal societies in the past were more fluid across ethnic and linguistic boundaries than what is often given credit. Moore (1994) critiqued the cladistic approach to culture by contrasting it with cladistic studies in biology in which, once two species diverge, they can no longer interbreed and transfer genetic information between each other; this is the foundation of the species concept. When cladistic approaches are applied to human cultures and populations, this approach leads to the erroneous assumption that once two human populations diverge, they cannot interbreed, exchange ideas, or share cultural traditions (Moore 1994:928-929). This is not the case, as human biological, linguistic, and cultural populations continue to interact and influence one another after the populations separate, and quite different populations can fuse their identities (e.g., Sharrock 1974). Moore (1994:930) proposed that interacting human populations would be more accurately envisioned as a braided river system, in which channels diverge and recombine in complex patterns throughout time, rather than a linear parent-to-daughter relationship. On the northern Plains, the nodes where these intersecting populations would recombine and diverge can be readily construed as large sites like Stelzer and Muhlbach.

We can also reasonably assume that Stelzer and the Sonota mound-building complex represent the actions of several different groups of people; not so much because the mounds were difficult to build, but rather because the practice of burying your dead together and witnessing the event is an important means of achieving social cohesion and integration (Arnold 1996; Earle 2000). Conflict that might arise between and within groups can be minimized by mutually recognized ceremonies that bond groups together. In addition, if the construction of the burial mounds was related to marking and delineating territory, then this marking needs to be conducted with multiple groups to ensure that the significance of the activity is witnessed and recognized. Sonota, Stelzer, and the burial mounds can effectively be seen as a stage on which these groups were exchanging materials and transmitting ideas. Such a perspective is very much in line with recent thinking about ceremony and ritual in and near the Hopewell world (Buikstra 1998; Carr 2006a, b; Pugh 2001; Spielmann 2002).

Considering the burial mounds in this manner illuminates how KRF exchange might have occurred in the past. While a valuable commodity, KRF was more important to Sonota than to Hopewell. The amount of KRF that appeared in

Hopewell sites was very small, and could stem from only a couple of trade events (Clark 1984). This pattern contrasts with Sonota use of KRF, which sees heavy exploitation of the material; cores and cobbles of the material are being moved towards large campsites like Richard's Village and Stelzer, in which primary reduction and tool manufacturing take place. It is possible that external groups, instead of taking KRF directly from the quarries, could engage the local Sonota population and seek permission to use the material.

This concept was explored by Smith (2013:11), who examined hunter-gatherer ownership and niche construction for mass kills; he stated that when resources are scattered across the landscape in low density, controlling access to these resources against outside groups would be difficult for small, nomadic populations. When resources are concentrated or occur in patches, they will be subjected to strongly enforced control of access by the hunter-gather groups (Smith 2013:11). KRF definitely falls under this latter category, as it is a highly valued material with a restricted source. Additionally, the source area of the high-value resource becomes more than a geographic location, instead occupying a central role in the economy and becoming embedded in the worldview and belief system (Smith 2013:11).

Smith (2013:11) used rock art to illustrate the importance of imparting a continuing marker of ownership and stewardship through time at these high value resource locales, under the concept of cyclical nucleation, a term Carlson and Bement (2013) used to define the scheduled aggregation of multiple subsets of a band society at predetermined seasonal locations. This concept means that small groups of family units would congregate at high-value resource locations periodically to exploit the resource, whether it is a communal kill site or a valuable lithic raw material source. This congregation sets the stage for social integration and networking through cultural constructs like feasting, ceremony, gambling, and marriage (Carlson and Bement 2013).

This model of hunter-gatherer interaction can easily be applied to the Sonota use of burial mounds, in which monumental architecture, burial rituals, and feasting would all facilitate interaction and exchange of a highly valued material between groups. External groups could have participated in this cyclical nucleation, and in doing so, received permission to access the high-value KRF source area. Minimally they could acquire ample material from the quarries while spending time at regional centres like Stelzer. Recalling the pattern observed by Binford (2004:7), we see that when hunter-gatherer groups have cemeteries, they often occur within a central place for a larger societal grouping that is spread over a greater area. Additionally, when hunter-gatherer cemeteries are organized at a family level, visitors will be attracted over a larger regional area to participate and witness the funeral event (Binford 2004:6). If this pattern was occurring in the past, it could explain the far-flung occurrences of KRF at a site like Muhlbach or in the Hopewell world, in which the construction of burial mounds could influence and attract agents from a large regional area and thereby distribute the highly valued material over a greater area (see also Carr 2006a). What we now term "Sonota" can in this sense be seen as the manifestation of this interaction between Besant groups and the Hopewellian societies yet farther east.

Muhlbach in Context

If the activities at Stelzer are related to regional interaction and exchange, how does this pattern relate to the Muhlbach site and the "Prestige Chain" exchange pattern seen for KRF in Besant sites? Sonota is a reflection of the interaction between groups in the Middle Missouri region and the Hopewell Interaction Sphere, and their material culture is an echo of that interaction. This interaction within Besant will not reflect the same patterns seen between Sonota and Hopewell, but rather the interaction can be expected to reinforce shared Plains cultural traditions and concepts. There will be a different material culture signature for the interaction between Besant groups on the northwestern Plains and Sonota groups in the Middle Missouri region. We need to consider the context in which Muhlbach and these other high-frequency KRF sites are occurring, and what bearing that information has on the observed phenomenon.

A recurring pattern with all of these sites is that they are large communal kills that are abandoned after a short occupation. This pattern is observed at Muhlbach (Gruhn 1969), Fincastle (Bubel 2014; Foreman 2010), Melhagen (Ramsay 1991), and Fitzgerald (Hjermstad 1996). An important and often overlooked attribute of all these sites is that they occur in sand dune complexes. The northern Plains region has a number of eolian sand deposits arising from glacial lake deltas, usually in the form of sand dunes or sand sheets (Wolfe *et al.* 2007). Typically distinct from the surrounding area, they often exhibit broader ecological diversity that Wolfe *et al.* (2007) postulated would allow for a wider breadth of resources to be exploited by aboriginal people. Furthermore, an impermeable clay stratum often underlies these sand dune complexes, creating a perched water table and a source of water for both animals and people. These factors make sand dune complexes an attractive place to settle, and their unique topography and ecosystems make them easy to recognize and locate in a wider region. The undulating terrain of sand dune complexes also makes them excellent locales for bison pounds, as hunters were able to take advantage of subtle changes in the terrain to obscure and hide the pound during approach (Verbicky-Todd 1984).

Sand dune areas also have significant spiritual and cultural meaning for many northern Plains aboriginal groups, as these regions were perceived as gathering centres for ceremonies and cemeteries. One study that emphasized this perception was carried out by Peters *et al.* (2006), who interviewed elders from First Nations under Treaties 4, 6, and 7 in response to potential impacts from developments in the Great Sandhills in Saskatchewan. Their ethnographic study demonstrated a pervasive theme amongst all the groups involved, in which sand dune complexes were associated with the dead, powerful medicine, and important ceremonies (Peters *et al.* 2006). For the Blackfoot, the Great Sandhills are where the dead go to rest; Narcisse Blood described the region as a gateway to the world beyond (Peters *et al.* 2006:33). Other Cree and Assiniboine groups involved in the study also associated the Great Sandhills region with burials, as well as the important Sun Dance ceremony. All of the elders interviewed in the study repeatedly emphasized the spiritual importance of the area, as well as the cultural importance of preserving it from development. While the line of questioning pursued by Peters *et al.* (2006) was directed at perceptions regarding the Great Sandhills, the views and beliefs expressed in their study might apply to other sand dune areas. Hamilton and Nicholson (2006:259) ascribed similar beliefs regarding the Lauder Sandhills and the Brandon Sandhills in Manitoba as spiritual locales for Cree, Assiniboine, and Ojibwa groups. This perception of sand dune areas as spiritual and ceremonial centres was likely established widely on the northern Plains in the Precontact period.

Sand dune complexes were also perceived as neutral territory by aboriginal groups on the Plains, in which different groups could share the space and resources without conflict. Panas (2013) explored this theme at the Bodo Archaeological Site Complex, as he noted that the site was situated in a sand dune complex on the Neutral Hills of eastern Alberta, a territory that was considered a "no-man's" land between hostile Blackfoot, Gros Ventre, and Tsuut'ina bands on the one hand and Cree and Assiniboine bands on the other. This concept meant that each party could exploit the area with lessened fear of repercussion from the other. Peters *et al.* (2006) noted a similar pattern in the Great Sandhills in Saskatchewan; many different First Nations communities utilized the territory in the past. Jenish (1999:139) reported a historical occurrence of multiple groups occupying the Great Sandhills; during the winter of 1877, approximately 2000 Blackfoot people were camped in the region, along with several other bands of Cree, Assiniboine, Lakota, and Dakota people. This circumstance was unique, as the Great Sandhills was one of the few bastions of bison populations left, but this historical event highlights how several different ethnic groups (some of which were enemies) with multiple languages could all occupy the same geographic region at the same time, as it was recognized as neutral space.

This perspective on sand dune areas provided by the First Nations informants has significant implications for understanding the Muhlbach site and other high-frequency KRF sites on the northwestern Plains. The Muhlbach site produced numerous projectile points made from KRF, which based on the analysis of Stelzer and the burial mounds, may well have been obtained while participating in burial or other ceremonies occurring in the Middle Missouri region. The amount of material actually traveling from the Dakotas may dominate certain components of the tool kit but actually comprises very little weight, meaning that a single individual could easily carry the artifacts back to the northwestern Plains. Viewed in this way, highly valued KRF was ultimately deposited into the archaeological record in sand dune areas that may have had cultural and spiritual importance for groups engaged in socially significant communal hunting, undoubtedly preceded by important ceremonial activities. In the same way that Sonota burial mounds attracted a wider regional audience to the locale through cyclic nucleation, communal hunting sites like Muhlbach would be significant gathering places for regional groups (Carlson and Bement 2013). Fawcett (1987) highlighted the social importance of communal bison hunting for promoting social cohesion, mitigating conflict, and gaining prestige within society.

The fact that these high-frequency KRF sites are strongly associated with sand dune complexes, with their cultural and spiritual connotation, suggests that the possibilities for prestige enhancement and social integration may have figured prominently during communal hunting events. Additionally, these nucleation events on the northern Plains might occur only a handful of times throughout a person's lifetime, and since there is a critical population level needed to carry out one of these hunts, Ives (1990:326-328) advocated for varying strategies of endogamy and exogamy in allying the larger kin groups required to conduct communal game hunting and processing. Given that these events are uncommon, the abundance of KRF projectile points at these sites could be a reflection of individuals seeking prestige enhancement through utilization of a highly valued material. This interpretation explains why the utilization of KRF at Muhlbach fits a "Prestige Chain" model, even though it is neither a burial setting nor an accidental occurrence (Clark 1984). The use of KRF projectile points at the site could well be connected with prominent individuals who had participated in mortuary ceremonies on the Missouri and returned to take part in communal kill events on the northern Plains. High frequency KRF sites like Muhlbach and Fincastle are rare, temporally scattered over nearly a millennium. It may be that the episodic nature of these KRF-rich northern Plains occurrences could parallel the demographic exigencies that would drive periodic mound interments in the Dakotas.

Carr (2006a:608) outlined a variety of plausible mechanisms consistent with a "Prestige Chain" model that he expected to be connected with Hopewell transmission of high status exotics involving individuals and small groups. These included vision or power questing, pilgrimages to powerful places, travel to a centre of learning, travels of medicine persons, elite exchange of valuables, or buying of ceremonial prerogatives. All of these ethnographically documented alternatives would create circumstances in which an individual or small group of individuals could acquire an exotic raw material and transport it a great distance away from its source region prior to its use.

This "Prestige Chain" model explains the appearance of KRF at these far-flung sites better than other proposed models. One of the earliest suggestions attempting to explain this phenomenon was that these sites represent groups that regularly visited the KRF quarries as part of their seasonal round (Gruhn 1969). In a seasonal round model, there should be a continuous spread of KRF from the source area within the group's territory, reflecting steady consumption of KRF as distance increases from the source area. The problem with this theory is that, at 1 000 km from the source, Muhlbach is too far for a single group's seasonal movement, as the group has to traverse from central Alberta to North Dakota in order to access the raw material. The highly valued material is beyond the periphery of a group's territory, instead of playing a central role in economy, worldview, and belief system as one would expect (cf. Smith 2013:11).

Also these high-frequency KRF sites are both rare and far-flung, and we lack the intermediary locations between the formal-tool KRF-dominated assemblages at Muhlbach and the quarries in North Dakota. There should be Besant sites rich with cores and ample evidence of KRF reduction between Muhlbach and the source area, with KRF steadily being consumed along the seasonal round. This circumstance simply is not observed in the archaeological record. Most of the core reduction and tool manufacturing is happening either at the large campsites like Stelzer, or at the KRF source area, after which the formed tools appear at distant sites like Muhlbach.

The other possible scenario for these high-frequency KRF sites is that they reflect people migrating away from the Middle Missouri region, occupying Muhlbach and similar sites. They might initially be carrying large amounts of KRF with them, but cease having access to the source region with any frequency thereafter. This model has been popular among several researchers (Foreman 2010; Peck 2011; Syms 1977; Varsakis 2006), but has had some strong opposition (Reeves 1983). Most recently, Peck (2011) proposed that sites like Muhlbach represent Middle Missouri invaders immigrating to the northwestern Plains carrying large amounts of KRF. Yet, as we have seen, this migration pattern would need to start with Fincastle at 2500 years BP as an initial Outlook Complex wave of immigration, and culminate with Muhlbach a thousand years later. According to Peck (2011:331), incoming Sonota populations replaced widespread incumbent Besant groups after 1500 yrs BP. Foreman (2010) and Varsakis (2006) supported this viewpoint in their interpretations of Fincastle, identifying the finely crafted long-bladed, side-notched projectile points at these high-frequency sites as the Outlook point form. Bubel (2014) also concluded that some Fincastle points could be characterized as Outlook, but acknowledged that Outlook, Sonota and Besant forms are all present in the Fincastle point assemblage. She suggested that future research might well blur Outlook, Besant, and Sonota point terminologies.

There are several problems with this migration model. Chief among them is that the idea of separating the high-frequency KRF sites on the northwestern Plains from other contemporary Besant sites under this model is largely based on difference in projectile point forms. Sites like Muhlbach and Fincastle are classified as “Sonota” or “Outlook” because they have well-made, long-bladed, side-notched points, while Besant points tend to be stubby and poorly made (Foreman 2010; Peck 2011; Varsakis 2006). However, it is clear that the variability within Besant/Sonota/Outlook assemblages can simply be attributed to blade reworking and sharpening, without invoking cultural differences (Bubel 2014; Hamza 2013; Hughes 1981). On typological grounds, there is no reason to separate these sites based on projectile point form. This argument leaves the abundance of KRF at these sites as the key evidence of what would surely be a modest migration. The prestige- and ceremonial-based model for high-frequency occurrences of KRF on the northern Plains provides a more realistic scenario, in relation to communal hunts and the mortuary practices of the burial mounds in the Dakotas.

The migration/invader scenario also does not address why this large-scale migration would occur in the first place; what would push or pull groups out of the Dakotas and into the northwestern Plains? The northwestern Plains were not devoid of people; there had been continuous occupation for millennia, and widespread Besant populations had been established across the region. Incoming Sonota groups would need to establish a permanent range in territory that might already be claimed. For a wave of migration that replaces incumbent Besant populations with Sonota and Sonota precursor groups, starting with Fincastle at 2500 BP and ending with Muhlbach at 1600 BP as Peck (2011:331) proposed, we have only evidence for a weak, highly sporadic movement that occurred over a thousand year period.

A "Prestige Chain" model best explains that pattern of KRF utilization at Muhlbach and the handful of other high-frequency KRF sites on the northwestern Plains. The cyclical nucleation occurring at burial mound sites in the Dakotas set the stage for social integration and networking through cultural constructs like feasting, ceremony, gambling, and marriage (Carlson and Bement 2013). Individuals or groups from Alberta who participated in this cyclical nucleation would pass by the high-value KRF source area, perhaps receiving permission for access. Or instead, ample material from the quarries might simply be acquired during extended visits to regional centres like Stelzer. After spending time in the Sonota world engaged in what must have been large social gatherings, the group would return with the KRF artefacts to their home territory, carrying high-prestige, formed tools rather than the raw cores or manuports. Upon returning to their home territory, high-status individuals (ceremonialists, poundmakers, shaman figures, or others) carrying the KRF would eventually participate in a communal kill and aggregate with other bands. Since these high-frequency KRF sites are situated in spiritually and culturally important sand dune complexes, and given that these communal kill events would attract multiple groups who would undoubtedly engage in extensive ceremonial activities to facilitate successful bison hunting, considerable prestige could accrue to individuals and groups bringing valuable, exotic KRF tools.

This revaluation of old collections and records produced volumes of new data regarding these well-known archaeological sites, and demonstrated the importance of using these collections in current archaeological research. While Muhlbach and Stelzer were well known in the literature, there was little known about much of the assemblage. Additionally, theoretical, methodological, and technological advances over the past fifty years allow us to ask questions about the archaeological record that were not previously possible. There is much that these old collections from Muhlbach and Stelzer can teach us about the Besant-Sonota era and the regional interaction occurring on the northern Plains.

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Appendix A: Summary and Description of Significant Besant and Sonota sites on the Northern Plains.

Alberta

Smith Swainson (FeOw-1, FeOw-2, FeOw-3)

Despite Varsakis' (2006) assertion that the site was a surface collection, the Smith Swainson site is actually a large site complex with three separate sites in close proximity (Doll 1973a, 1973b, 1973c). Within a two kilometer area we find the Knife River Flint Site (FeOw-1, also known as Smith site 1), the Smith Site 2 (FeOw-3), and the Swainson site (FeOw-2). These sites are situated in a small unnamed sand dune complex near Sedgwick, Alberta, approximately 100 km northeast of the Muhlbach site. On hand at the Royal Alberta Museum from this site complex is a large collection of side-notch projectile points made almost entirely of KRF. Varsakis (2006:43) included this collection with her analysis of Besant sites, but thought the assemblage to be an unprovenienced surface collection (Varsakis 2006:43). Parts of the sites were actually excavated by Maurice Doll in 1974, and Alan Bryan surveyed the site in 1964.

The majority of the projectile points in the Smith Swainson collection were from Smith site 2, donated by Ben Weber in 1972 (Doll 1973c). Doll reported that out of the several hundred artefacts donated from the site, the majority were made from KRF. Excavations occurred in 1974, with Doll digging two 0.75 m by 3 m trenches to 0.3 m below the surface deep, and augering the site to a depth of 1.2 m. The occupation horizon proved to be very shallow, and extremely disturbed from the cultivation.

Bryan surveyed the Knife River Flint site in 1964, finding an abundance of fractured bison bone and lithic debris in the northeast corner of a cultivated field, covering an area of approximately 15 m across. He also observed a large collection of side-notched projectile points made from KRF. Doll did not excavate in this locale, as the field was in crop at the time. The collection donated to the

Royal Alberta Museum contained several small pressure flakes, a large number of projectile points, and an unspecified number of scrapers (Doll 1973a). The 15 m wide surface scatter of bison bone and projectile points at the KRF site is suggestive of a kill site.

The Swainson site, tested by Doll in 1974, is located on the east slope of a long ridge in the same field as the previous two sites. Researchers excavated three test trenches measuring 0.75 m by 3 m long to a depth of 0.3 m below the surface. Doll (1974b) reported an articulated mature bison skeleton and a partially articulated immature animal from the excavations, along with ample amounts of burnt and pulverized bone. Only two projectile points were recovered from the excavation, and some debitage. Surface collections from the site were more productive, displaying hundreds of projectile points. Doll (1974b) stated that 95% of the points in the surface collection were Besant, and that the majority of the sample was KRF. Also reported from the site were an atlatl weight, several pot sherds, bifaces, and scrapers. Doll (1974b) hypothesized that people were killing bison at the Swainson site by driving them into a nearby dried-up slough.

Fincastle (DlOx-5)

The Fincastle site is located 100 km east of Lethbridge, Alberta, in a large sand dune complex 3.8 km south of the Oldman River valley (Foreman 2010:25). Situated Inside of a large parabolic sand dune, the site has been excavated since 2003 as part of the University of Lethbridge archaeological field school. The excavators uncovered a single component containing an extensive bison bone bed, many KRF projectile points whose morphology is consistent with points from the Besant Phase, and several upright features (Bubel 2014; Foreman 2010; Hamza 2013; Varsakis 2006; Watts 2008). Initial impressions of the site gave rise to comparisons with the Muhlbach site, but radiocarbon dates demonstrated that the site was occupied around 2500 BP, nearly a thousand years earlier than expected (Foreman 2010). This early radiocarbon date caused scholars to separate the Fincastle site from the Besant Phase into the Outlook complex (Foreman 2010).

To date, there have been 138 projectile points, over 3 000 pieces of debitage, 120 stone tools, eight cores, and over 1 400 pieces of FCR recovered from this site (Hamza 2013:67). The debitage consisted of small finishing flakes, indicative of sharpening and fine tool modification occurring at the site, but not intensive lithic reduction. Exotic raw materials made up the bulk of the lithic assemblage, primarily KRF; this material accounts for 83% of the projectile points (Varsakis 2006:142). KRF is largely absent from the debitage, appearing only as small tertiary flakes (Bubel 2014).

Happy Valley (EgPn-290)

The Happy Valley Bison Kill site is located on the northwest side of Calgary, Alberta, along the south terrace of the Bow River (Shortt 1993). Excavations occurred at the site during the spring of 1991 to mitigate the impacts from the Valley Ridge Golf Course and other developments in the area. The excavation covered a total of 39.25 m^2, and produced over 38 000 bone fragments, as well as a small amount of lithics and FCR (Shortt 1993:15). Shortt (1993:42) published several conventional radiocarbon dates from the site, all clustering around 2400 years BP, an early date for the Besant Phase. The lithic assemblage from the site was small, containing only 13 projectile points, three bifaces, 11 retouched flakes, 24 pieces of debitage, and 12 large tools (Shortt 1993:44). The raw materials from the site were varied, demonstrating utilization of Swan River Chert, KRF, obsidian, siltstones, petrified wood, quartzite, and a variety of cherts. While KRF was present at the site, only limited amounts were recovered.

Shortt published his Master thesis on the site in 1993, focusing on the faunal assemblage from the site. The majority of bones from the bone bed were identified as bison, but there were cervid and canid remains found within the collection as well (Shortt 1993:65). Of the 38 826 bone fragments recovered from the site, only 3 886 specimens could be identified to elements, and 34 940 fragments could only be attributed to gross portion categories, like long bone or axial fragments. Based on tooth eruption and wear and the sex ratio in the herd structure, Shortt (1993:141) determined that the site was occupied during the late summer and early fall.

Ross Glen (DlOp-2)

The Ross Glen site is a multicomponent stone circle site on the outskirts of Medicine Hat, Alberta (Quigg 1986). Reported for the site are 18 buried stone circle features, some of which were relatively large, with 42 separate occupational features around the locale; these features include middens of FCR, hearths, and postholes. Although the stone circles were buried, the occupation was relatively shallow, ranging from 4-19 cm below the surface (Quigg 1986:9). There were two occupations present at the Ross Glen site; a major Besant occupation comprising most of the stone circles, and a smaller, later occupation limited to only two of the stone circles (Quigg 1986:131). Based on the spatial distribution of stone circles at the site, Quigg (1986:133) hypothesized that two groups of related Besant families had used the site simultaneously. Quigg related differing sizes of the stone circles to the social status and wealth of individuals within the group.

Excavations produced a variety of lithic raw materials, primarily quartzite and argillite, with an assortment of cherts (Quigg 1986:144). Exotic raw materials like KRF and obsidian were noted at the site, but the majority of the assemblage was locally sourced lithic material. Also reported from the site were 37 small body sherds (inside a stone circle associated with a Besant point), 13 projectile points, 10 bifaces, five endscrapers, a uniface, and a hammerstone (Quigg 1986:97). Limited faunal remains were recovered from the site. One sample produced an age of 4260 ± 140 ^{14}C yrs BP (RL-1585). Quigg (1986:124) proposed that this date was related to an Oxbow or Hanna occupation at the site. The second radiocarbon date was comprised of weathered bone fragments from across the whole site, as well as burned and calcined bone fragments from Feature 3. This composite sample produced two dates based on bone apatite and gelatin proteins in the collagen, 1485 ± 165 ^{14}C yrs BP (GX-5892-A) and 1330 ± 160 ^{14}C yrs BP (DX-5892-G) respectively (Quigg 1986:124). These assays do need to be treated with some caution.

Head-Smashed-In (DkPj-1)

Head-Smashed-In Buffalo Jump is a UNESCO World Heritage site located on the southeastern edge of the Porcupine Hills in southwestern Alberta (Brink and Dawe 1989). The site was extensively occupied over a 5 500 year period, including McKean, Pelican Lake, Besant, Avonlea, and Old Woman's Phases (Brink 2008). Head-Smashed-In has several constituent parts, including a drive lane area above the cliff, a large kill site deposit that was 11m thick, as well as a camp and processing area covering 500 000 m^2. Since the processing site was so densely occupied over such a large time span, it is difficult to associate different components of the assemblage with individual phases. The Besant Phase at the site could only be demonstrated by projectile points that fell within the typological form (Foreman 2010:64). Out of the 311 projectile points recovered from the site during the 1985/1986 excavations, only 12 were attributed to the Besant Phase (Brink and Dawe 1989:215). Raw materials for these points were typically local cherts, mudstones, and petrified wood, but three points were made from KRF, and one specimen was made from gold dendritic chert. Reeves (1990) associated several radiocarbon results with a Besant/Pelican Lake occupation at the site: Layer 11 dated to 1930 ± 80 ^{14}C yrs BP (GX-1253) and Layer 3 dated to 1900 ± 100 ^{14}C yrs BP (RL-331) as well as 1705 ± 90 ^{14}C yrs BP (GX-1220). Reeves (1990:165) proposed that the Besant occupation represents only a limited duration at the site.

Saskatchewan

EdOh-23

EdOh-23 is a uniquely situated Besant site in Great Sand Hills of Saskatchewan, as many archaeological sites are on the periphery of this geological feature and very few are inside of it (Johnson 1983). Johnson (1983:41) reported that the site was on the western edge of this 1900 square kilometers glacial sand deposit, inside a blow out of a stabilised sand dune. The blowout was 60 m long by 25 m wide and 7 m deep, but the archaeological site was only a small lithic scatter, 8 m by 2 m in size. The excavators recovered two complete points and five point fragments from the site, all of which fit within the Besant typology. Johnson (1983) also reported two bifaces made from green jasper and white chalcedony, and a quartzite chopper from the site. The majority of the artefacts were made from KFR, with approximately 200 g of material represented at the site (Johnson 1983:44).

Johnson (1983) reported a large quantity of FCR present at the site, even though the closest source of sizeable cobbles to the site was two kilometers away. The distance between the site and the source of the cobbles caused the inhabitants to recycle and reheat existing FCR at the site. A survey of the area uncovered a cache of 200 kg of granite cobbles one kilometer away. This cobble cache cannot be securely associated with the occupation at EdOh-23, but the proximity is suggestive. Johnson (1983:44) reported that bone was being used as fuel at the site, and that environmental factors would have limited the number of people that could have inhabited the site. The site was radiocarbon dated to 1675 ±115 ^{14}C yrs BP (S-2348).

The Fitzgerald Site (ElNp-8)

The Fitzgerald site is a large bison pound with a separate processing area in the Moose Woods Sandhills, southeast 15 km of Saskatoon, Saskatchewan (Hjermstad 1996). Excavations at the site produced 122 bifacially worked projectile points, as well as 21 points made on trimmed flakes, similar to the points found at the Muhlbach site (Gruhn 1969). Hjermstad (1996:66) attributed the points to the Outlook side-notched (93%) and Bratton side-notched (7%) projectile point series; he considered both types varieties within the Besant Phase. Excavators also collected from the site a small biface, a wedge, 14 endscrapers, and six unifaces (Hjermstad 1996:89). The lithic assemblage was dominated by KRF, making up 97% of the projectile points, 90% of the debitage, and 66% of the formed tools (Hjermstad 1996:77). Other exotic raw materials included fused shale, TRSS, and obsidian, but locally available quartzite and Swan River Chert were more common than these other exotics. Three pot sherds were also recovered from the site, but the specimens are very small and lack any diagnostic indicators to indicate their cultural affiliation. Excavators identified several features from the site, notably a thick burnt bone layer, several bone upright features, hearths, and post molds. An analysis of the faunal remains demonstrated that female bison were being selectively butchered over their male counterparts, leading to an abundance of certain male elements in the assemblage. Hjermstad (1996:25) reported four radiocarbon dates from the site: 1490 ±90 ^{14}C yrs BP (Beta 69005), 1270 ± 140 ^{14}C yrs BP (S-3546), 1340 ± 60 ^{14}C yrs BP (Beta 69004), and 1160 ± 170 ^{14}C yrs BP (S-3547). He dismissed the S-3546 and S-3547 dates as the standard deviations for these samples was too high, and indicated that the Beta samples reflected a more accurate representation for the age of the site.

Melhagen (EgNn-1)

The Melhagen bison kill site is located in the Aiktow Sandhills in Saskatchewan, and excavations uncovered five separate concentrations of bison bone (Ramsey 1991). These concentrations of bison bone are thought to be from multiple kill events at the site during the Besant Phase, a conclusion based on numerous projectile points that fit within this typological form. The majority of the projectile points are made from KRF, although Swan River Chert and quartzite are common as well. Ramsey (1991:165) analyzed the mandibles from the site, and determined that the communal hunting occurred most intensively during the fall and tapered off throughout the winter and into the spring. Ramsey (1991:287) published six radiocarbon dates from the site, 1960 ± 90 ^{14}C yrs BP (S-491), 1910 ± 70 ^{14}C yrs BP (S-1640), 1710 ± 45 ^{14}C yrs BP (S-1641), 1905 ±110 ^{14}C yrs BP (S-2855), 1575 ± 115 ^{14}C yrs BP (S-2856), and 810 ± 205 ^{14}C yrs BP (S-2857). The last sample is likely erroneous, as it lands outside the Besant interval and has a wider error range.

Elma Thompson (EiOj-1)

The Elma Thompson site is a Besant stone circle site in west central Saskatchewan (Finnigan and Johnson 1984). At this site, found southwest of Flaxcomb, excavators uncovered a stone circle with a hearth and rock-filled pit in a 27 m^2 excavation. The stone circle was exposed on the surface, with 57 rocks in ring measuring 4.64 m north-south and 4.72 m east-west. Finnigan and Johnson (1984) reported that the hearth was east of the ring, and measured 35 cm by 45 cm. The rock filled pit was partially under the west side of the stone circle. The site produced low concentrations of cultural material; the only diagnostic artefacts recovered from the site were two Besant projectile points made from local material. The Elma Thompson site was radiocarbon dated to 1675±145 ^{14}C yrs BP.

Manitoba

The Kain Site (DlLw-11)

The Kain site is a multicomponent campsite on a terrace overlooking Willow Creek near the Assiniboine River and Chater, Manitoba (Nicholson 1994). Excavations at the site revealed several paleosols with stratified Late Precontact occupation horizons. A Besant/Sonota horizon was defined around the depth of 45 cm below the surface, based on a Sonota projectile point and an associated radiocarbon date from bone that produced an age of 1700 ± 100 ^{14}C yrs BP (Nicholson 1994). Lower in the profile, a Pelican Lake occupation was defined based on a projectile point and a radiocarbon date of 2065 ± 100 ^{14}C yrs BP, although the Pelican Lake projectile point would fall within range of variability seen within Besant and Sonota assemblages. KRF is common at this site, but the use frequency for this material peaks during the Besant/Sonota and Pelican Lake occupations (Nicholson 1994:195). Nicholson remarked that the Kain site fell within the KRF source area as defined by Ahler (1977), although only finished tools and debitage were recovered from the site.

Richards Kill (DhLw-2) and Richards Village site (DhLw-1)

The Richards Kill and Village site is a pair of sites near the town of Killarney, Manitoba, in the southwestern part of the province. The site was initially discovered by the landowner, J. C. Richards, who uncovered a concentration of bison bone and projectile points in a slough while breaking a field (Hlady 1967). Richards returned and excavated a 6.1m by 3 m area, and recovered 83 projectile points, three sidescrapers, and 14 pieces of debitage. Hlady (1967) returned to the site in 1967, and excavated a small 0.9 m^2 test on the edge of Richards' previous excavation. He recovered 11 more projectile points, five pieces of debitage, and bison bone fragments. Hlady attributed all 23 complete projectile points to the Besant Phase, and many of the fragmentary specimens are consistent with this time period as well. The projectile points are primarily made of KRF, comprising 90% of the assemblage. Other raw materials include some type of grey chert and red jasper. Hlady (1967) concluded (based on the amount of projectile points and bison bone) that the site had been used to trap and kill bison in the slough. There are two radiocarbon dates from the Richard Kill site: 1375 ± 120 ^{14}C yrs BP (GX-2059) and 1240 ± 130 ^{14}C yrs BP (GX-1193) (Syms 1977:87).

Approximately 200 m east of this kill site is the Richards Village site (Thompson 1985). The Richards family collected intensively from this area, and the site was tested by Leigh Syms in 1973 and by Ken Pugh in 1974. There were five major collecting sites present at this locale; Sites 1 and 2 are the largest and encompass what is commonly referred to as the Richards Village site. Thompson's (1985:39) analysis of the surface collection demonstrated that the site had been occupied since the Oxbow Phase, extending through Pelican Lake, Besant, Avonlea, and into the Late Precontact. In Site area 2 at the Richards Village site, Besant/Sonota style points make up 60% of the projectile point assemblage. Thompson (1985) also reports six endscrapers and three hammerstones collected from the site. Of all formed tools, KRF comprises 74% of the assemblage. The other five areas at the site produced a variety of material, but Area 2 had the highest concentration of Besant/Sonota diagnostics. Syms (1977:90) reported that the Sonota material from Richards Village contained almost all KRF, as well as one obsidian point, ceramics similar to Sonota examples, atlatl weights, large bifaces, and nodules of KRF that Syms referred to as trading blocks. He further stated that there is at least one burial mound associated with this site. It is not unreasonable to assume that the kill site is contemporaneous with at least part of the Sonota occupation at the village site.

The Calf Mountain Site (DhLo-1)

The Calf Mountain site is a large campsite located on Calf Mountain in Southern Manitoba, with a large burial mound located 0.48 km south of the site (Reeves 1983:358). Chris Vickers amassed a large surface collection from the campsite, demonstrating an occupation spanning from McKean to the Late Precontact. There was a sizeable Besant component from the site, demonstrated by numerous broadly side-notched projectile points largely made from KRF. Montgomery (1910) excavated the burial mound at the site, finding several secondary human burials, copper artefacts, and a number of bison skulls interred in the Mound. An exquisitely carved conch shell mask was recovered from one of the burials (Montgomery 1910: Plate 3). Syms (1977:122) attributed the burial mound to the Devil's Lake-Souisford Burial Complex. Reeves (1983:359) radiocarbon-dated a bone sample from an exposed profile at the site, producing an age of 1105 ± 85 ^{14}C yrs BP (GX-1192). He attributed this age to the Besant occupation at the site. Syms (1977:142) dismissed this association, stating that Reeves' bone sample came from a profile section that also produced a Blackduck rim sherd, and is likely associated with the Blackduck occupation at the site.

Wyoming

Muddy Creek Site Complex (48CR324, 48CR325, 48CR1737)

The Muddy Creek site complex encircles several large clusters of stone circle features, a complete bison pound with preserved wings and ramp, and a large burial mound (Reher 1987). Looters had extensively collected from the site prior to any archaeological investigations, creating difficulties for interpreting different areas of the site. One portion of the site complex, the Upper Village and Burial Mound area (48CR325), contained 32 stone circles located on a high ridge overlooking the valley (Reher 1987), with a large stone cairn/burial mound measuring 13 m by 15 m across and 1.5 m high (Larson and Longenecker 1979). Reher (1987:27) excavated 13 one meter units in the village component of the site, and mapped the distribution of stone circles. He noted a tight double row of 11 stone circles that seemed to be associated, but other circles appeared to represent multiple occupations at the site (Reher 1987:38). Excavators recovered few projectile points from the site, but the sample indicates an occupation extending from the Late Archaic into the Late Woodland period (Reher 1987:59).

The burial mound at the Upper Muddy Creek site (also known as the Shirley Basin Stone Cairn) was extensively looted prior to the excavations at the site, creating a 4 m wide, 1.25 m deep hollow in the centre of the mound. Larson and Longenecker (1979) tested parts of the burial mound, producing a limited amount of bone and shell beads, faunal remains, and two subadult secondary burials. The mound contained a very complex stratigraphy and mound construction process involving layers of white clay, large rocks, and juniper timbers. Reher (1987:36) hypothesized a sequence of events for mound construction: the mound floor was prepared with a covering of white clay, possibly from the excavation of a central burial pit; the burials were placed into the mound and covered over by some type of earth and timber structure, and the mound was then covered by a layer of large cobbles. He suggested that the rock layer could be an addition from later groups at the site. Craigie (1985:43) reported a radiocarbon date from timber in the mound, producing an age of 1720 ± 120 ^{14}C yrs BP (RL-1338). This date places the construction of the mound in line with other Sonota burial mounds in the Dakotas, but the characteristics of this burial mound deviate considerably from other known Woodland mounds.

The Main Village and Pound (48CR324) lie at the foot of the same ridge upon which the Upper Village and Burial mound is located, slightly to the east (Reher 1987). The pound was extensively looted prior to the investigation at the site, with over 400 points known to have been taken from the site. Almost all of the projectile points fall with the range of variation seen with the Besant Phase. The pound was situated in the saddle of a small hill, apparently hidden from view on approach (Reher 1987:42). A single row of posts, rather than a double row fence, was used to construct the pound, as demonstrated by numerous postholes underlying the looted area of the pound. West of the pound were linear rock features, interpreted to be part of the drive lanes leading up to the mouth of the pound. At the west side of the pound structure, surveys noted a large linear cairn measuring 10 m long and 2.5 m. Reher (1987:45) proposed that this feature was used as a ramp into the pound, to trap the animals inside the pound after jumping from the ramp. Estimates of size place the pound between 18 and 24 m across. Frison (1978) radiocarbon dated a sample of bone from the pound, producing an age of 1720 ± 110 ^{14}C yrs BP (RL-394). This result is almost identical to the burial mound, suggesting that they were in use at the same time during the Besant Phase.

The stone circle village associated with the bison pound produced the majority of the artefacts from the site. There were at least 61 stone circle features, although there may be up to 70 including partial stone arcs (Reher 1978:49). The stone circles ranged between 2-7 m in size, with the bulk residing in the 2-5 m range. Over 100 projectile points were collected from this area, with only three specimens falling outside of typical Besant morphology. Bifaces, scrapers, cores, drills, and debitage were collected from the site. Raw material types were incredibly varied, with 117 different types represented (Hughes 1981:56). The majority of the material is locally sourced, but there is some KRF present at the site (Foreman 2010:85).

The South Village (48CR1737) at the Muddy Creek Site Complex contained at least 46 stone circles on a hill southwest of the previous two sites (Reher 1987:52). Reher did not extensively explore this site, as it was discovered late in the field project. There were two main clusters of stone circles at this site, with three particularly large stone circles measuring 8.5 m across. Reher (1987:54) hypothesized that these could have been used by important individuals within the society, or as ceremonial structures.

The Ruby Site (48CA302)

The Ruby site is a single component Besant bison pound site with preserved drive lanes and an ellipsoid ceremonial structure adjacent to the pound (Frison 1971). Located on the side of an arroyo, the site is covered by approximately 3 m of alluvium and colluvium deposits. Frison (1971) excavated the site during two field seasons, and then used heavy equipment to strip the sediments down to the occupation horizon, exposing the large distribution of bison bone, postholes, and other features. Many of the postholes had bison long bones and long flat stone jammed along the walls of the feature. The postholes were concentrated around the bone bed, and also formed two rows of parallel postholes running north from the site. Frison (1971:77) interpreted this as part of the wing used to corral animals into the pound. East of this wing was an elliptical posthole structure with preserved juniper timbers, bison bone uprights, and complete bison skulls. This was thought to be a ceremonial structure, associated with rituals focused on the success of the kill (Frison 1971:85). Excavators recovered 201 projectile points from the site, with 102 complete or near complete specimens (Hamza 2013). Most projectile points were made from quartzite (58), but KRF (7), chalcedony (15) and various cherts (15) were present as well (Hamza 2013:126). Frison (1971) radiocarbon dated the bone bed, producing an age of 1670 ± 135 ^{14}C yrs BP (GX-1157).

Montana

Wahkpa Chu'gn (24HL101)

The Wahkpa Chu'gn site is a multicomponent Besant bison kill site west of Havre, Montana (Brumley 1973). Four separate occupations areas were defined at the site; Area A had the deepest archaeological deposits from successive bison kills at that location (Brumley 1973:3), and Areas B, C, and D contained stratified cultural deposits from processing camps and some evidence of kill activities. Excavators also uncovered several postholes into the sterile sediment underlying the occupation horizon, suggesting that some type of pound structure had been used at the site. The earliest use of the site was dated to 2000 ± 70 ^{14}C yrs BP and the latest occupation dated to 1440 ± 80 ^{14}C yrs BP (Brumley 1973:3).

The Dago Hill site (24CA72)

The Dago Hill site is a Besant bison kill site in Cascade County, east of Simms in Montana (Shumate 1976). Excavators found a large bison bone deposit on a valley edge along the Sun River, measuring 27 m along the landform and 0.46 m thick (Shumate 1976:14). The bone bed was imbedded into a matrix of fine to coarse gravel, and was capped by a thin layer of clay. Shumate (1976) reported 88 Besant projectile points, two knives and one endscraper from the site. The points are made of a variety of raw materials, such as jasper (41), chert (13), chalcedony (11), agate (9), KRF (5), siltstone (2), obsidian (1), and a variety of other local materials (Shumate 1976:15). They dated the obsidian projectile point using obsidian hydration, producing an age of 5015 ± 110 years BP. This age is well outside the Besant Phase, and likely is not an accurate result.

The Stelling site (24CA73)

The Stelling site is another Besant bison kill site near the Dago Hill site, situated on the same terrace edge along the Sun River, west of Fort Shaw in Montana (Shumate 1976). The site has two buried components at the base of a short steep slope, and is relatively small due to erosion. The bone bed extends 18 m along the exposed bank, and is capped by 1.04 m of sterile clay (Shumate 1976:20). The first bone layer component at the site is 0.2 m thick with a fine to medium gravel matrix, followed by a 0.28 m thick clay strata, and another 0.61m of bone mixed with fine and medium gravel. Excavators recovered projectile points only from the lower component. These are made from jasper (11), chert (7), chalcedony (6), obsidian (2), agate (1), and quartzite (1) (Shumate 1976:22). A single quartzite biface was recovered from the site.

Reeves (1970:257) sampled bone from the Stelling site for radiocarbon dating, producing an age of 660 ± 120 ^{14}C yrs BP. He rejected the results of this date as being too late to fall into the Besant Phase. Even calibrated at two sigma, this date falls well outside of the accepted time range for the Besant Phase. Shumate (1976:26) had the obsidian projectile points dated using Obsidian Hydration, producing dates of 1900 ± 90 years BP and 2700 ± 90 years BP. Shumate questioned the reliability of these obsidian hydration dates, and given the questionable radiocarbon date, the true age of this site is not known.

The Mini Moon site (24DW85)

The Mini Moon site is Besant campsite located in the Upper Badlands of eastern Montana, near the North Dakota border (Hughes 1991:27). Excavators found two buried components at the site: the upper occupation horizon dated to 1520 ± 70 ^{14}C yrs BP (Beta-10044), and the lower occupation produced two dates of 1910 ± 80 ^{14}C yrs BP (WSU-2379) and 1930 ± 80 ^{14}C yrs BP (WSU-2380) (Hughes 1991:28). The occupants of this small campsite hunted bison, deer, and variety of small game during the warm season, based on the abundant faunal remains and pollen from the soil samples. Excavators recovered a large variety of artefact types from the site, including projectile points, biface, scrapers, drills, and cores as well as plenty of FCR. Raw materials were mostly local, but there was some KRF from North Dakota present. Hughes (1991) analyzed the spatial distribution of artefacts and faunal remains in relation to the features at the site. Using ethnographic analogies involving men's and women's roles in large game focused societies, Hughes determined that there were gendered work areas where women were cooking and processing animals for food, and where men were fashioning tools around a hearth.

North and South Dakota

High Butte (32ME13)

Wood and Johnson (1973) published a report on the High Butte site and mound near Garrison Dam, Mercer county in North Dakota. The site is situated 60 m above the nearby flood plain, with the burial mound 400 m away. The burial mound measured 26 m long by 9 m wide and 0.6 m high (Wood and Johnson 1973:36). The most intriguing feature of the site was the effigy found at the camp site. During some point of the occupation, the turf was cut a few inches deeper from a 7.62 by 5.18 m area to form effigy in the shape of a turtle (Wood and Johnson 1973:40). This turtle effigy was surrounded by six shallow oval depressions roughly six meters in diameter.

Wood and Johnson (1973:40) tested one of these shallow oval depressions during the summer of 1969. They excavated a 6.1 m by 6.1 m area to a depth of 0.3 m foot over one of these surface depressions. Most of the artefacts came from 0.2 to 0.3 m below the surface, but the excavators never reached sterile sediment. Wood and Johnson (1973) uncovered several concentrations of crushed bone meal in a two to five centimeter thick layer, ranging up to 1.4 m^2 in size. There were two hearths at the same level as the bone meal concentrations, one of which was ringed with stones. A radiocarbon date of 1600 ± 150 ^{14}C yrs BP (N1428) was produced from a hearth (Wood and Johnson 1973).

There was extensive surface collection carried out at the site, producing a sizeable artefact assemblage (Wood and Johnson 1973:45). The most common material was KRF, making up 91% of all artefact types and 90% of all debitage. The next highest raw material type was porcellanite, making up 6% of all artefacts and 2.7% of the artefact classes. There were only 12 cores from the site, which Wood and Johnson (1973:45) remarked was odd considering the abundance of material from the site and the proximity to KRF quarries nearby. Also recovered from the site was a pendant made from canid third incisor, several bone fragments thought to be residue from making bone beads, a split rib knife, and a polished long bone (Wood and Johnson 1973:59-61). The faunal remains were predominately bison, but some deer elements were recovered. All of the fragments were small, averaging 2 cm with none exceeding 10 cm. Wood and Johnson (1973:62) also reported *Ligumia recta* (mussel) shell fragments from two specimens from this site, an occurrence that they thought was unusual.

Glenharold Mine (32OL270)

The Glenharold Mine site is a Besant stone circle site located in west central North Dakota on the south side of the Missouri River valley (Fredlund *et al.* 1985). The site was excavated and mapped as part of a mitigation effort in advance of mining activity in the area. The sod was stripped using heavy equipment to expose the occupation layer, unveiling 11 stone circles with several hearth, pit, midden, posthole and upright features around the site. These features were mapped, but only two stone circles were excavated. Excavators collected few ceramic body sherds from the site, and most specimens exhibited characteristics typical of Plains Woodland pottery (Fredlund *et al.* 1985:132). Other diagnostics include 50 Besant projectile points and two Pelican Lake-like points. Interestingly, KRF accounted for approximately 95% and 69% of all the lithics from the two stone circles excavated and TRSS only accounted for 25% and 3% of these lithic assemblages (Fredlund *et al.* 1985:135). This is significant as raw cobbles of TRSS could be found in the local environment, but the occupants still preferred to utilize KRF. Fredlund *et al.* (1985:136) also reported charred *Chenopodium sp.* (goosefoot) seeds from the site.

Researchers submitted numerous radiocarbon samples from the site, and determined that there were two periods of occupation that occurred at the site (Fredlund *et al.* 1985:136). An early Besant occupation occurred at the site between 1590 and 1410 ^{14}C yrs BP and a later Besant occupation occurring between 1066 and 860 ^{14}C yrs BP. The results of the radiocarbon dating are summarized in Table 2.1.

Table A.1: Radiocarbon dates from 32OL270 with features sampled and associated stone circles. Adapted from Fredlund *et al.* (1985:129-131)

Sample ID	Feature #	Ring #	Feature Type	Sample	^{14}C Date	Sigma
Beta-7307	1	4	Midden	Charcoal	1070	100
Beta-7775	15	4	Upright	Charcoal	1780	60
Beta-7776	33	9	Midden	Charcoal	1660	110
Beta-7957	3	4	Midden	Bone	860	80
Beta-7958	7	9	Hearth	Charcoal	900	90
Beta-7959	8	9	Upright	Bone	1310	100
Beta-7960	14	2	Upright	Bone	1450	100
Beta-7961	19	3	Hearth	Bone	1470	80
Beta-7963	34	5	Hearth	Charcoal	1070	150
Beta-8145	25	8	Upright	Bone	1450	70
Beta-8146	28	5	Upright	Bone	1430	70
Beta-8147	36	9	Hearth	Charcoal	1070	100
Beta-8588	20	4	Hearth	Bone	1740	110
Beta-8590	29	9	Midden	Bone	1210	100

Porcupine Component (32SI6)

Neuman (1975) referred to the Porcupine Component as a potential habitation site for the Boundary mound builders. Located 6.5 km upstream of the Boundary Mound Site, the site rests on the lowest terrace overlooking the junction of Porcupine Creek and the Missouri River valley (Scheans 1957:43). In 1957, Sheans (1957) excavated 17 test pits and trenches at the site, and recorded three buried components at the site, the Young Component, X Component, and the Porcupine Component. Excavators collected a variety of historic and protohistoric artefacts from the first component, and the second component produced only a small number of pot sherds. The third component at the site producing cord roughened pottery, broadly side notched and corner notched projectile points, a variety of scrapers, and some bone tools. Seven of the projectile points were made from KRF, one was made from TRSS, and one specimen was made from petrified wood (Scheans 1957:63). Excavators also recorded two basin-shaped hearths in this level, and a bone upright containing three bison long bones situated next to one of the hearths. Scheans (1957) noted the similarity between the material culture in the Porcupine Component and what Neuman (1975) recovered at the

Boundary Mounds, and postulated that the two sites might have similar ages. Reeves (1983:262) submitted a bone sample for radiocarbon dating, and the analysis produced an age of 1545 ± 80 ^{14}C yrs BP (GAK-1505), a result close to the later period of mound building at the Boundary Mound Site.

The Schmidt Site (32MO20)

Neuman (1975:79) excavated the Schmidt site in 1960, testing one of the eight burial mounds at the site. This 22.8 m wide, 0.39 m high burial mound had a burial chamber with vertical walls and a flat bottom extending 1.09 m below the original ground surface. The edge of the burial pit on the original ground surface was lined with limestone slabs and charred wood fragments. The burial pit contained one secondary interment of an adult male, comprised of a skull and a stack of long bones on the burial chamber floor. Next to the burial pit on the mound floor was a partially articulated bison skeleton. Neuman (1975:79) reported only three artefacts recovered from the excavation, two knife fragments and a point tip, all made from KRF. Based on the articulated bison skeleton, the style of mound construction, and the inclusion of KRF, Neuman (1975) thought that the Schmidt site was related to other Sonota sites in the region.

The Boundary Mound Site (32SI1)

The Boundary Mound Site contained four burial mounds on the first terrace on the west side of the Missouri River valley, bounded on the south by John Grass Creek, and the west by an abandoned railroad cut (Neuman 1975:64). There were two periods of excavation that occurred at the site, one carried out by Wood (1960) in the summer of 1956, and another directed by Neuman (1975:64) in the summer of 1960. Wood excavated the western-most burial mound that was impacted by the rail road cut, and designated it Mound 1. Neuman excavated the remaining three burial mounds, and labelled them Mounds 1, 2, and 3, at the time identifying the mound Wood excavated as Mound 4. He later rectified the duplication by referring to the burial mound excavated by Wood as Mound 1A (Neuman 1975:64).

Mound 1 from the Boundary Mound Site measured 22.86 m across and 0.82 m high at the apex. In the centre of the burial mound, dug into the original ground surface, was a pit measuring 3.05 m by 1.67 m and 0.91 m deep. This subfloor pit contained four secondary burial locations with at least 15 individuals interred, representing a variety of age groups and sexes (Neuman 1975:65). The burial pit was not covered by anything, but timbers were exposed running parallel to the long axis of the feature. The mound floor produced a multitude of bison remains, including 18 intact skulls, and at least another 15 fragmentary crania, as well as one articulated bison skeleton (Neuman 1975:66). One cluster of bison skulls also had an intact canid skull, placed upside and oriented in the same direction as all the bison skulls.

Several artefacts were directly associated with the burials, most notably a collection of projectile points associated with Burial 5. This burial locale contained the secondary burials of two children, comprised mainly of the axial skeleton and some articulated long bone elements. Both individuals were placed in a supine position with their crania lying on the burial pit floor. The second individual was buried in a matrix of purplish-brown, red, and yellow pigments, with six projectile points, heavily coated in red ocher, lying in a ring on top of the rib cage (Neuman 1975:65). Further associated with this burial cluster were two more projectile points, one biface, two drills, two atlatl weights, a small bone bead, and some very small shell fragments. Burial 2 also produced an interesting assortment of artefacts, including a very large broad side-notched point made from KRF. Neuman (1975:67) drew parallels between this specimen and the Snyders Point, a biface form associated with Hopewell. Other artefacts found in this burial mound include a tubular bone bead made from a small mammal, a small bone bed with a dentalium shell bead inside of it, a canine tooth pendant, another pendant with two drilled holes and spiral grooves carved into the end, and a pendant made from the incisor portion of a canid maxilla. Neuman (1975:70) radiocarbon dated timbers from the mound floor, producing an age of 1540 ± 160 ^{14}C yrs BP (II-499).

Mound 2 from the Boundary Mound site was slightly asymmetrical, measuring 18.29 m by 20.42 m and reaching a height of 0.85 m above the existing ground surface. In the centre of the burial mound was an ovoid subfloor burial pit, measuring 1.92 m by 3.35 m and extending 1.22 m into the ground. Unlike other burial chambers in Sonota mounds, this pit had a step dug into the east wall of the feature (Neuman 1975:70). The pit walls and floors were covered by a poorly preserved mat made from interwoven grass. There were three secondary burial locales inside the burial chamber, representing at least seven individuals. Massive timbers had been placed on top of the burial pit, crossing the narrow end of the pit. Neuman (1975:71) inferred that these timbers originally were used as supports for some type of covering over the top of the burial pit. Excavators uncovered two complete bison skulls and one articulated bison axial skeleton on the mound floor. The only artefacts of note were associated with Burial 3, a single interment of a skull and long bone fragments in a tight cluster. This burial produced an atlatl weight as well as several bear maxillae that were heavily stained with red ochre and incised to be worn like a pendant (Neuman 1975:71). A small obsidian biface was also collected from the burial pit fill. Wood samples from the timber in the burial pit produced a radiocarbon age of 1340 ± 150 ^{14}C yrs BP (II-498).

Mound 3 was the largest burial mound at the site, measuring 25.91 m across and 1.74 m high. In the central area of the burial mound floor was a rectangular subsurface pit measuring 3.2 m by 1.98 m and 1.28 m deep. Like Mound 2, the walls of the burial chamber were lined with a woven grass mat. Neuman (1975:74) estimated that there were 24 individuals interred in the burial pit, in 10 separate secondary burial locations. On the mound floor, around the periphery of the burial pit, excavators found complete segments of charred timbers reaching 2.13 m long and 0.3 m in diameter. These timbers did not extend over the pit, but rather seemed to act as supports for some other covering. One complete bison skeleton and an articulated axial skeleton from a bison were recovered around the burial pit, as well as a complete bison skull.

Most of the artefacts recovered from the burial pit are associated with Burial 9. This secondary burial locale contained the skull and long bone elements from an adult, with infant remains intermixed, resting against the burial pit wall. Interred with these individuals were a variety of large, highly polished tubular bone beads made from small and medium mammals, a very long and polished antler pin, and worked beaver mandibles (Neuman 1975:76). These beaver mandibles were incised in front and behind the tooth row, and were likely worn as pendants. Burial 4 produced several human mandibles and maxillae segments that had been purposefully ground, shaped, and coated with red ochre (Neuman 1975:77). Two specimens were fashioned from the palate; the teeth were ground down to the roots and the entire element was coat in red ochre. The other three specimens were made from the horizontal ramus of the human mandible, in which the cortical bone was ground and smoothed all around the alveolar process (Neuman 1975:77). Given the contents of the burial pit, and the larger size of the mound, Mound 3 stands out as divergent from other Sonota burial mounds. There are many similarities, but definitely some striking differences. Neuman (1975:77) radiocarbon dated charcoal from the burned timbers, producing an age of 2200 ± 125 ^{14}C yrs BP (II-414), making it the oldest Sonota burial mound.

Mound 1A (i.e., Wood's Mound 1, Neuman's Mound 4) was tested by Wood (1960), as it had been partially impacted by the railroad construction. He profiled the exposed section of the burial mound, and placed a narrow excavation trench through the centre of the burial mound. At the centre of the burial mound, Wood (1960:72) noted a rectangular burial pit that measured 3.05 m across and 0.61 m deep. This burial chamber had been covered over with a number of timbers, which had collapsed into the hollow burial chamber after the mound was constructed. The excavators uncovered five secondary burial locales within the pit, containing a variety of human long bone and cranial fragments placed in what appeared to be bundle burials (Wood 1960:74). Burial locale 2 had a tight concentration of lithics, a grooved pendant, antler, endscrapers, and eight projectile points, all coated in red ochre. Wood (1960:74) hypothesized that the associated artefacts had been placed there inside of a pouch filled with red ochre.

Alkire Mound Site (32SI200)

The Alkire Mound site is in Sioux County, North Dakota, approximately 3.2 km north of the Boundary Mounds (Neuman 1975:79). The mound is 27 m in diameter and 0.85 m high, and was comprised of a central burial pit into the mound floor, capped by logs and overlain with earth. The ovoid burial pit was 2.77 m long by 1.86 m wide and 1.10 m deep, and contained one primary and five secondary burials. The primary burial was coated in hematite, and placed in a seated position against the wall of the burial pit with the feet outstretched. The secondary interments also were coated in hematite, and consisted of some articulated elements and bundles of long bones and skulls (Neuman 1975:80). The excavators noted the presence of basketry impressions in the clay of the burial pit around the interments. They also found a side-notched point, a utilized KRF flake, a bone awl, and five plain pot sherds in the burial mound. A wood sample from the site was radiocarbon dated, producing an age of 1650 ± 200 ^{14}C yrs BP (SI-310).

Swift Bird Mound Site (39DW233)

Neuman (1975:38) excavated two burial mounds at the Swift Bird Mound site, as well as a later, unrelated house structure that was directly adjacent to one of the burial mounds. The site is situated on the first terrace overlooking the Missouri River valley to the east and a small ravine to the south, the same landform upon which Grover Hand, Stelzer, and Arpan were situated. Mound 1 at the site measured 21.34 m in diameter, and reached 0.88 m above the surround ground surface. In the centre of the burial mound, excavated into the original ground surface, excavators found a burial chamber measuring 11.5 m by 2.07 m and 0.88 m deep (Neuman 1975:39). The burial pit contained at least 13 individuals in four secondary burial locations, seemingly placed into the burial pit in bundles of long bones, cranial elements, and axial segments. Excavators recovered at least 17 individuals from the burial mound, with five adults and 12 sub-adults identified (Neuman 1975:127). Several segments of charred timber were found on the edge of the burial pit, which appeared to have covered the burial pit. Some of the timbers had fallen into the pit, and appeared to have charred the interments located in Burial 5; Neuman (1975:40) interpreted this feature as evidence that the burial pit was covered with timber and fired prior to the construction of the mound superstructure. The burial pit was not filled with sediment until after the fire. Directly west of the burial pit were two nearly complete articulated bison skeletons.

Neuman (1975:41) described several different classes of artefacts from this burial mound. There were four pot sherds recovered from the mound, but all the specimens were found either on the surface or within the first few centimeters of sod and are consistent with much later ceramic traditions. Two side-notched points consistent with Besant were found in the burial pit, made from a red chert and a translucent chalcedony. Also recovered from the burial pit floor was an atlatl weight made from the centre column of a conch shell, measuring 15 cm long, with grooves incised at each end of the weight (Neuman 1975:42). Probably the most fascinating artefact recovered from any of the Sonota burial mounds is the "Thunderbird" pendant. Found with Burial 1 in the burial pit, this artefact was made from an unknown type of marine shell, and was carved into the shape of a bird in flight, with incisions to simulate the feathers. Another artefact of note is a small bacculite segment that was found in the upper sediments of the burial pit fill. If Neuman's hypothesis regarding the burning of the timbers and the subsequent collapse into the burial pit is correct, this artefact would have originally placed on top of the burial pit. A similar fossil was found in the Arpan Mound 1. These fossils are associated with ceremonial activities across the northern Plains (Peck 2002). Neuman (1975:42) dated charcoal from timber in the burial pit fill, producing a radiocarbon age of 1825 ± 120 ^{14}C yrs BP (I1-718).

Mound 2 from the Swift Bird site measured 22.86 m in diameter, and had an apex of 0.94 m above the surrounding ground surface. In the centre of the mound was a subfloor ovoid burial chamber with vertical walls, measuring 3.17 m by 1.95 m, extending 0.76 m beneath the original ground surface. The burial chamber contained 32 individuals placed into five secondary burial locations. Neuman (1975:43) noted that most of the burials were placed in the northern third of the pit, leaving the southern two-thirds largely empty. Excavators collected nine further individuals from the mound floor, bringing the total number of people interred in the burial mound to 42. Sub-adults dominated the population demography, with 30 subadult individuals represented as compared to 11 adults (Neuman 1975:127). The majority of the sub-adults fell within the under two years of age bracket. Other than the human remains, Neuman (1975:44) estimated that remains of 18 bison had been included on the mound floor, in varying degrees of completeness and articulation. Like Mound 1, the edge of the burial pit in Mound 2 had evidence of several segments of timber, although Neuman (1975:43) did not observe any sort of covering for the burial pit.

A single projectile point was recovered from the mound floor, a crudely shaped side-notched point made from petrified wood. Excavators collected several bifaces and scrapers from the mound, largely from the mound floor. One marine shell pendant made from *Olivella sp.* was recovered from the burial pit fill, as well as a small chalcedony biface fragment. Neuman (1975:45) dated a wood sample from the edge of the burial pit, and obtained an age of 1600 ± 100 ^{14}C yrs BP (II-719).

Grover Hand Site (39DW240)

The Grover Hand site is situated across from a deep ravine that borders the northern edge of the Stelzer site, along a vertical bank on the first terrace overlooking the Missouri River valley. Neuman (1975:47) excavated three out of the four burial mounds at the site. Mound 1 was the largest burial mound at the site, measuring 24.38 m in diameter and 1.28 m high at the apex (Neuman 1975:48). At the centre of the mound was a subfloor burial pit, measuring 1.95 m by 3.47 m and 0.76 m deep below the original ground surface. The burial chamber contained eight separate burial locales with primarily human long bones and skulls, representing at least 48 individuals. Overlying the pit was a mass of timbers, some of which were charred, but not in sufficient amount to cover up the burial pit. On top of the burial pit fill, in line with the original ground surface, was another secondary burial of an adult female lying on her back. Neuman (1975:49) hypothesized that the burial pit must have been filled in and covered by a hide or some type of vegetation that did not preserve; otherwise the secondary burial of the adult on top of the burial pit would have fallen in. Like other Sonota burial mounds, piles of bison skulls and articulated bison skeletons were found around the burial mound floor. In total, the burials in Mound 1 represent 52 individuals, with roughly equal proportions represent by adults and sub-adults. However, the largest age categories represented in the mound are three to six years old and under two (Neuman 1975:110).

Neuman (1975:51) recovered a fair number of artefacts from this mound, including five pot sherds, four projectile points, 21 bifaces/knives, four scrapers, one flesher, two awls, and several artefacts made from shell. Some of these artefacts were found generally associated with the articulated bison skeleton and skulls, but many artefacts were directly associated with burials in the pit. Three of the projectile points were complete, and one specimen was a point tip fragment. Neuman (1975:53) used charcoal radiocarbon samples from the burial pit fill to produce an age of 650 ± 200 ^{14}C yrs BP (SI-167). This result is far outside of the Besant/Sonota Phase, and warrants reconsideration. Given that the contents of the burial mound and the diagnostic artefacts within all correspond with characteristics typical of the Besant/Sonota Phase and not later periods, it seems likely that the radiocarbon determination of age is incorrect and that this mound should be resampled to establish a more precise estimate of age.

The second burial mound excavated by Neuman (1975:54) at the site measured 22.86 m in diameter and 0.46 m high above the ground surface. Located in the centre of the mound was a rectangular burial pit measuring 2.74 m by 1.92 m and 0.76 m below the original ground surface of the mound. All of the burials were found within this pit, containing 25 individuals in six secondary burial locales. Unlike Mound 1, Mound 2 contained more adults than sub-adults (17 to 8 respectively), with relatively even distribution between the age brackets, with the highest proportions of the population represented in the over 41 category and the 7-12 age bracket (Neuman 1975:110). Excavators noted that the top edges of the burial pit had sections of timbers that extended over the burial pit fill, but sufficient to cover the entire feature (Neuman 1975:54), as well as several bison skeleton remains placed on the burial mound floor. Neuman (1975:66) used wood samples from the burial pit for radiocarbon dating, producing an age of 1640 ± 80 ^{14}C yrs BP (SI-168).

Excavators recovered a single projectile point from this burial mound, a small projectile point with a single notch and concave base. This projectile point was found in the burial mound fill, but the exact providence is not known. The mound also contained a variety of marine shell pendants and beads, made from *Olivella sp.* and *Dentalium sp.* (Neuman 1975:55). The inclusion of these artefacts demonstrated the long-range trading network connections that were present in the Sonota homeland. Another artefact of note was a slender and highly polished antler pin with a spiral carved into the proximal end, associated with Burial Locale 8 in Mound 2. Boundary Mound 3 produced a similar antler pin specimen (Neuman 1975:76), although their purpose is not known. The tips of these artefacts are blunt and would not function as awls; comparisons have been made to the long slender pegs above the doors of tipis used to hold the front of a lodge together (John W. Ives 2013 personal communication).

Neuman (1975:56) also described a unique artefact associated with Burial 4, a conical pipe bowl fired from some type of greensand material. This artefact had very thick walls, with a series of punctates and incised lines around the rim of the vessel. The base of the artefact was broken off, creating a hollow tube, giving the impression that it was a clay pipe. While the artefact does have a resemblance to modern pipes, the author does not know of any archaeological examples that are similar to this specimen. Most examples of Precontact and Historic pipes on the northern Plains are made from catlinite, a red-brown argillite that is easy to shape and carve. The bowl and elbow of the pipe are carved from a single piece of stone that is then attached to a stem, while the Grover Hand example would need to be attached to an elbow and a stem. Interestingly, this “clay pipe” shows the same decoration motifs as the full-size clay vessels associated with the Sonota complex (Andrew Lints 2014 pers. comm.). If the bottom of the artefact was not broken, it would have formed a perfect miniature replica of the larger Sonota vessel. Toy pots made by children have been documented in other archaeological and ethnographic contexts (P. Smith 2006), and toy arrow and atlatl points are evident from the miniature flake points from northern Plains sites (Dawe 1997). It is within the realm of possibility that this "clay pipe" is actually a toy pot.

Mound 3 at the Grover Hand site measured 16.76 m in diameter and 0.43 m above the original ground surface at the apex (Neuman 1975:56). In the centre of the mound was a rectangular burial pit dug into the original ground surface, measuring 2.53 m by 1.74 m and extending 0.43 m into the ground. The burial chamber contained three individuals in three separate burial locales, but there were several human elements buried throughout the mound fill, outside of the burial pit. There were eight individuals in total, six adults and two sub-adults, but the age demographic was evenly distributed across the different age brackets (Neuman 1975:110). Burial 1 in the pit contained a mostly articulated axial skeleton of a young adult lying on its back, and a large conch shell artefact with two perforations and coated in hematite (Neuman 1975:56). Other artefacts recovered include four projectile points, three bifaces, two scrapers, and two shell beads. Neuman (1975:58) dated wood samples from the burial pit fill, producing a date of 1720 ± 75 ^{14}C yrs BP (SI-48).

Arpan Mound Site (39DW252)

Neuman (1975:59) excavated one of the three burial mounds present at the Arpan Mound site during the summer of 1965. Mound 1 was 21.3 m across, 0.82 m high at the apex, and contained a central burial pit that was 1.92 m by 2.87 m and 0.67 m deep. Inside the burial chamber, excavators found six secondary burial locations that contained at least 35 individuals; the burial population consisted of 13 adults and 22 sub-adults, the majority of which fell within the under two years of age bracket (n=16) (Neuman 1974:135). On the edge of the burial pit were preserved timbers, but there was no evidence that there were timber supports overlying the burial pit (Neuman 1975:61). North of the burial pit, lying on the mound floor were piles of bison skulls and mandibles, as well as an articulated bison pelvis.

A small number of artefacts were recovered from the excavations at the mound, but this mound produced some of the more curious objects. Excavators recovered a mosasaur caudal vertebra fossil from the fill of the burial pit, as well as a bacculite fossil from the mound fill. The inclusion of these two artefacts in the mound is intriguing, as many different groups on the northern Plains incorporated different types of fossils into their ceremonial life (Peck 2002). Another artefact of note is the near-complete four litre ceramic vessel that was recovered from the floor of the burial chamber. Neuman (1975:62) defined a new Woodland ceramic tradition called Arpan Punctate using this vessel, based on the smoothed finish on the interior and exterior of the vessel. There is a single projectile point from the burial mound, a small side-notched arrowhead typical of later projectile point typologies. This point was found in the first 15 cm of the burial mound fill on the east side of the structure, and this stratigraphic positon suggests that it is likely not tied to the construction of the mound. Neuman (1975:63) dated Mound 1 using timber from the edge of the burial pit, producing an age of 1850 ± 90 ^{14}C yrs BP (SI-311).

Appendix B: Muhlbach Artefact Assemblage

This appendix contains more detailed information about the Muhlbach artefact assemblage, including tool descriptions, metrics, and provenience information. These artefacts are depicted in Figure 3.32 and 3.33.All measurements were taken using a Fisher Scientific digital caliper.

FfPb-100-88 – Retouched Flake

Collected from Unit L10, measuring 59 mm by 48 mm and 14 mm thick, this coarse quartzite flake was split from a larger cobble using bipolar percussion. The left lateral margin of the flake exhibits minor unifacial retouch to create a sharp cutting edge. Otherwise, there has been minimal alteration to this unimarginal, unifacial flake tool.

FfPb-100-132 - Retouched Flake

Found in Unit A20, this large chert flake measures 43 mm by 49 mm and 15 mm thick. The left margin near the platform of the flake shows a fine even unifacial retouch along the length of this edge. The other edges of the flake also exhibit fine, uneven edge modification, but these small flake scars could have formed from natural breakage of the edge, and do not seem purposeful.

FfPb-100-77 – Retouched Flake

An excavator found this small KRF flake in Unit A12 underneath a skull fragment. Measuring 42 mm by 21 mm and 4 mm thick, this thin flake still has some cortex near the platform. The edges of the flake have been minimally modified, except for the left margin near the platform. This section has several small flake scars along this edge, creating a sharp surface for cutting.

FfPb-100-178 – Retouched Flake

Found in Unit A23, this small KRF flake measures 29 mm by 18 mm and 5 mm thick. The platform angle indicates that this was a bifacial retouched flake, although cortex is still visible over most of the dorsal surface. Fine, evenly spaced retouch flake scars are present on both margins, but only on the dorsal surface.

FfPb-100-31 – Endscraper

Found in Unit A12, this extremely small KRF endscraper fragment measures 20 mm by 12 mm and 3 mm thick. Broken in half longitudinally, the distal end of the tool has a steep bevelled edge, with minor retouch along the right margin.

FfPb-100-166 –Endscraper

Collected from Unit B14, this KRF endscraper has a steeply bevelled edge on the distal end with minor retouch along the margins, and measures 21 mm by 22 mm and 10 mm thick. Cortex is visible over 50% of the dorsal surface. Due to its small size, this endscraper was likely at the end of its use life.

FfPb-100-179 – Graver

This tool has a heavy patina over the entire surface of the artefact, similar to how KRF develops patina, but not exclusive to that material, making precise identification difficult. It measures 44 mm by 23 mm and 10 mm thick. Found in Unit B14, both margins have rough and uneven retouch that bring the artefact to a thick point. This morphology is similar to other examples of gravers, but the heavy patination has obscured the flake scars and any relevant use wear or edge grinding that would indicate hafting.

FfPb-100-216 – Bimarginal Uniface

Found in Unit A13, this tool was made from a thick tan quartzite flake measuring 41 mm by 43 mm and 13 mm thick. The distal end of the flake is a steep step fracture, but the lateral edges show minor retouch to create a cutting edge. The right edge has flake scars only on the dorsal surface, and the left edge has flake scars on the ventral surface, creating a bimarginally flaked tool with unifacially worked edges.

FfPb-100-? – Biface Fragment (Figure 3.33 bottom left)

Made from a fine white quartzite, this tool exhibits heavy bifacial reduction over the entire surface. Measuring 45 mm by 51 mm and 16 mm thick, it exhibits a large step fracture near the middle of the biconvex biface that presumably broke the tool in half, although it still would have been possible to use the biface as a knife. The right edge of the biface has been heavy ground along the edge towards the tip, while the left edge has fine flake scars along with the larger shaping flake scars on the edge. This configuration suggests that the right side of the biface was hafted, while the left edge was used for cutting. The catalogue number has rubbed off this artefact, and its provenience is unclear.

FfPb-100-? – Biface (Figure 3.33, centre)

Made from a fine quartzite, this complete biface measures 100 mm by 49 mm and 20 mm thick. Asymmetrical in profile and slightly biconvex in cross-section, this biface has numerous flake scars over one face, but minimal alteration to the other. While still bimarginally worked, one margin has been heavily ground along the entire length of the biface, while the other has fine retouch along most of the edge. This pattern is similar to the other bifaces in the collection; this biface was likely hafted longitudinally. There is no provenience information for this artefact.

FfPb-100-276 – Biface Fragment

This biconvex biface fragment measures 31 mm by 31 mm and 9 mm thick. Collected from Unit A19, this fine quartzite biface is much thinner and smaller than the other biface fragment, but also exhibits grinding along one edge, and fine retouch along the other. Both sides of the artefacts have been extensively bifacially worked.

FfPb-100-28 – Biface Fragment

Found in Unit A13, this asymmetrical biface fragment measures 45 mm by 25 mm and 6 mm thick. Made from KRF, a large platform and some cortex are visible on the dorsal surface of the flake. The platform angle indicates that the flake came from core reduction rather than biface reduction. The flake was extensively bifacially worked, but the frequency of fine retouch increases towards the rounded tip of the flake. The left lateral edge of the flake has light edge grinding, extending the same length as the platform. If this area of the biface were hafted, the remaining knife blade extending beyond the haft would have been short.

FfPb-100-177 (C10-574) – Bone Gouge

This tool was fashioned from the shaft of a large mammal metapodial. The proximal end of the tool exhibits a curving spiral fracture, presumably from the initial butchery of the animal. The bone has been shaped along the length of tool, working the shaft fragment to a curved tip. Small, deep “V” shaped chop marks are visible along the side of the bone, likely from the shaping of the bone (Figure

3.34). As well, I observed small flake scars on the tip of the tool, likely produced as pressure applied to the tip of the tool flaked off small chips of bone on the working surface. The surface of the cortical bone is poorly preserved, causing it to peel off in thin flecks. Based on the shape and wear on the tip, this element was likely used as a bone gouge, for either hide working or use on similar soft objects. A sample for radiocarbon dating produced an age of 1625 ± 20 ^{14}C yrs BP with a δ^{13}C value of -19.6 (UCIAMS 131381).

A12-565 – Scapula Spokeshave

This small fragment of the scapular process from a large mammal scapula exhibits a semicircular groove into the cortical bone along the edge of the element. This groove is steeply bevelled and smoothed on one side (Figure 3.35). The side opposite of the groove, which would have been composed of bone from the interior blade of the scapula, has also been worn smooth. The entire specimen shows a polished sheen, likely from use and being handled. The bevelled groove on this bone specimen has similarities to lithic spokeshaves. A sample for radiocarbon dating yielded an age of 1660 ± 20 ^{14}C yrs BP (UCIAMS 131378) with a δ^{13}C value of -19.0.

A12-780 – Awl

This tool has been shaped from a large mammal long bone fragment, exhibiting small cut marks perpendicular to the length of the bone, increasing in frequency near the rounded tip (Figure 3.36). The proximal end of the tool has two spiral fractures that extend along the length of the awl. The cortical surface of the bone is in poor condition, but the bone exhibits a light polish around the tip. I sampled the awl for radiocarbon dating; it yielded an age of 1620 ± 20 ^{14}C yrs BP with a δ^{13}C value of -19.5 (UCIAMS 131379).

A22-192

Shaped from a bison radius, this element has a heavy polish along its curved edge (Figure 3.37). Under magnification, small linear striations can be seen running parallel to the edge; this type of wear is consistent with the edge being used in a slicing motion. In addition, fine, "V" shaped cut marks appear along the edge, suggestive that the bone had been purposefully shaped. This bone tool shows evidence of modification and polish from use, but it is not clear what type of tool or the function it served. It is an expedient tool with minimal alteration. This artefact was radiocarbon dated to 1645 ± 20 ^{14}C yrs BP (UCIAMS 131380) with a δ^{13}C value of -18.8.

C10-127 – Scapula Beamer

This bison scapula exhibits several spiral fractures at the proximal end of the fragment, presumably from techniques used during initial butchery to remove the forelimb from the axial skeleton. These strong blows at the neck of the scapula were needed to break the thick cortical bone and separate the scapular head from the rest of the element. I observed this type of breakage frequently in the rest of the Muhlbach faunal assemblage, in which the head of the scapula was broken off with a series of blows, resulting in large spiral fractures around the neck of the element.

There is further alteration along the interior side of the scapular process. Running parallel to the scapular process, on the dorsal side of the scapula, are a series of broad flake scars creating a steep, sharp edge along this side of the bone fragment. This alteration to the scapula is not the result of butchery, as there is no need to remove the cortical bone at the centre of the scapular blade. Any meat in this region of the carcass either is already on the dorsal side of the scapula, or was removed when the scapular head was smashed off. In this region of the element on other scapulae specimens in the collection, the cortical bone either shows linear fractures from drying and abrasion, or is intact; this is the only specimen in the collection that shows this kind of alteration. Furthermore, these flake scars can only form while the bone was still greasy and fresh, as dry bone does not conchoidally fracture.

This element has been shaped for use as a beamer: a tool used in the dehairing and fleshing stages of hide processing. Beamers are often made from ribs, but have also been made from scapulae like the example here. While this tool has been purposefully shaped for use, it likely was an expedient tool and received limited use before being discarded.

Appendix C: Review of Stelzer Features

This review of features from the Stelzer site is drawn from Neuman's (1975), original site records, maps, and photographs. All black and white photographs are courtesy of the South Dakota State Historical Society, and the colour photographs are provided by John Brumley. Site maps and features number references can be found in Chapter 6 and within this appendix (Figure 6.7, C.12-6.17). The site excavation was recorded following the Feature system; a system of recording in which excavation trenches and even certain field notes are recorded as features. As a result the numbering of features in the site is not always sequential. Feature 20, 21, and 67 are omitted for this reason, as they represent descriptive field notes of the overall excavation, rather than physical archaeological features. Feature 52 and 53 are omitted as well because they are descriptions of soil monoliths taken for profiling. Furthermore, the excavation of multiple areas at the site led to different features receiving the same feature designation. While attempting to stay true to Neuman's original feature numbers, new designations will be given to site features in order to better organize the features as to illustrate the extent of activities occurring at the site.

Area 1, Excavation Unit 1

Feature 1

Feature 1 is an irregular basin shaped pit, measuring 54.9 cm by 48.8 cm and 27.4 cm deep. The pit contained 8 small fragments of mammal bone, three of which were later identified as bison: a left distal humerus, and a right and left distal tibia.

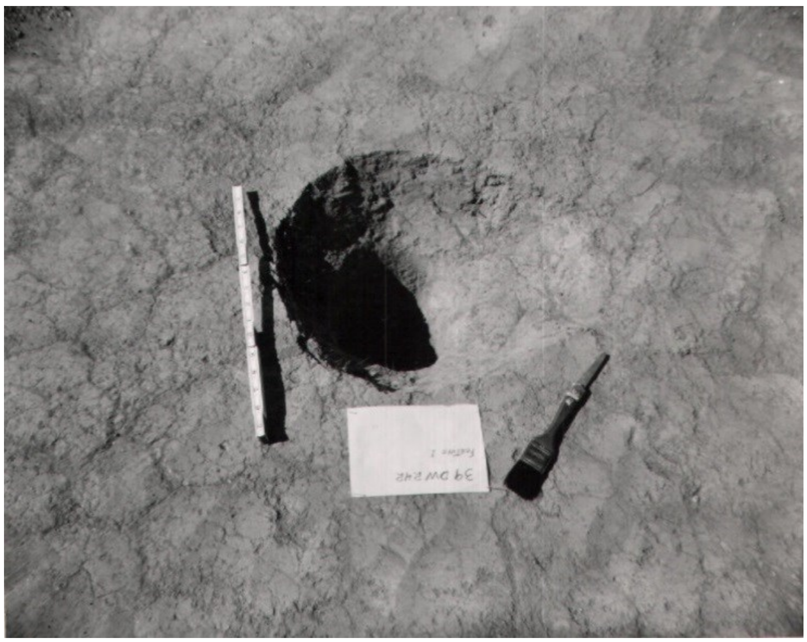

Figure C.1 : Feature 1 after being cored, view northwest.

Feature 2

Feature 2 comprises of a large midden overlying a small shallow pit, located in four separate excavation units. The midden feature measured 2.01 m long by 1.83 m wide, and the pit feature measured 1.4 m long by 91.4 cm wide and 15.2 cm deep. The midden and pit contained a variety of artefacts including two body sherds, a scraper, a drill fragment, two small utilized cores, a hammerstone, chopper, a bone awl, a utilized flake, and approximately 85 fragments of bone. Of the 85 fragments recovered, 32 were identified to species and element. There were two canid elements, a left scapula and left mandible, and one white-tail deer left distal tibia. The remaining elements were bison, which included two right and one left horn cores, two right maxillae, one thoracic vertebra, 5 right and two left distal tibias, two right astragalus, two right cuboids, two right proximal and one right distal metatarsals, six first phalanges, two second phalanges, and two third phalanges. Neuman also reported that there was an articulated lower portion of a bison limb in the feature.

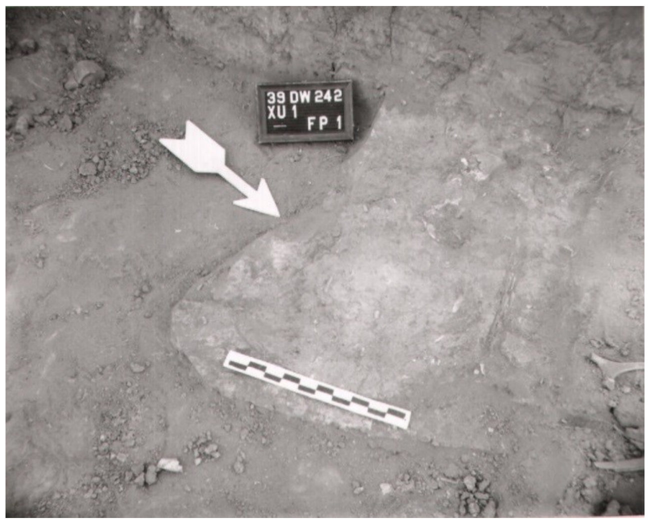

Figure C.2 : Feature 2; mislabelled as Firepit 1, view southwest.

Figure C.3 : Feature 2 with articulated limb segment, view southwest.

Feature 3

Feature 3 is a small midden deposit of bone, measuring 39.6 cm long by 30.5 cm wide and 9.1 cm deep. The feature contained a scraper, and 15 bone fragments, none of which have been identified.

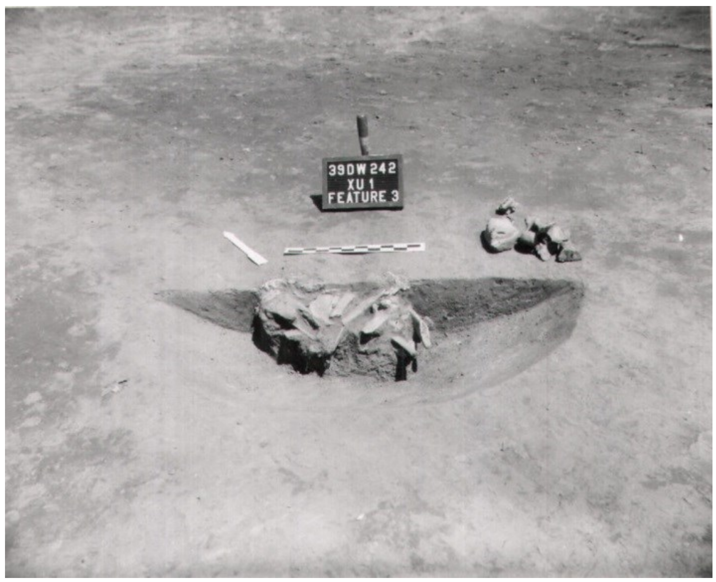

Figure C.4 : Feature 3 cross-sectioned, view northeast.

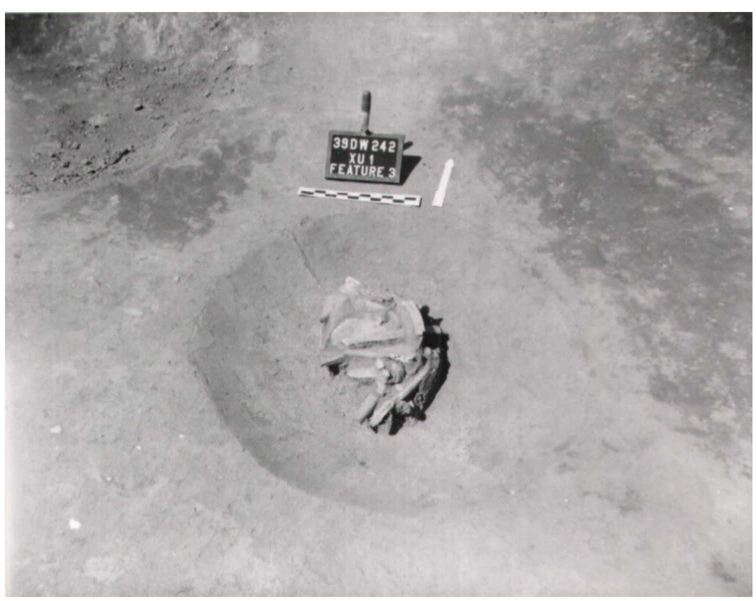

Figure C.5 : Feature 3 on pedestal, view north.

Feature 4

Feature 4 is a midden overlaying a small basin-shaped pit. The midden measured 2.19 m long by 1.03 m wide, and the pit measured 91.4 cm long by 91.4 cm and 12.2 cm deep. This feature contained a body sherd, a biface, one possible mano, two scoria abraders, a broken bone awl, 25 pieces of debitage, and 46 bone fragments. None of the faunal remains in this feature have been identified, but the feature did contain small amounts of charcoal.

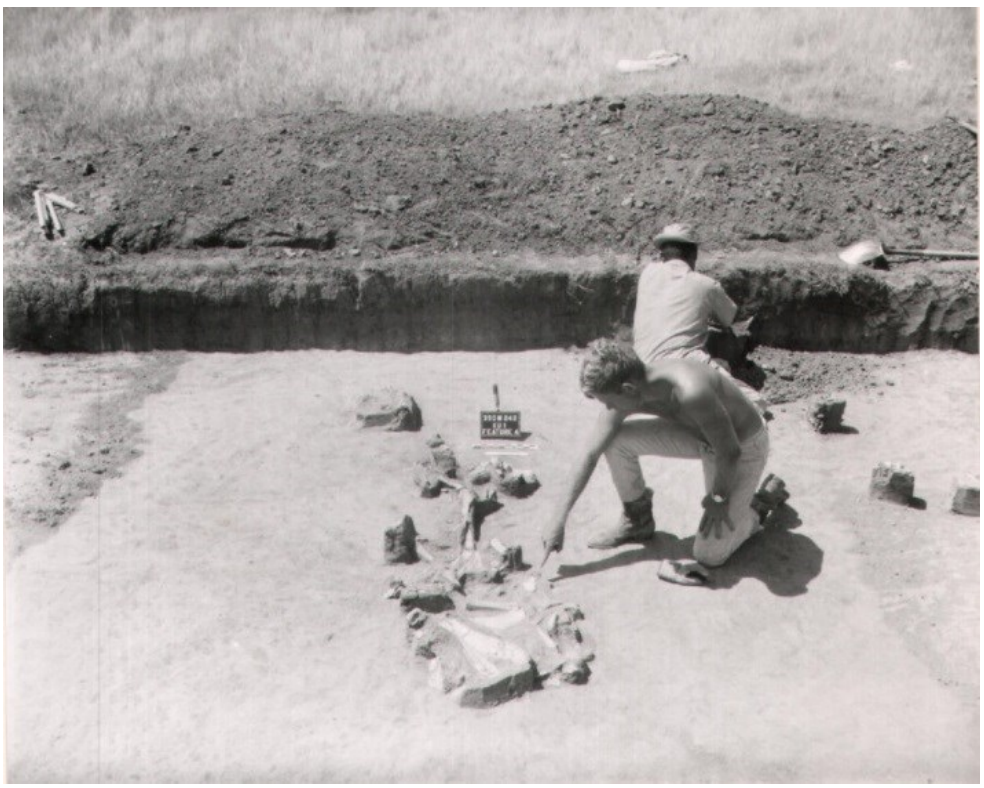

Figure C.6 : Feature 4, view west.

Feature 5

Feature 5 is a dark ovoid soil discolouration, measuring 1.62 m long by 1.83 m wide. This feature was in the slump area of the site. Inside of this dark soil stain, two scrapers and 12 pieces of debitage were recovered. The source of this soil stain is unclear, and may be unrelated to the occupation of the site.

Figure C.7 : Feature 5 on slumped bank at north end of site, view northwest.

Feature 6

Feature 6 is a small cylindrical pit, measuring 1.16 m long by 94.5 cm wide and 64.1 cm deep. The feature contains a wide variety of artefacts, including two body sherds, one complete TRSS projectile point, four scrapers, one scoria fragment, 24 piece of debitage, and 88 bone fragments. None of the faunal remains were identified. There were also a large amount of stone fragments in the feature.

Figure C.8 : Feature 6 prior to excavation, view east.

Figure C.9 : Feature 6 cross-sectioned. Indicating an in situ point; view east.

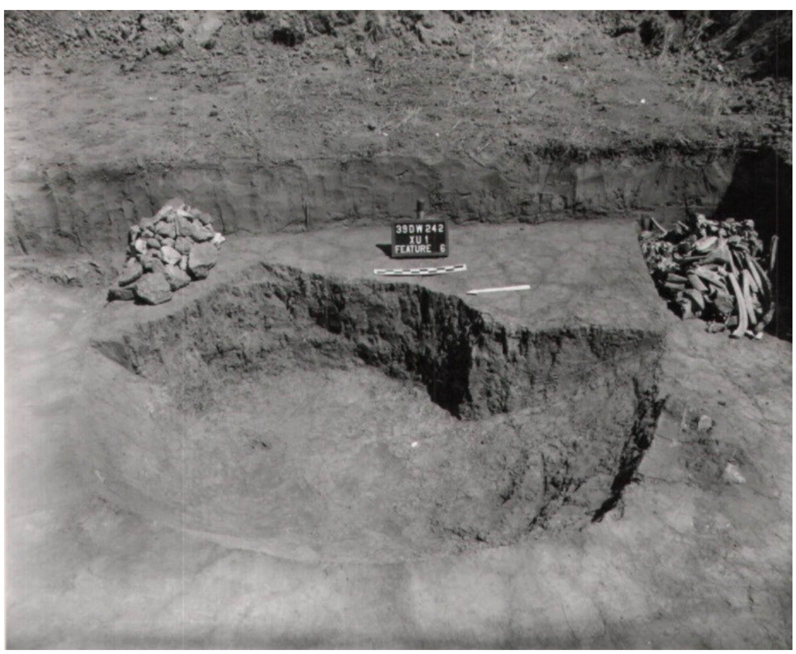

Figure C.10 : Feature 6 after coring, with bone and stone refuse, view east.

Feature 7

Feature 7 is an ovoid midden overlying two pits. The midden is 2.74 m long by 1.52 m wide, and contained two scrapers, one chopper, one grooved maul, 18 pieces of debitage, and 37 bone fragments. There are no dimensions given for the two pits underlying the midden, and the faunal remains were not identified.

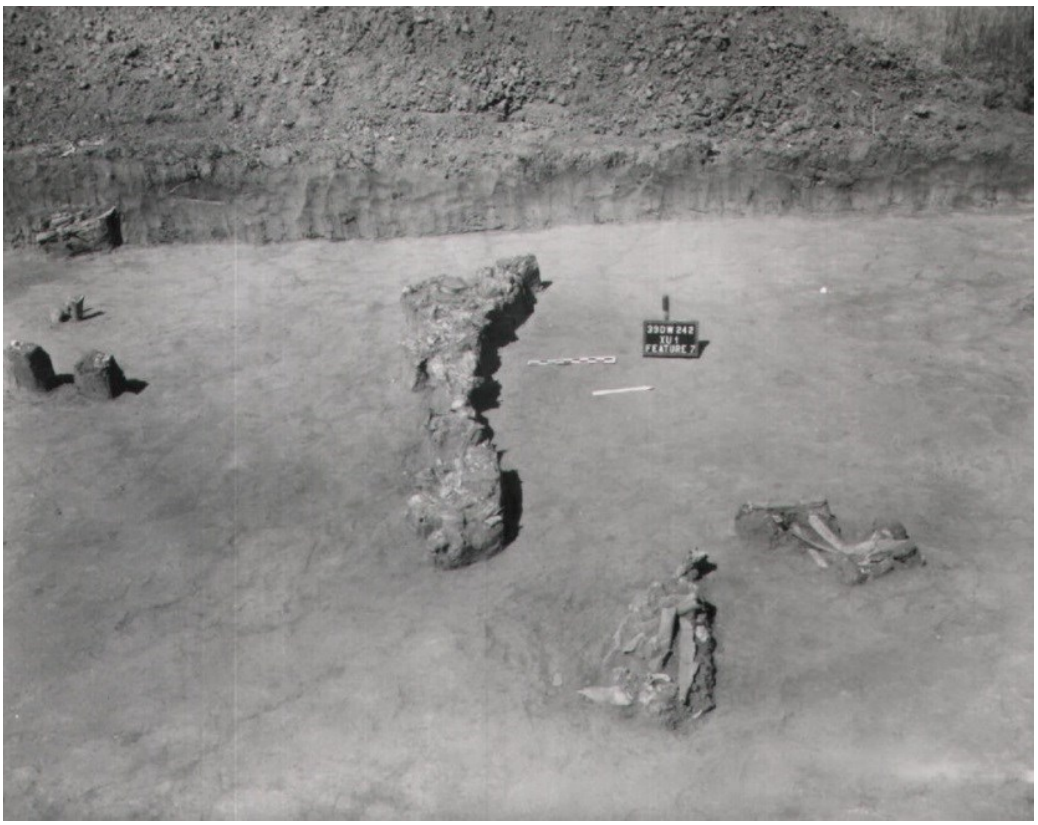

Figure C.11 : Feature 7, view west.

Feature 8

Feature 8 is a bone upright, containing tightly packed vertical bison bone. The feature measured 15.2 cm long by 12.2 cm wide, and was in direct association with four scrapers and 57 pieces of debitage. There were 10 bone fragments in the feature, which were unidentified; however, Neuman states that they were bison limb bone and that some elements are articulated.

Figure C.12 : Feature 8 in pedestal, view west.

Feature 9

Feature 9 is an irregularly outlined midden with a circular hearth on the edge of the midden. The midden measure 2.9 m long by 2.9 m wide, and the hearth is 76.2 cm long by 76.2 cm wide and 6.1 cm deep. Collected from the midden was one piece of debitage and 11 bone fragments, none of which have been identified.

Figure C.13 : Feature 9 prior to excavation, view northeast.

Feature 10

Feature 10 is a basin-shaped hearth, measuring 85.3 cm long by 76.2 cm wide and 9.1 cm deep. Small bone fragments and some debitage were noted while excavating this feature, but nothing was collected.

Figure C.14 : Feature 10 prior to excavation, view northeast.

Figure C.15 : Feature 10 cross-sectioned, view east.

Figure C.16 : Feature 10 with nearby bone upright features 93, 104, 105, and 94, view north.

Feature 11

Feature 11 is a small midden, measuring 79.2 cm long by 67.1 cm wide and 9.1 cm deep. The midden contained two bifaces, two scrapers, four pieces of debitage, and 17 bone fragments. The faunal remains have not been identified.

Figure C.17 : Feature 11, view northwest.

Feature 12

Feature 12 is an irregular midden deposit over a circular area, measuring 2.44 m long by 1.83 m wide. The midden consists of several smaller deposits of bone, underlain by a group of upright features. The location and contents of the upright features are not clear; only that they contain vertically set mammal long bone. The feature as a whole contains two scrapers, a hammerstone, a butt of an awl, 17 pieces of debitage, and 38 bone fragments. None of the faunal remains were identified.

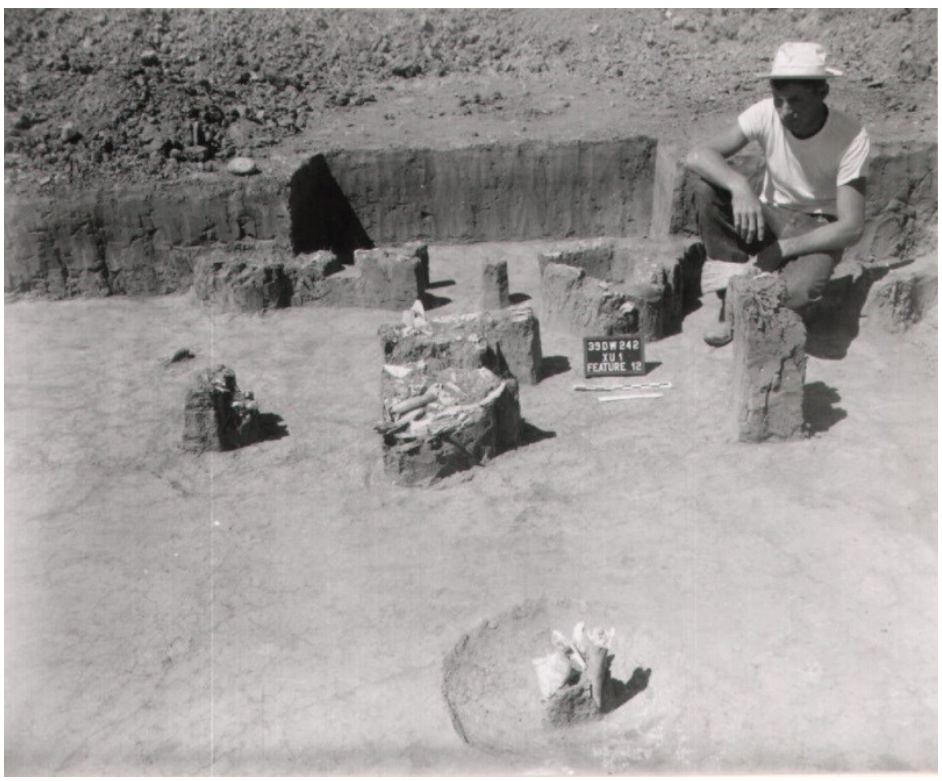

Figure C.18 : Feature 12 with Feature 96 in foreground, view west.

Feature 13

Feature 13 is a small cylindrical soil stain, which has been interpreted as a post mold. The feature measures 24.4 cm long by 21.3 cm wide and 15.2 cm deep, and contained only a few flecks of charcoal.

Figure C.19 : Feature 13, view west.

Figure C.20 : Feature 13 cross-sectioned, view west.

Figure C.21 : Feature 13 cored, view west.

Feature 14

Feature 14 is a small conical hearth with a charcoal-stained fill, and an upright feature in close association. The hearth measures 21.3 cm long by 7.6 cm wide and 9.1 cm deep, and contained one piece of debitage and two bison skull fragments. There are no dimensions given for the upright feature, but the site records indicate that there were 12 large mammal bones in the feature. Of these elements, a right proximal ulna, six rib fragments, and fragments of a scapula have been identified.

Figure C.22 : Feature 14 cross-sectioned, view north.

Feature 15

Feature 15 is a basin-shaped pit, measuring 36.6 cm long by 30.5 cm wide and 21.3 cm deep. A body sherd, a brown chalcedony point base, a scraper, and five animal bones were collected from this feature. The pit also contained several rock fragments which were not collected, but seemed to comprise the majority of the feature fill. Neuman originally interpreted this feature as a hearth that had been filled in with camp debris, but the concentration of rock fragments and faunal remains are more indicative of a boiling pit. The site records indicate that there was also an upright feature in the same unit as Feature 15. However, no such feature was recorded on the site maps; nor can any upright feature be seen in the photographs of Feature 15 and the surrounding area. It is likely that the 14 animal bones from the upright were incorrectly labelled.

Figure C.23 : Feature 15 cross-sectioned, view south.

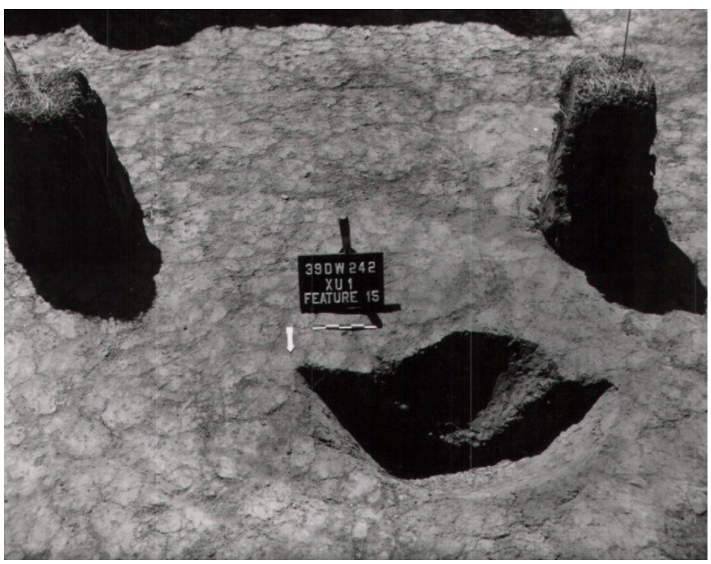

Figure C.24 : Feature 15 cored, view south.

Feature 16

Feature 16 is a dense circular midden deposit in a basin-shaped pit. The midden measured 79.2 cm long by 61 cm wide; the pit measured 79.2 cm long by 79.2 cm wide and 15.2 cm deep. The feature contained a biface and 23 bone fragments, none of which have been identified.

Figure C.25 : Feature 16, view northeast.

Feature 17

Feature 17 is a large midden deposit with two large irregularly rounded pits underneath. The midden measured 4.08 m long by 3.96 m wide, and the two pits were roughly 1.52 m across and 30.5 cm deep. There was a wide variety of artefacts recovered from the feature, although the majority of the material was found in the pits underlying the midden. Archaeologists recovered a projectile point blank made from brown chalcedony, a chalcedony point base, two bifaces, six scrapers, a chopper, and 50 pieces of debitage. A piece of worked shell and a bison metatarsal flesher were also recovered, in addition to 220 bone fragments from the feature itself.

All of the 220 bone fragments recovered from the Feature 17 were identified as bison, and are summarized in Table C.1. In general, most of the bison carcass is represented in this feature, including a number of low utility elements like phalanges, tarsals, and metapodials, in addition to low value limb elements such as humerii and tibiae. Neuman also notes that several of the elements were still articulated. The feature appears to contain waste from the butchery of the bison; in particular, elements that one might expect to remain at the kill location. There were also three white tail deer elements identified: a thoracic vertebra, a left pelvic fragment, and a right proximal femur. Five canid elements were identified as well, four caudal vertebrae and a right tibia. A MNI of nine bison was calculated for this feature, based on eight left distal tibia and an immature right distal tibia; in addition, an MNI of one was determined for both white-tailed deer and canine species.

Table C.1 : Feature 17 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
occipital	4					2	2
horn core	1						1
atlas	1					1	
axis	1					1	
cervical	1					1	
thoracic	3					3	
lumbar	3					3	
caudal	4					4	
scapula	11	5	6			10	1
humerus	12	5	7	2	10	9	3
radius	4	4		2	2	4	
ulna	1	1		1		1	
metacarpal	7	2	3	5	2	7	
pelvis	2	2					2
femur	8	4	1	7	1	1	8
tibia	14	4	10	3	11	13	1
astragalus	3	2	1			2	
calcaneum	3	1	2			3	
cuboid	4	2	2			4	
metatarsal	4	2	2	4		4	
1st phalanx	14					14	
2nd phalanx	18					18	
3rd phalanx	5					5	

Figure C.26 : Feature 17, view south. Landscape still smolders from recent fire.

Figure C.27 : Feature 17 cored, view west.

Feature 18

Feature 18 is two small hearths, which were identified as Feature 18A and 18B. Feature 18A is 24.4 cm across and 15.2 cm deep, and contained only a grey silty fill. Feature 18B is 61 cm long by 36.6 cm wide and 10.7 cm deep, and contained a shell fragment, four pieces of debitage, 18 bone fragments and flecks of charcoal mixed into the fill. None of the faunal remains have been identified.

Feature 19

Feature 19 is an irregularly shaped pit with a dark stain soil fill, and was apparently disturbed by rodents. The pit measured 82.3 cm long by 73.2 cm wide and 12.2 cm deep, and contained flecks of charcoal, small bone, and rock fragments. However, no artefacts were collected from this feature. The contents seem to suggest a refuse pit.

Feature 22

Feature 22 is a shallow pit measuring 1.25 m long by 91.4 cm wide and 9.1 cm deep. The pit was filled with highly fragmented large mammal rib and long bones, as well as several pieces of broken quartzite which are assumed to be fire-cracked. Only a biface and two bison bone fragments were collected from this feature; a right distal tibia and a left lateral malleolus. The pit appears to be filled with butchery debris and FCR, and is in close association with an upright (F23) and a small concentrated pile of rocks which may have served as an anvil.

Figure C.28 : Feature 22 with F23, view north.

Feature 23

Feature 23 is an upright feature that measures 30.5 cm long by 24.4 cm wide and 6.1 cm deep. This upright is in close association with Feature 22. The upright was composed of 16 articulated bison long bones and some additional fragments which formed a 12.2 cm wide empty ring in the centre of the feature, tapering out at the bottom. The inside of the feature was filled with a light clay sediment intermixed with caliche, a mineral that forms in the presence of calcium. It is likely that the caliche was derived from the bones in the feature, and formed under natural processes. There were no artefacts associated with the feature except for some burned bone fragments, but it is likely that an object was removed from the hollow ring in the centre. Considering that the feature is only 6.1 cm deep, it is implausible that it could have been a post. In view of the close association with Feature 22 and the stone anvil there, this feature likely had a rock in the centre that was being used as anvil, and was later removed.

Figure C.29 : Feature 23, view north.

Figure C.30 : Feature 23 cross-sectioned, view west.

Figure C.31 : Feature 23 cored, view north.

Feature 24

Feature 24 is an upright feature with some associated rock fragments, measuring 24.4 cm long by 18.3 cm wide and 12.2 cm deep. The feature contained two bison limb bones positioned vertically in the sediment, with five rock fragments, bone flakes, and some debitage associated with the feature. One piece of debitage and four bone fragments were collected from this feature, none of which have been identified.

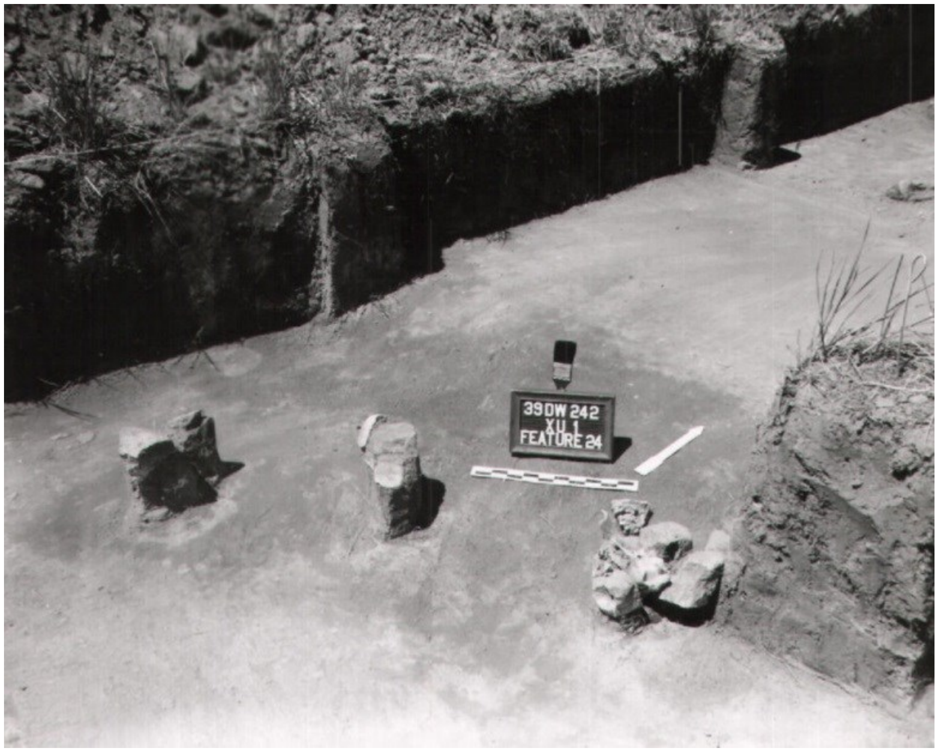

Figure C.32 : Feature 24, view northwest.

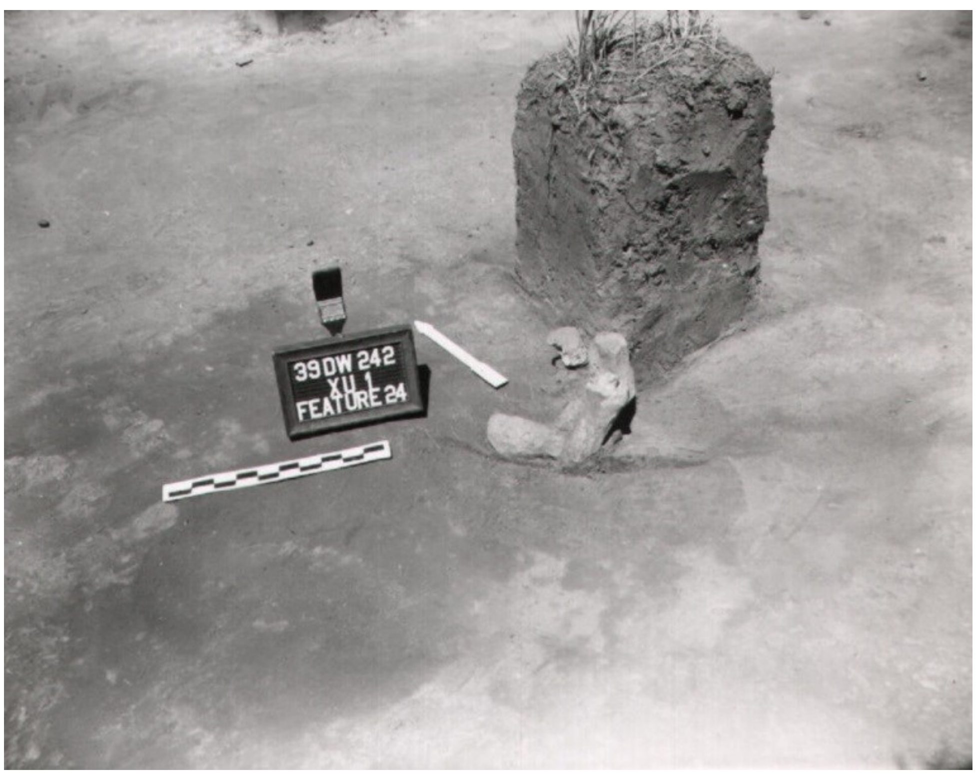

Figure C.33 : Feature 24, view northeast.

Feature 25

Feature 25 is an upright feature with a quartzite cobble in the centre. The feature measures 25.9 cm long by 13.7 cm wide and 18.9 cm deep. The feature comprised of four bison long bones, tightly packed around a quartzite cobble. The upright was surrounded by a fill of charred bone fragments, charcoal flecks, and a quartzite flake. The fill around the feature suggests that the bone was placed into a previously existing pit at the site, into which burnt bone and charcoal were incorporated. Only three elements were collected from the feature, none of which have been identified.

Figure C.34 : Feature 25, view northwest.

Feature 26

Feature 26 is an upright with a small deposit of stones 45.7 cm to the southwest. The feature measures 18.3 cm in diameter and 15.2 cm deep. Contained in the feature were bison limb and rib bones, some of which were articulated. A total of 16 elements were collected from the feature, none of which have been identified. The fill consisted of a fine silt with charcoal, small stone fragments, and bone splinters, suggesting that the feature was created in a previously existing pit that was filled in with surrounding debris before the upright was made.

Figure C.35 : Feature 26, view southeast.

Feature 27

Feature 27 is a bone upright measuring 21.3 cm in diameter and 27.4 cm deep. The fill comprised of grey silt, a granitic stone, bone splinters; articulated and isolated bison limb bone fragments. Three of the bison long bones on the west side of the feature were oriented vertically, and one element appeared to articulate with a lone bone fragment overlying the feature. Two other long bone fragments were similarly arranged, with an overlying articulating element. None of the faunal remains have been identified, but the whole feature was coated in wood glue and removed as a unit. This feature appears on Plate 4 of Neuman's report (1975:147).

This arrangement suggests that whole limb segments were positioned in the upright feature, and likely stood above the original ground surface before the soft tissues decomposed and the uppermost elements collapsed. There was no evidence of a pit in the feature, but the bone and stone inclusions around the feature suggest that the elements were placed into an existing hole, into which small bone and stone fragments fell. If the feature was pushed into the ground surface, there ought to have been no inclusions around the feature. The bone would have displaced the sediment around the feature, leaving no space for debris to fall.

Figure C.36 : Feature 27, view southwest.

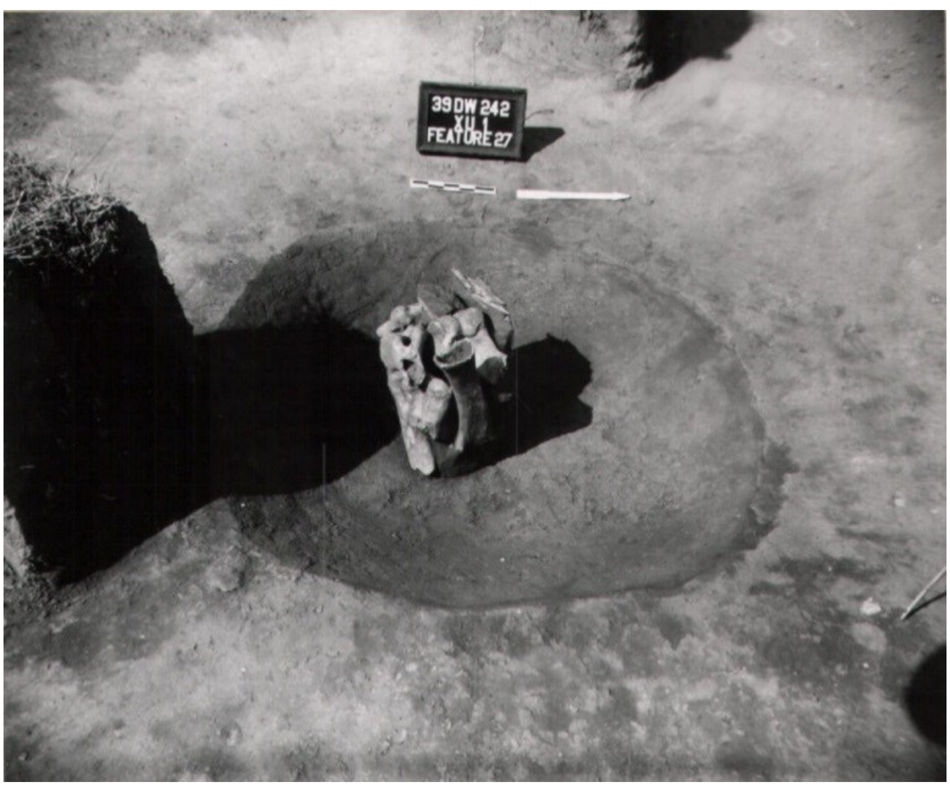

Figure C.37 : Feature 27 on pedestal, view southwest.

Feature 28

Feature 28 is a midden measuring 30.5 cm long by 15.2 cm wide, and consists of a tight concentration of 17 pottery body sherds and some bone fragments. Vessel reconstruction was not possible for the sherds, but all are likely from the same vessel. None of the bone fragments were collected or identified.

Feature 29

Feature 29 is a midden deposit with two upright features associated with it. The midden measures 1.46 m long by 88.4 cm wide and 9.1 cm deep. This feature contained flecks of charcoal, a broken stone maul, debitage, bone fragments, and stone fragments. Only the stone maul was collected. The upright features are identified as Feature 29A and 29B. The upright 29A contained three bison limb bones, a distal humerus, a proximal femur, and a scapula. All three elements were positioned with the articular surface upwards. Feature 29B comprised of a single bison long bone element, most likely a metapodial with the proximal articulation uppermost. A total of eight bone fragments were collected from Feature 29A and 29B, despite only four elements being described in both features. The location of these four other elements from the feature is not clear.

Feature 30

Feature 30 is a midden deposit measuring 41.1 cm long by 61 cm wide and 18.3 cm deep. The feature contained some debitage, four granitic cobbles which were not collected, a biface and scraper, and 19 animal bones. The faunal assemblage from this feature has been analyzed, but attrition due to the storage of the collection has rendered the elements almost unidentifiable. Initial analysis from the site identified 14 of the 19 elements as bison, and one element as canid. The bison remains are summarized in Table C.2. The canid element is a single lower molar from an adult specimen. The bison elements in the feature are all low ranking elements for meat, fat, and grease, indicating that this feature is a discard pile formed during butchery of the bison.

Table C.2: Feature 30 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
molar	3						3
caudal	4					4	
scapula	2	2				2	
humerus	2	2			1	1	1
metacarpal	1				1		
calcaneum	1	1				1	
cuboid	1	1				1	

Figure C.38 : Feature 30, view south.

Feature 31

Feature 31 is a bone upright deposit measuring 27.4 cm long by 15.2 cm wide and 33.5 cm deep. The feature consists of three tightly clustered bison scapulae positioned vertically into the sediment with the articular facets facing upwards. There were slivers of bone wedged around the scapulae, as well as a left unciform. Neuman states that there is no indication of soil disruption that could indicate the presence of a post. The scapulae were either placed into a previously existing pit which was indistinguishable from the surrounding sediment, or the feature was created when the sediment was wet enough to push the scapulae in without much resistance. Neuman describes the sediment as clayey and gumbo-like, especially with depth (Neuman 1975:6); this feature may have allowed the site inhabitants to push the bone into the saturated sediment.

Feature 32

Feature 32 consists of three elongated midden deposits measuring about 3.05 m long by 30.5 cm wide and 9.1 cm deep. The northernmost midden had an upright feature underneath it, containing four long bone fragments and one flat bone fragment extending 27.4 cm beneath the midden deposit. The three middens were composed of a concentration of bone fragments and rock debris, as well as two bifaces, a scraper, and two retouched flakes. Described as unidentifable, none of the bone was collected from the feature.

Feature 33

Feature 33 is a midden deposit with an underlying bone upright around a postmold in the northern edge of the feature. The midden measures 2.77 m long by 64.1 cm wide and 12.2 cm deep. The midden contained a mixture of bone and quartzite cobble fragments, none of which were collected or identified. A graver, two bifaces, two scrapers, and a drill were also discovered in the feature. It appears that this midden feature is a continuation of Features 32 and 29, which form a large arch through the site.

Feature 33A

Feature 33A is an upright feature found underlying the midden deposit Feature 33. This feature is under the northern portion of the midden, and measures 24.4 cm long by 15.2 cm wide and 30.5 cm deep. The upright comprised of seven long bone elements packed around a visible post mold. The bone appears to have been placed around the post after it was erected, as the base of the post mold is deeper than the bottom of the bone uprights. Of the seven elements in the feature, four have been identified as bison: a left proximal radius, a left distal ulna, as well as a right and left distal humerus.

Feature 34

Feature 34 is a bone upright feature in close association with Feature 35 and 36. This upright measures 24.4 cm long by 15.2 cm wide, and contains five tightly packed bison bones: a femur with the distal end down, a pelvic fragment, and three long bone fragments.

Figure C.39 : Feature 34 in pedestal. Feature 36 is also visible, view northwest.

Feature 35

Feature 35 is a bone upright feature measuring 15.2 cm long by 12.2 cm wide and 18.3 cm deep. There are two bison long bone elements in the feature; one positioned vertically in the sediment, and the other lying horizontally to the west.

Feature 36

Feature 36 is a bone upright feature reaching 16.8 cm beneath the occupation surface. The upright is composed of one bison long bone fragment, which was not collected.

Feature 37

Feature 37 is a basin-shaped hearth, measuring 1.19 m long by 76.2 cm wide and 9.1 cm deep. The hearth was filled with a red-orange sediment, and five bison bone fragments, none of which were collected.

Feature 38

Feature 38 is a bone upright feature with a grantic rock in close association. The feature extends 27.4 cm beneath the occupation level, and contained a fragmented bison long bone positioned vertically in the sediment. No artefacts were associated or collected from this feature.

Feature 39

Feature 39 is a bone upright feature with two stones in the centre of the feature. The upright measures 21.3 cm long by 12.2 cm wide and 45.7 cm deep. The feature contained two small cobbles surrounded by vertical bison long bones, with bone fragments, flecks of charcoal, and burnt bone at the bottom of the feature. There was a brown chalcedony projectile point base, a utilized cobble, and a vertical bone collected from the feature. The burnt and fragmented bone at the bottom of the feature suggest that there was an existing hole into which the bone fragments fell, and were then overlain by the vertical bison long bones and cobbles.

Figure C.40 : Feature 39 crossection, view north.

Feature 40

Feature 40 is a basin-shaped hearth, measuring 54.9 cm long by 42.7 cm wide and 12.2 cm deep. The hearth was lined with a reddish and blackened earth, and filled with camp refuse. No artefacts were collected from this feature.

Figure C.41 : Feature 40 cross-section. Feature Board is mislabled, view east.

Feature 41

Feature 41 is a basin-shaped hearth filled with camp refuse, measuring 1.34 m long by 1.22 m wide and 18.3 cm deep. The hearth was lined with a 6.1 cm layer of reddish sediment, and filled with a 12.2 cm layer of bone fragments and debitage. A small piece of fired clay with fingerprint impressions was collected from this feature, along with a single scraper. Mallory indicates that this feature is at the centre of a larger general midden area, which includes features 7 through to 40. These features form a larger arch around this hearth, although Mallory's comments suggest that the midden features may not be as discrete as previously described. This hearth does appear to be at the centre of activity in this area of the site.

Figure C.42 : Feature 41 cross-section, view southeast.

Feature 42

Feature 42 is large pit, measuring 1.37 m long by 1.13 m wide and 45.7 cm deep. There was a smaller pit underlying the main pit, measuring 79.2 cm in diameter and 6.1 cm deep. The entire pit was lined with a layer of intermixed dark and reddish-orange sediment, and burnt bone fragments. Overlying this burnt layer were randomly-oriented bison long bones and scapulae. A total of 14 scapulae were collected from a concentration located in the smaller pit in a trench oriented northeast-southwest. From the rest of the Feature 35, bison bone fragments were collected, 18 of which have been identified, and are summarized in Table C.3. A variety of artefacts were recovered from this feature, including a brown chalcedony projectile base, two bifaces, two scrapers, two utilized flakes, and a bison metatarsal flesher with heavily worn teeth on the working end. Neuman suggests that the pit was originally used as a roast pit which was filled in with camp refuse after use. The burnt earth and bone concentration at the base of the pit do support this hypothesis, although the concentration of 14 bison scapulae is highly suggestive of some sort of cache at a later stage at the site.

Table C.3 : Feature 42 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
mandible	1	1					
scapula	14						
ulna	2	1			2	2	
metacarpal	3				3	3	
tibia	1		1		1		1
lateral malleolus	1					1	
talus	1		1			1	
long bone	1					1	
sesamoid	1					1	
caudal vertebra	1						1
second phalanx	2					2	
third phalanx	3					3	

Figure C.43 : Feature 42 cross-section, view southwest.

Figure C.44 : Feature 42, view southwest.

Figure C.45 : Feature 42 cored, view southwest.

Feature 43

Feature 43 is a basin-shaped hearth , measuring 67.1 cm in diameter and 10.7 cm deep. The fill is an intermixed reddish and black sediment with debitage and bone fragments. Collected from the feature were two retouched flakes and four bison carpals.

Feature 44

Feature 44 is a linear midden, measuring 1.83 m long by 9.1 cm wide and 12.2 cm deep. The midden is oriented east-west, and contains bison mandibles, ribs, and unidentified bone fragments. A total of eight bones were collected from this feature, which included six molars and two mandible fragments. A worked section of bison rib was also recovered from the base of the feature. The tool, comprised of a very long section of solid cortical bone, is heavily worked and smoothed at one end, and worked to a rough point at the other. The rib was broken in half at some point in post-deposition. The function of this particular tool is unclear, but it could have been a pin or stake, used for holding down a hide or tipi.

Figure C.46 : Feature 44. Board is mislabled, view southeast.

Feature 45

Feature 45 is a midden deposit overlying a pit which was designated Feature 45A. The midden measures 70.1 cm long by 1.04 m wide and 10.7 cm deep. A worked flake, a utilzed cobble, 36 animal bones, and a mussel shell were retrieved from the midden. Of the 36 animal bones collected, 21 have been identified as bison, and are summarized in Table B:4. Also recovered from the midden was a left and right prairie dog humerus, and a bird phalanx.
This midden is continous with the the depoists in the underlying pit that was designated Feature 45A. The pit is 88.4 cm long by 61 cm wide and 15.2 cm deep. The fill is composed of a dark brown sediment, small flecks of characoal, bone fragments, and FCR. Recovered from this feature were a scraper, two retouched flakes, and 17 animal bones. Of the 17 bone collected, 13 have been identified as bison, and are summarized in Table C.5. Feature 45A appears to be a boiling or roasting pit, with fragmented bone and FCR, and was subsquently filled by a general camp refuse, creating Feature 45. There are several hearths nearby, which could have been used to heat the rocks for use in the boiling pit.

Table C.4 : Feature 45 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
occipital	1					1	
lumbar vertebra	1					1	
scapula	2					2	
humerus	2	2			2	2	
radius	2	1	1		2	1	1
metacarpal	2	2		1	1	2	
tibia	3	2	1		3	3	
astragalus	2	1	1			2	
navicularcuboid	1		1			1	
first phalanx	1					1	
second phalanx	2					2	
third phalanx	2					2	

Table C.5 : Feature 45A bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
petrous pyramid	1	1				1	
molars	2					2	
cervical vertebra	1						1
thoracic vertebra	2					2	
radius	1	1		1		1	
patella	1	1				1	
metacarpal	1		1	1		1	
tibia	1		1		1	1	
metatarsal	1	1			1	1	
sesamoid	1				1	1	

Figure C.47 : Feature 45, view southwest.

Figure C.48 : Feature 45, view west.

Figure C.49 : Feature 45 with upright nearby, view east.

Figure C.50 : Feature 45A, view south.

Feature 46

Feature 46 is a small pit with an associated bone upright feature which is designated Feature 46A. The pit measures 64.1 cm in diameter and 9.1 cm deep; the fill consisted of broken bone fragments, debitage, and quartzite cobble fragments. A body sherd, a retouched flake, and five animal bones were collected from the pit. The faunal remains were all bison, and comprised of a right distal tibia, a molar, and three caudal vertebrae.

Feature 46A is the upright feature underneath the SE corner of Feature 46. The upright measured 9.1 cm long by 6.1 cm wide and 33.5 cm deep. Covered by the refuse in the Feature 46 pit, the upright contained several bison long bone fragments positioned vertically in the sediment. There is very little information on the contents or the nature of the deposit.

Feature 47

Feature 47 is a bone upright feature, measuring 15.2 cm in diameter and 21.3 cm deep. The feature was filled with a tight concentration of bone fragments and some debitage. Three bison bones were collected from the feature, two of which were articulated. None of these bones have been identified, but site records indicate that one might have been a pelvic fragment, and another either a humerus or femur.

Feature 48

Feature 48 is a bone upright feature, measuring 24.4 cm in diameter. The feature was not completely excavated, as it was left in situ for display to site visitors. The fill was comprised of vertical bison long bone in a tight concentration. A total of eight bones were collected from this feature, none of which have been identified.

Feature 49

Feature 49 is a small midden, measuring approximately 61 cm wide and 64.1 cm deep. The midden was filled with an assortment of bison ribs and long bones, some of which were still articulated in the feature. A total of twelve bison bones were collected from the feature; they are summarized in Table C.6. There appears to be at least two front limbs present in the feature, but none of the ribs that were described in the original field notations.

Table C.6 : Feature 49 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
molars	3					3	
humerus	2	2			2	2	
ulna	2	2		2		2	
radius	1	1		1		1	
long bone	1						
sesamoid	1					1	
first phalanx	2					2	
second phalanx	1					1	

Figure C.51 : Feature 49 on pedestal, view east.

Feature 50

Feature 50 is a basin-shaped pit measuring 1.68 m long by 1.13 m wide and 12.2 cm deep. The fill consisted of fire-cracked quartzite cobbles, and charcoal, as well as burned and charred long bone fragments. A biface and two retouched flakes were collected from this feature, in addition to a long brown chalcedony projectile point with an impact fracture running down the half the length of the point. Based on the fill of FCR and burnt and fragmented bone, this feature appears to be a boiling or roasting pit. Yet, the feature is very shallow and wide, which is not typical of boiling pits. It is most likely a refuse pit, filled with general camp debris, rather than a functional feature.

Figure C.52 : Feature 50 cross-sectioned, view northeast.

Feature 51

Feature 51 is a small cylindrical pit, measuring 39.6 cm in diameter and 18.3 cm deep. The fill consisted of dark brown sediment mixed with some bone fragments, and small amounts of debitage and charcoal. No artefacts were collected from the feature, but three caudal vertebrae and a segment of rib were noted. The pit was originally interpreted as a cache, but the feature was almost completely empty. The feature itself is too wide to have been a post hole, so likely something was stored in the pit, and was subsequently removed.

Figure C.53 : Feature 51 cross-sectioned, view northwest.

Feature 54

Feature 54 is a bone upright feature with a granitic cobble in the centre. The feature measures 24.4 cm long by 21.3 cm wide and 21.3 cm deep, and consists of a fill of dark brown sediment, broken and burnt bone, FCR, and charcoal. The bones were set into the original surface of the occupation layer in a rough triangle arrangement with a granitic cobble in the centre. A total of five bones were collected from this feature, none of which have been identified.

Feature 55

Feature 55 is a small midden deposit, measuring 1.04 m long by 45.7 cm wide and 24.4 cm deep. There is little detail on the fill of the feature; only that it contained caliche and bone fragments. The photograph of the feature clearly reveals that there was a considerable amount of bone present. A scraper and a bison rib were collected from the midden.

Figure C.54 : Feature 55 on pedestal, view east.

Feature 56

Feature 56 is a basin-shaped pit, measuring 82.3 cm long by 79.2 cm wide and 27.4 cm deep. It was filled with dark brown sediment with bone fragments, and was disturbed by a rodent burrow on the north edge of the feature. A biface and 57 animal bones were collected from this feature. Of the 57 bone fragments collected, 45 have been identified as bison, and are summarized in Table C.7.

Table C.7 : Feature 56 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
molars	7					7	
mandible	5					4	1
scapula	2	1	1			2	
humerus	1	1			1	1	
radius	1				1		1
carpals	7		5			7	
metacarpal	1		1			1	
ilium	1		1			1	
femur	5			5		5	
patella	3					3	
sesamoid	4					4	
first phalanx	2					2	
second phalanx	2					2	
third phalanx	2					2	

Feature 57

Feature 57 is a post mold with bison bone placed vertically along the wall of the feature, measuring 12.2 cm in diameter, and 36.6 cm deep. The fill consisted of dark brown sediment with two vertical bison rib fragments and a fragment of granitic rock along the north side of the feature; one rib was above the rock and the other was below. The inclusions in this post mold feature were likely placed alongside an existing post, acting as a shim to stabilize the structure.

Feature 58

Feature 58 is a small basin-shaped pit, measuring 70.1 cm long by 48.8 cm wide and 30.5 cm deep. The pit was filled with large and small bone fragments, debitage, and charcoal. A side-notched projectile point was listed in the Feature description as being associated with this feature, but it is not listed in the site catalog; only a single cut rib was collected from this feature. The feature was interpreted as a pocket cache pit; again, there is nothing in the contents to suggest that there was anything being cached here. It is very similar to the other pit features at the site, which are filled with general refuse from camp and butchery activities.

Feature 59

Feature 59 is a midden, measuring 1.04 m long by 94.5 cm wide and 9.1 cm deep. The fill consisted of fragmented ribs, long bones, and granitic rocks. A scraper and four bison bones were collected from this feature: a right distal metatarsal, a right distal humerus, as well as a first and second phalanx.

Feature 60

Feature 60 is a small bowl-shaped pit measuring 51.8 cm in diameter and 18.3 cm deep. The fill consisted of an unspecified amount of bone fragments and debitage. A total of six bison bones were collected from the feature: two left scapulae, a right proximal metatarsal, a right talus, a left radial carpal, and a first phalanx.

Feature 64

Feature 64 is a soil stain of unspecified dimensions. There is little information on this feature, as field records indicate that it dried out before notes could be taken. There are several artefacts associated with this feature, including a body sherd, two projectile points, and two biface fragments. One of the projectile points is a complete brown chalcedony point; the other is a projectile point base with most of the midsection, made from TRSS, and with only one notch.

Feature 65

Feature 65 is a small bowl-shaped pit, measuring 33.5 cm in diameter and 21.3 cm deep. The pit is filled with fragmented bison long and flat bones, as well as two granitic rocks. Six bones were collected from this feature, three of which were identified as a right proximal metacarpal, a distal metacarpal, and a left distal tibia. This feature was originally interpreted as a pocket cache, but there is little indication that anything was being cached in this pit. The contents are similar to the general camp refuse found in other pits and middens at the site.

Feature 66

Feature 66 is a small bowl-shaped pit, measuring 48.8 cm long by 42.7 cm wide and 24.4 cm deep. The pit was filled with dark brown sediment, bone fragments, and a variety of artefacts. Collected from the feature were a body sherd, biface, drill, two scrapers, two retouched flakes, and four animal bones. The four animal bones were identified as bison: two second phalanges, and two third phalanges.

Figure C.55 : Feature 66 on pedestal, view south.

Feature 77

Feature 77 is a bone upright, containing both right and left bison distal tibia positioned vertically in the sediment with the articular surfaces up. Both of these elements were radiocarbon dated, the results of which are summarized in Table 6.1. Interestingly, the δ^{13}Cvalues of each element are vastly different: -14.9 ‰ and -18.1‰. In terms of anatomical units, these two bones could have come from the same animal, but the δ^{13}C value of the samples demonstrates that the bone in this feature came from two different animals. Furthermore, the δ^{13}C results suggest that these animals were engaging in different foraging strategies, leading to an increase of C4 grass consumption in one individual over the other (Chisholm *et al.* 1986).

Feature 78 to 98

There are a large number of upright features at the Stelzer site which were excavated, collected, and marked on the site map. However, they were never given a feature designation, and were not included in Neuman's original report (1975). There is little known about the dimensions or the depth of these features, but the contents were collected and analyzed. It appears that all of these features were found placed into the floor of the occupation level, intruding into the sterile sediment below the site. The contents of these features are summarized in Table C.8.

Table C.8 : Feature 78 to 98 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
Feature 78 (548)							
thoracic vertebra	1					1	
humerus	4		4		4	2	2
tibia	8	3	5		8	3	5
long bone	1						
Feature 79 (545)							
humerus	1	1			1	1	
radius	2	2			2	2	
metacarpal	4	2		3	1	3	1
carpals	8	6				8	
tibia	4	3	1		4	3	1
lateral malleolus	1	1				1	
navicularcuboid	1	1				1	
astragulus	1	1				1	
seasamoid	2			2		2	
Feature 80 (550)							
cervical vertebra	1						1
thoracic vertebra	2						2
vertebra	2						2
manubrium	1					1	
rib	3						
femur	1	1		1		1	
second phalanx	1					1	

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
Feature 81 (556)							
scapula	1		1			1	
humerus	3	1	1	2		3	
metacarpal	1					1	
femur	2		2		1	2	
tibia	2		2	1	1	1	1
tarsals	2	1	1			2	
long bone	3						
second phalanx	1					1	
Feature 82 (563)							
scapula	1	1				1	
humerus	1		1		1	1	
metacarpal	1	1		1		1	
cuneiform	3	3				3	
magnum	1	1				1	
scaphoid	1	1				1	
tibia	1	1			1	1	
Feature 83 (568)							
scapula	5	2	2			5	
thoracic vertebra	1					1	
Feature 84 (576)							
mandible	1	1				1	
incisor	1						
humerus	3	1	1		3	3	
femur	2	1		2		2	
tibia	2		1	1		2	
long bone	1					1	
Feature 85 (560)							
scapula	1	1				1	
humerus	2	2			2	2	
metacarpal	1				1	1	
long bone	4					4	
Feature 86 (554)							
humerus	1	1			1	1	
radius	2	1			1	1	
metacarpal	1	1		1		1	
carpals	5	5				5	
Feature 87 (594)							
rib	3						
ulna	1			1		1	
carpals	1					1	
tibia	1		1		1	1	
long bone	4						

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
Feature 88 (593)							
humerus	1		1		1	1	
tibia	1	1			1	1	
fragments	7						
Feature 89 (591)							
rib	4		2				
Feature 90 (643)							
humerus	1		1		1	1	
Feature 91 (650)							
rib	1						
metacarpal	1						
pelvis	1						
tibia	2		1	1	1	1	1
Feature 92 (672)							
scapula	1		1			1	
Feature 93 (669)							
humerus	1		1		1	1	
carpals	5	5				5	
metacarpal	1		1	1		1	
femur	1		1	1		1	
tibia	1		1	1		1	
long bone	2						
Feature 94 (685)							
humerus	1	1			1	1	
Feature 95 (660)							
radius	3		3	3		3	
ulna	1		1	1		1	
astragulus	1	1				1	
navicularcuboid	1		1			1	
metatarsal	1	1				1	
Feature 96 (693)							
humerus	2	1	1		2	2	
calcaneum	1			1		1	
Feature 97 (679)							
rib	1						
carpals	1						
femur	1		1	1			1
Feature 98 (681)							
humerus	5	4	1		5	5	
patella	1						
fragments	3						

Figure C.56 : Feature 79 cross-sectioned, view north.

Figure C.57 : Feature 86 cross-sectioned, with Ellen Neuman in background, view north.

Figure C.58 : Feature 90 cross-sectioned, view northeast.

Figure C.59 : Feature 95 cross-sectioned, view north.

Figure C.60 : Feature 96 on pedestal, view northwest.

Feature 99 to 108

These features are all bone uprights which were marked on the site maps. Unfortunately, there is no information of the contents, the dimensions, or stratigraphic position, making analysis of these features limited.

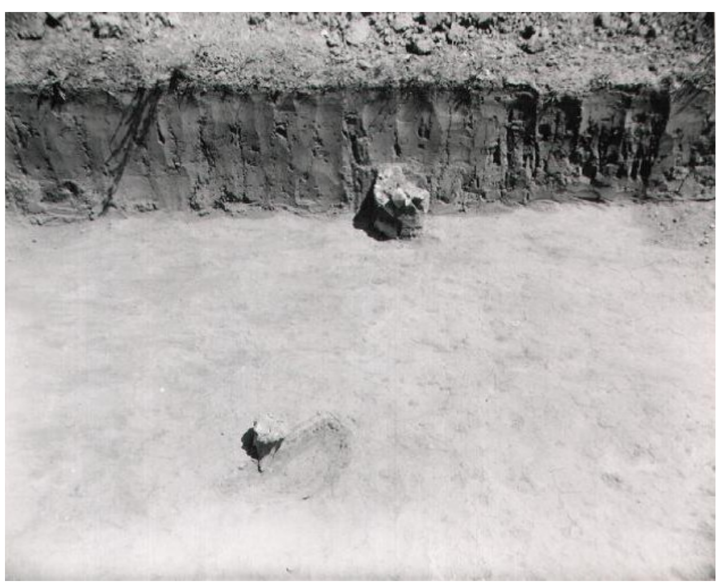

Figure C.61 : Fore to back: Feature 97 and 107, view east.

Figure C.62 : Feature 101 cross-sectioned, view north.

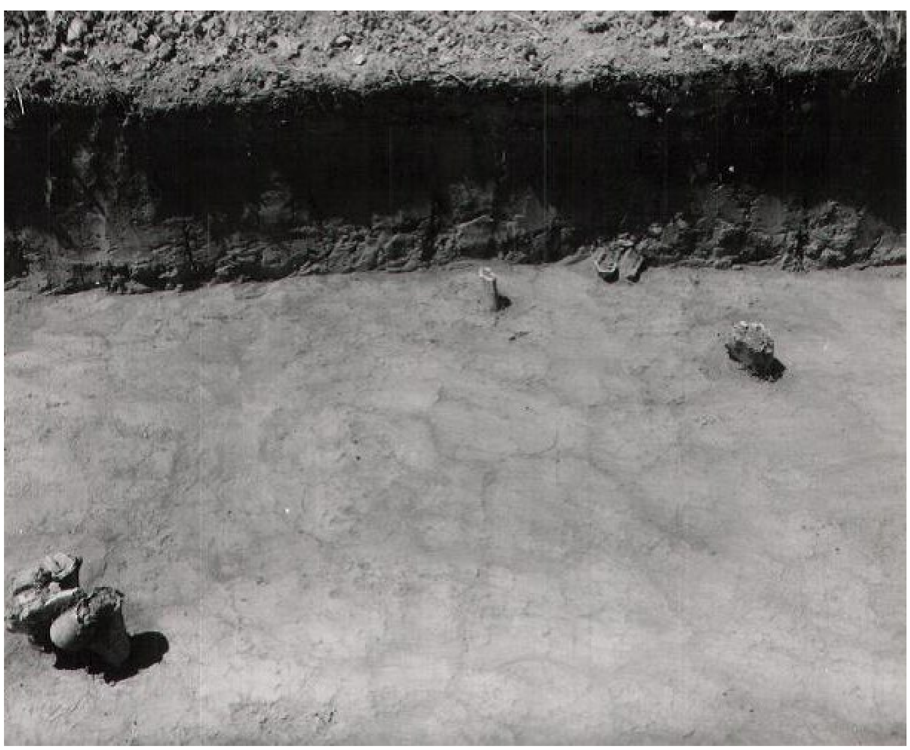

Figure C.63 : From Left to Right: Feature 84, 100, 83, and 99, view west.

Area 1, Excavation Unit 2

This excavation trench was positioned to the east of Excavation Unit 1 against the eroding bank of the reservoir, extending southwards into the landform. A total of 80 m^2 was excavated in this area, exposing a hearth and a small pit. There is a concentration of artefacts around the hearth and pit, but the small excavation area limits meaningful spatial analysis.

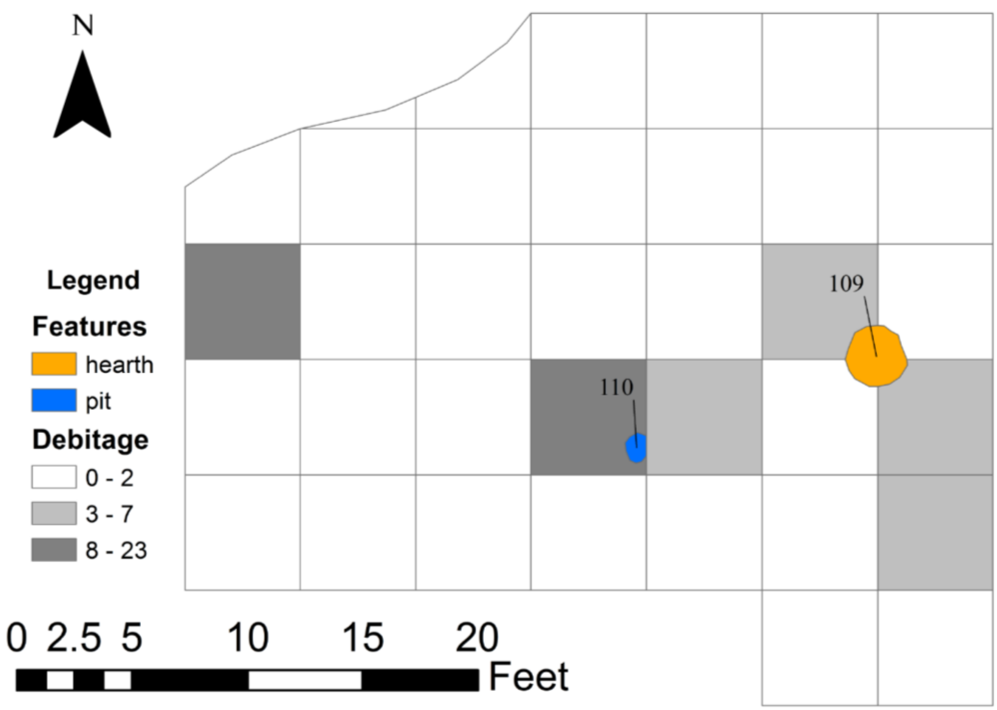

Figure C.64: Stelzer Area 1, Excavation Unit 2 based on site maps from the National Anthropological Archives, Smithsonian Institution.

Feature 109 (Previously Feature 1)

Feature 109 is a shallow basin-shaped fire pit, measuring 85.3 cm long by 76.2 cm wide and 10.7 cm deep. The hearth was filled with a light to dark grey clay sediment, as well as burnt bone, ash, charcoal, debitage, and rocks. Collected from this feature were a scraper, four piece of debitage, a piece of bone that was worked and polished into a twist, and five animal bones. Two of the bone fragments were separated, as they were thought to be tools; a charred rib that was thought to be a knife handle, and a cancelleous bone ball. Upon reviewing the material, it is evident that there is no purposeful modification beyond butchery. The only other bone fragment identified was a canid right radius.

Figure C.65 : Feature 109 in profile. Board is mislabelled, view southeast.

Figure C.66 : Feature 109 cored; view southeast.

Feature 110 (Previously Feature 2)

Feature 110 is a shallow basin-shaped pit, measuring 39.6 cm long by 36.6 cm wide and 6.1 cm deep. The fill consists of a grey to dark grey clay, bone fragments, and debitage. Collected from the feature were a body sherd, a biface, and five bone fragments. Identified from the collected faunal remain were two left bison scapulae.

Figure C.67 : Feature 110 on pedestal, view southeast.

Area 1, Excavation Unit 3

Excavation Unit 3 is south of Excavation Unit 1, and is the farthest trench from the terrace edge. In this area covering 37.16 m^2, a single hearth and pit were uncovered, as well as a series of five small pit or soil stains around the larger pit. Very little material was recovered from this trench; no cultural material was found in either the pit or hearth feature. The small soil stains are a bit of mystery, as they form two parallel lines around the larger pit. Similar features were noted elsewhere at the site that was attributed to rodent burrows carrying material from other features, and this seems a plausible explanation for these small soil stains.

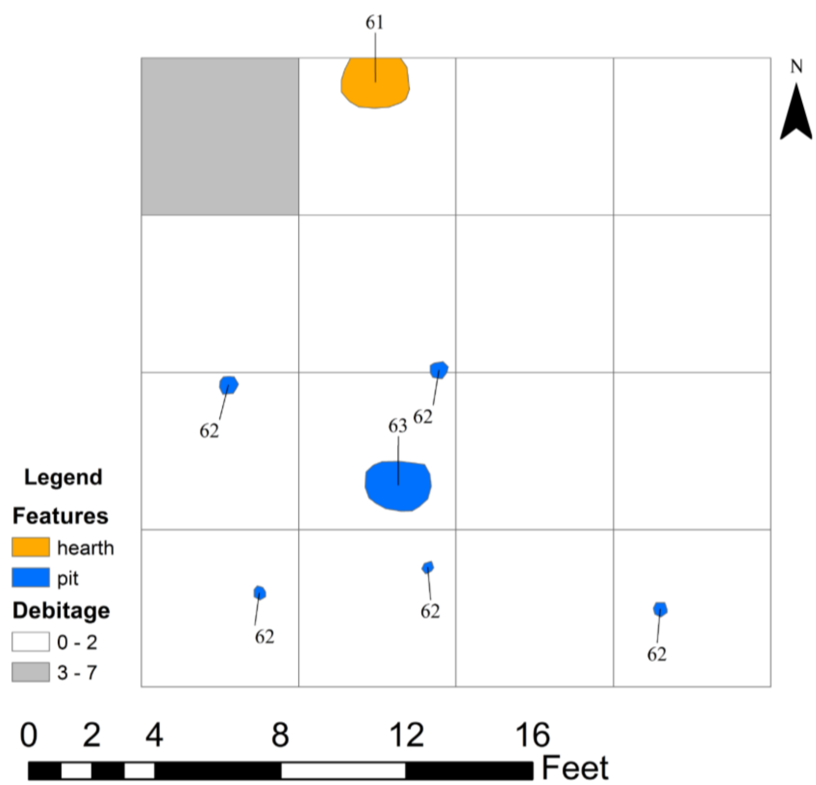

Figure C.68: Stelzer Area 1, Excavation Unit 3 based on site maps from the National Anthropological Archives, Smithsonian Institution.

Feature 61

Feature 61 is a basin-shaped hearth, measuring 67.1 cm long by 61 cm wide and 15.2 cm deep. The bottom of the hearth was lined by a layer of reddish-black sediment 4.6 cm thick. No artefacts were recovered or noted in the feature.

Feature 62

Feature 62 is a series of five small soil stains, averaging around 9.1 cm deep. The five soil stains form two parallel rows running roughly east-west, with two stains forming the north line and three forming the south line. Debitage and bone fragments were found in association with the westernmost stains, but little else was associated. The soil stains are too shallow to have contained a vertical post, having a depth of around 9.1 cm. Similar soils stains elsewhere at the site were attributed to rodent activity.

Feature 63

Feature 63 is a shallow basin-shaped pit, measuring 70.1 cm by 54.9 cm and 15.2 cm deep. There was very little inside the feature, only a few pieces of debitage. There is little evidence as to the nature of this feature, but it is most certainly associated with Feature 62. This pit is associated with the soil stains, positioned in the centre between the two parallel rows; the significance of this association remains unclear.

Area 2, Excavation Unit 1

This excavation unit is composed of a series of test trenches along the terrace edge, and as a result, artefacts were grouped from each 50 foot trench rather than the units, making any sort of meaningful spatial analysis difficult. A total of 90.4 m^2 was excavated from this area, exposing two middens and a hearth. In this excavation, Feature 112 is of particular interest, as this 4 m long midden feature contained a tightly packed mixture of bone fragments, FCR, and a variety of artefacts. The faunal assemblage in this feature contained at least five bison and two elk specimens. Feature 113 also contained bison bone and FCR. . I submitted a bison distal tibia from Feature 112 for radiocarbon dating, producing an assay of 1775 ± 20 ^{14}C yrs BP (UCIAMS 143668).

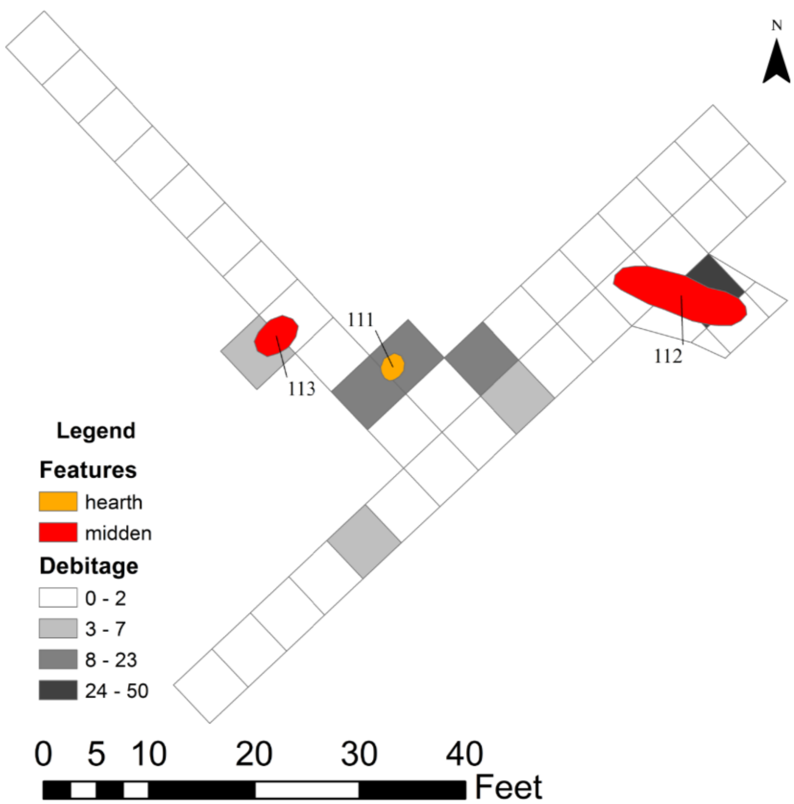

Figure C.69: Stelzer Area 2, Excavation Unit 1 based on site maps from the National Anthropological Archives, Smithsonian Institution.

Feature 111 (Previously Feature 4)

Feature 111 is a shallow basin-shaped hearth, measuring 79.2 cm in diameter and 12.2 cm deep. The hearth was lined with a white ash layer with tiny fragments of charcoal and burnt bone. The upper parts of the feature were disturbed by a rodent burrow. Two scrapers, a retouched flake, and 22 stone fragments were collected from this feature.

Figure C.70 : Feature 111 cored, view northeast.

Feature 112 (Previously Feature 5)

Feature 112 is a large midden deposit, measuring 4.18 m long by 1.07 m wide and 12.2 cm deep. The midden was composed of a tightly packed mixture of bone fragments, debitage, fire-cracked granitic cobbles, and pot sherds. In addition, there were small amounts of ash and charcoal. Collected from the feature were seven body sherds, a brown chalcedony point midsection with notches, a complete TRSS side-notched point, two bifaces, a retouched flake, 35 pieces of debitage, and 90 animal bones. A total of 36 bones were identified, revealing both bison and elk faunal remains in this feature. Table C.9 summarizes the bison faunal remains, and Table C.10 details the elk remains. In total there are at least five bison represent in the feature, as well as one mature and one immature elk. I submitted a bison distal tibia from the feature for radiocarbon dating, producing an assay of 1775 ± 20 ^{14}C yrs BP (UCIAMS 143668) with a $\delta^{13}C$ value of -15.9.

Table C.9 : Feature 112 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
mandible	4	2	2			2	
cervical vertebra	1					1	
lumbar	1					1	
scapula	5	3	2			5	
humerus	1		1	1		1	
radius	4	4		1	3	1	
ulna	1	1		1		1	
femur	2		2		2	2	
patella	2	2				2	
tibia	5	4	1	1	4	5	
astragalus	1	1				1	
navicularcuboid	1					1	
metatarsal	3	3		3		3	

Table C.10 : Feature 112 elk faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
molar	2	1	1			1	1
mandible	1	1					1
scapula	1	1					1
humerus	1	1		1			1

Figure C.71 : Feature 112. Board is mislabled; view northeast.

Figure C.72 : Feature 112. Board is mislabelled; view southeast.

Figure C.73 : Feature 112, view southwest, view southwest.

Feature 113 (Previously Feature 6)

Feature 113 is a small midden, measuring roughly 91.4 cm long by 61 cm wide and 12.2 cm deep. The midden was composed of bone fragments, fire-cracked cobbles, pot sherds, and debitage. Only 17 bone fragments were collected from the feature, 13 of which were identified as bison. A submitted bone sample for radiocarbon dating failed to produce sufficient collagen.

Table C.11 : Feature 113 bison faunal remains.

Element	Quantity	Right	Left	Proximal	Distal	Adult	Immature
humerus	1		1		1	1	
radius	1	1		1		1	
tibia	2	1	1		2	2	
calcaneum	1		1			1	
metatarsal	2	1		1	1	2	
first phalanx	2					2	
second phalanx	2					2	

Area 2, Excavation Unit 2

There were no features uncovered in this excavation unit. Covering 30.2 m^2, small amounts of debitage were recovered from this area as well as five scrapers, three pot sherds, and a bifacially worked knife.

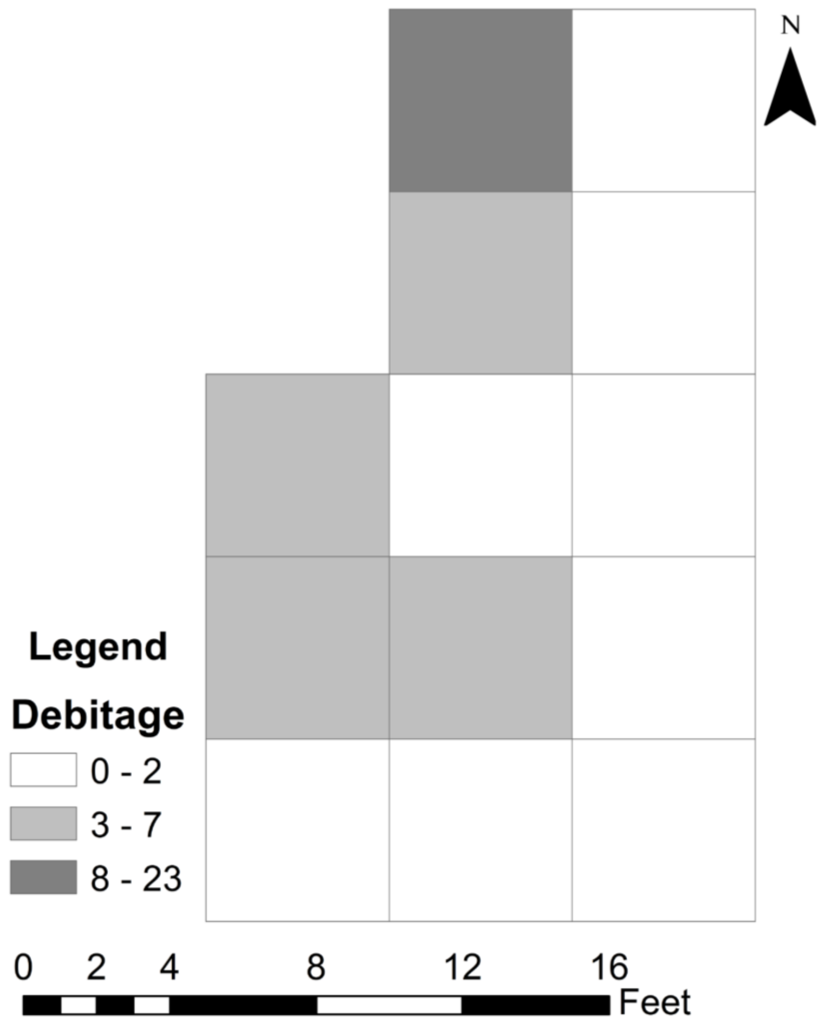

Figure C.74: Stelzer Area 2, Excavation Unit 2 based on site maps from the National Anthropological Archives, Smithsonian Institution.

Area 2, Excavation Unit 3

A total of 43 m^2 was excavated from this southernmost excavation unit at the site, uncovering three separate hearths, as well as a series of small soil stains that were attributed to rodents burrowing through the artefact and charcoal rich hearths. There is a heavy concentration of debitage, points, scrapers, knives, and sherds around these hearths, but there is no separation as was observed in Area 1, Excavation Unit 1. Most of the features intrude into Zone 4, the sterile caliche-rich sediment below the occupation layer (Figure 6.2), but Feature 114 intrudes into the top of the cultural horizon, indicating that it was formed near the abandonment of the site.

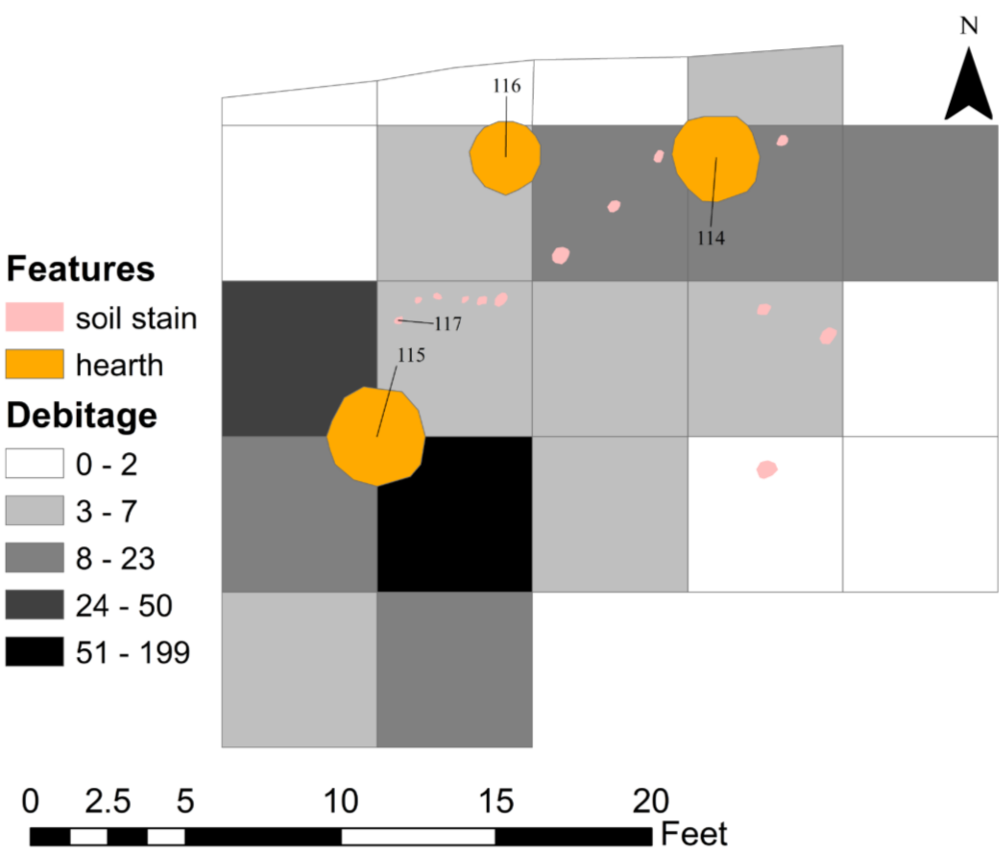

Figure C.75: Stelzer Area 2, Excavation Unit 3 based on site maps from the National Anthropological Archives, Smithsonian Institution.

Feature 114 (Previously Feature 7)

Feature 114 is a shallow basin-shaped hearth, measuring 79.2 cm long by 73.2 cm wide and 18.3 cm deep. The fill was composed of charcoal and ash mixed with burnt bone fragments and debitage. This feature is only 45.7 cm below the surface, bringing the top of this feature in line with the uppermost part of the culture-bearing deposits at the site; this placement is different from the majority of features at the site. Most of the features intrude into the sterile caliche-rich sediment below the occupation layer. The stratigraphic placement of this feature in the profile suggests that this feature is part of the later manifestation at the site, around or shortly after the site was largely abandoned. A utilized flake and seven pieces of debitage were collected from this feature.

Feature 115 (Previously Feature 8)

Feature 115 is a basin-shaped hearth, measuring 97.5 cm long by 1.01 m wide and 7.3 cm deep. The fill was composed of intermixed ash and charcoal, as well as a variety of artefacts. Collected from the hearth was a complete side-notched point made from brown chalcedony, a body sherd, a biface, a scraper, a retouched flake, a piece of copper, and 17 pieces of debitage.

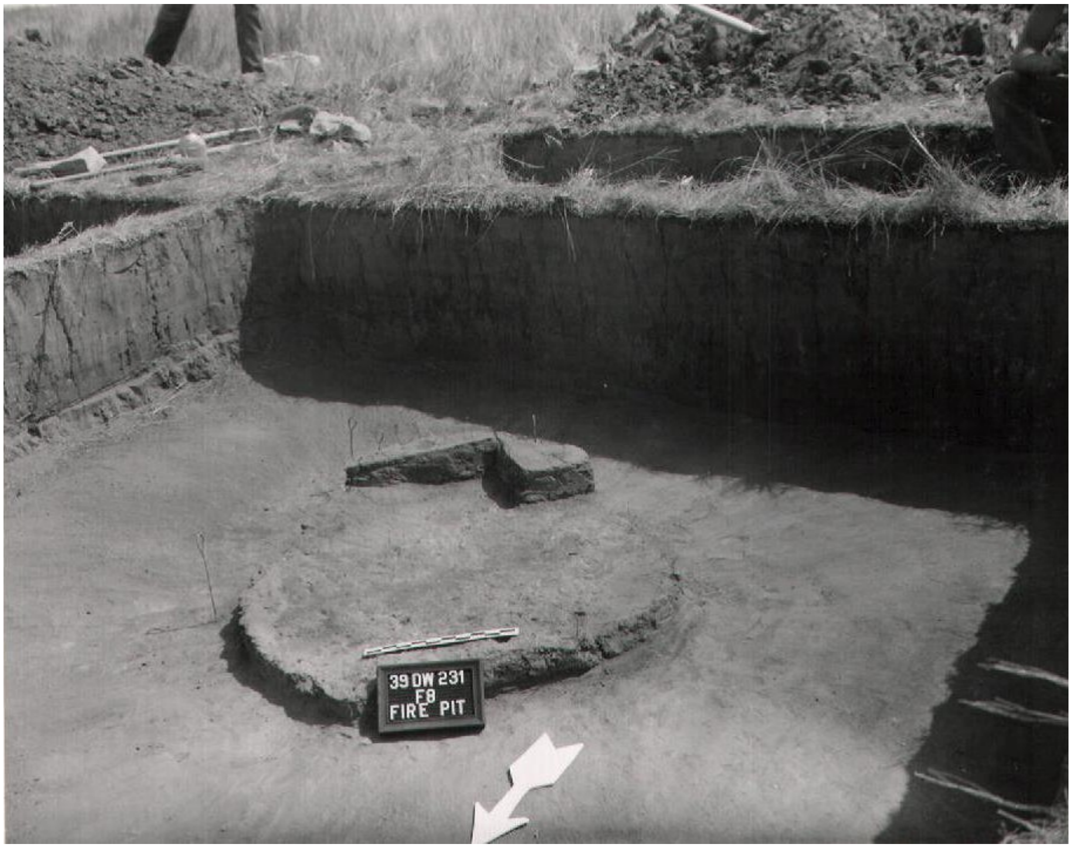

Figure C.76 : Feature 115 on pedestal, view southeast.

Feature 116 (Previously Feature 9)

Feature 116 is a basin-shaped hearth, measuring 54.9 cm in diameter and approximately 15.2 cm deep. The fill contained ash, bone fragments, and debitage. There is little information or material is associated with this feature, as it was mostly removed before the hearth was recognized.

Feature 117

Feature 117 is a series of dark circular soil stains around the hearth features in Excavation Unit 3, which all appear to be the result of rodents burrowing in and around the hearths.

Features 70 to 76

Features 70 through 76 were a series of test excavations carried out in 1965 into circular depressions that were found scattered around the Area 1 excavation trenches. It was thought that these depressions represent house pits from the occupation, but subsequent excavation demonstrated that these depressions were above the occupation layer, and not related to the site. The origin of these features is most likely natural, caused by either blowouts or animal wallows. Underneath the depressions were intact archaeological deposits, associated with the larger site complex. The pattern of features and artefacts recovered conforms to what has been seen at the rest of the site, and is likely contemporary. Samples from Feature 119 and 127 were submitted for radiocarbon dating, producing an age of 1785 ± 20 ^{14}C yrs BP (UCIAMS 143669) and 1755 ± 25 ^{14}C yrs BP (UCIAMS 143670), demonstrating contemporaneity of different parts of the occupation away from the largest excavation area.

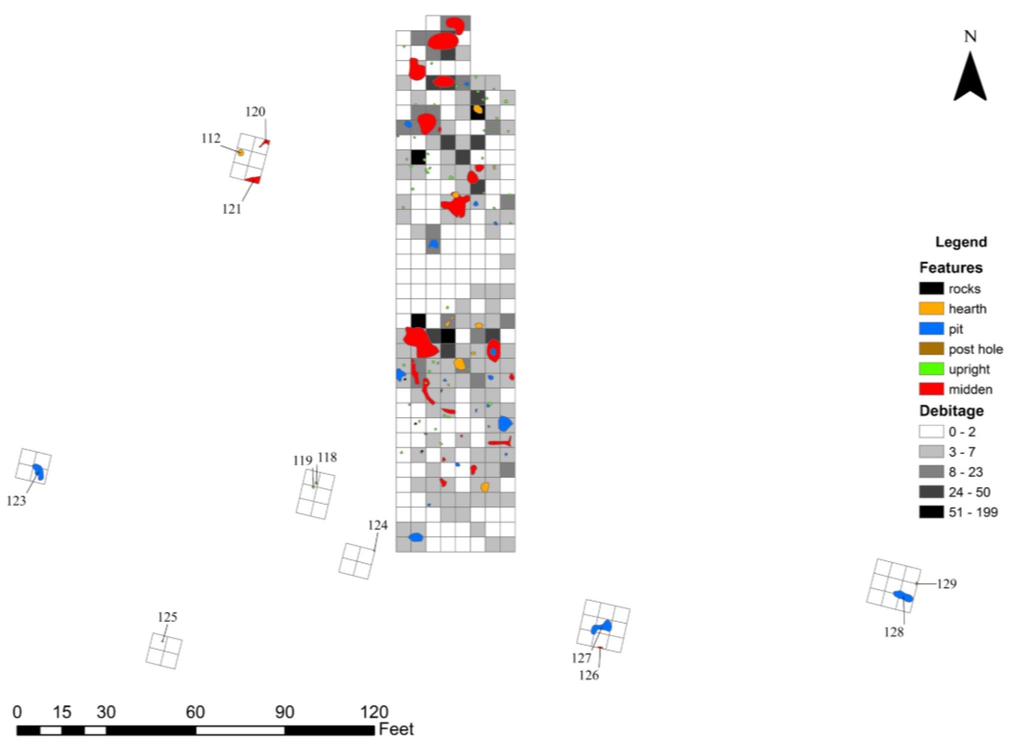

Figure C.77: Stelzer features 70-76 with internal features numbered based on site maps from the National Anthropological Archives, Smithsonian Institution.

Feature 70

Feature 70 is a circular depression on the surface, measuring 2.8 m long by 2.5 m wide and 16.8 cm deep. A 3.05 m by 4.57 m excavation grid was laid over top of the depression; the bottom of the depression stopped above the occupation layer, and did not intrude into the occupation level. Collected from this trench was a body sherd, a complete chalcedony side-notched point, two scrapers, nine piece of debitage, and 12 bone fragments. Two upright features were noted in the excavation.

Feature 118 (Previously Feature 70A)

Feature 118 is a bone upright feature in Feature 70, containing two bone fragments. Based on photographs, it appears that a bison humerus and a tibia were collected from the feature. The top of the feature starts just above the occupation layer, and ends just below the same layer. Based on patterns of uprights seen elsewhere at the site, this placement would suggest that the upright was created around or shortly after the site was abandoned.

Figure C.78 : Feature 118 in F70, view west.

Feature 119 (Previously Feature 70B)

Feature 119 is a bone upright feature in Feature 70. There is little information about this feature; just that there were some bone fragments collected from it, and that it has a similar stratigraphic position as Feature 118. A sample from a bison pelvic fragment was submitted for radiocarbon dating from this feature, producing an age of 1785 ± 20 ^{14}C yrs BP (UCIAMS 143669) with a $\delta^{13}C$ of -14.3.

Feature 71

Feature 71 is a circular depression on the surface, measuring 1.89 m long by 1.8 m wide and 12.2 cm deep. A 4.57 m by 3.05 m grid was laid over the surface depression, and the feature was found to partially intrude into the occupation level. A small subsurface pit was found underlying the larger surface depression, but it was determined that the two were unrelated. Also, there were two midden concentrations in the southeast and northeast corners of the excavation. Collected from the excavation were a decorated pot sherd, three projectile point fragments, five bifaces, fifteen scrapers, a mano, nine retouched flakes, eight pieces of debitage, and 36 bone fragments. One projectile point was a brown chalcedony side-notched base, and the other was a petrified wood tip.

Feature 120

Feature 120 is a linear midden deposit in Feature 71. There is no information on the contents or dimensions of this feature.

Feature 121

Feature 121 is large midden deposit in Feature 71. There is no information on the contents or dimensions of the feature.

Feature 122

Feature 122 is a small pit in Feature 71 that partially overlaps with the overlying surface depression. There is very little information about the contents or dimensions of the pit, but field notes indicate that there was very little recovered from the pit itself. Neuman states that the pit contained burned earth and ash, and he interpreted it as a hearth (1975:12).

Figure C.79 : Feature 122, view west.

Figure C.80 : Feature 122 cross-sectioned, view west.

Feature 72

Feature 72 is a circular depression on the surface, measuring 1.25 m long by 1.16 m wide and 9.1 cm deep. A 3.05 m by 3.05 m excavation grid was laid over the top of the depression, revealing a large irregular pit that was unrelated to the overlying depression. The pit was filled and partially surrounded by camp detritus. All the artefacts collected from this trench are presumably associated with the pit.

Feature 123

Feature 123 is a large irregularly-shaped pit, filled with general camp detritus. Associated with the pit was a TRSS projectile point blank, a mano fragment, and 68 animal bone fragments. There has been no identification of the faunal remains, but photographs suggest that they were mostly bison limb bones.

Figure C.81 : Feature 123 cored with contents piled to side, view west.

Figure C.82 : Feature 123 expanded and cored, view northwest.

Feature 73

Feature 73 is a circular depression on the surface, measuring 1.37 m long by 2.23 m wide and 9.1 cm deep. A 3.05 m by 3.05 m excavation grid was laid over the surface depression, that again did not intrude into the occupation level. Collected from Feature 73 were four body sherds, two projectile point tips, three bifaces, two scrapers, a graver, two retouched flakes, a core, 24 pieces of debitage, and 23 bone fragments. The edge of a midden deposit was uncovered in the northeast corner of the excavation; it is not clear what, if any, artefacts came from this area of the site.

Feature 124

Feature 124 is the edge of a midden deposit in the northeast corner of the Feature 73 excavation. There is no information on the content or dimensions of the feature.

Figure C.83 : Feature 124 in centre of photograph, view northeast.

Feature 74

Feature 74 is a circular depression on the surface, measuring 1.58 m long by 1.46 m wide and 0.3 deep. A 3.05 m by 3.05 m excavation grid was placed over the surface depression; it revealed that the surface depression did not intrude into the occupation layer. Bison bone fragments and large cobble fragments were noted in the occupation layer, but nothing was collected from the feature. A bone upright was also noted in the excavation.

Feature 125

Feature 125 is a bone upright in Feature 74. There is no information about the contents or dimensions of this feature.

Figure C.84 : Feature 125 cored, view northeast.

Feature 75

Feature 75 is a circular depression on the surface, measuring 3.66 m long by 3.05 m wide and 12.2 cm deep. A 4.57 m by 4.57 m excavation was placed on top of the depression, which was found to overlap with a midden deposit and an irregularly-shaped pit. These features were not associated or the cause of the surface depression. Collected from the excavation were seven body sherds, three biface fragments, six scrapers, two retouched flakes, a mano fragment, a very long bone awl, a bone tube, and 72 bone fragments. A bison proximal metatarsal was submitted for radiocarbon dating from the general faunal collection, producing an age of 1755 ± 25 ^{14}C yrs BP (UCIAMS 143670) with a δ^{13}C of -15.6.

Feature 126

Feature 126 is a midden deposit in Feature 75. The contents and dimensions of this feature are unclear, as it appears only in the south profile in the excavation maps and site photographs. Field notes suggest that it may have extended over Feature 127 originally.

Feature 127

Feature 127 is an irregularly-shaped pit in Feature 75, filled with bone and rock fragments. There is little information on the contents or dimensions of the feature; it is assumed that most of the artefacts collected from Feature 75 came from this pit and surrounding area.

Figure C.85 : Feature 126 and Feature 127 cored, view south.

Feature 76

Feature 76 is a circular depression on the surface, measuring 1.62 m long by 1.49 m wide and 12.2 cm deep. A 4.57 m by 4.57 m excavation unit was laid over the depression, uncovering a linear basin-shaped pit and a bone upright feature in the occupation level. However, there was no evidence that the surface depression was a result of site activities. A biface fragment, scraper, and retouched flake were recovered from this feature, as well as 10 bone fragments.

Feature 128

Feature 128 is an irregularly-shaped pit in Feature 76, filled with camp refuse. There is little information about the contents and dimensions; it appears that most of the artefacts collected from Feature 76 were associated with this pit.

Feature 129

Feature 129 is a bone upright in Feature 76, in the east wall of the excavation area. There is no information on the content or dimensions of this feature.

Figure C.86 : Feature 128 and 129, view east.

Appendix D: Stelzer Projectile Points Metrics

Projectile point metrics were recorded from points recovered in Neuman's original excavation, as well as a sample of complete points from the surface collection; these data is detailed in Table C.1. Projectile points belonging to the 06-0086 surface collection are housed at the South Dakota State Historical Society Archaeological Research Centre, and the measurements of these points were on file at the centre, courtesy of William Robert Perkins. The Smithsonian collections from the 1960s excavations are housed at the Department of Anthropology, Smithsonian Institution. A Fisher Scientific digital caliper was used to determine the maximum length, maximum width, basal width, neck width, and thickness. Length measurements are presented in millimetres, and the mass is in grams.

Table D.1: Stelzer (39DW242) Projectile Point Metrics

Catalogue #	Collection	Portion	Material	Max Length	Max Width	Thickness	Base Width	Neck Width	Mass
39DW242-28	06-0086	complete point	black siltstone	30.58	16.93	5.89	17.6	15.28	2.9
39DW242-16	06-0086	complete point	brown chalcedony	42.52	16.65	5.42	15.67	12.46	3.5
39DW242-26	06-0086	complete point	brown chalcedony	42.2	22.9	5.64	19.5	15.06	5.6
39DW242-42	06-0086	complete point	brown chalcedony	40.33	22.28	5.68	18.38	14.6	5.5
39DW242-32	06-0086	complete point	brown chalcedony	38.94	22.72	5.84	19.93	16.72	4.7
39DW242-38	06-0086	complete point	brown chalcedony	37.93	22.54	4.84	20.21	15.12	4.4
39DW242-7	06-0086	complete point	brown chalcedony	37.84	20.11	5.87	18.48	13.26	4.9
39DW242-22	06-0086	complete point	brown chalcedony	35.78	22.1	5.34	19.67	16.15	4.5
39DW242-17	06-0086	complete point	brown chalcedony	35.4	19.98	6.37	19.15	15.87	3.9
39DW242-2	06-0086	complete point	brown chalcedony	34.18	20.26	5.69	19.29	13.79	3.9
39DW242-37	06-0086	complete point	brown chalcedony	33.17	20.26	3.84	18.84	15.06	2.5
39DW242-41	06-0086	complete point	brown chalcedony	31.12	22.51	6.13	20.46	17.48	4.2
39DW242-10	06-0086	complete point	brown chalcedony	30.08	18.35	6.04	18.91	15.45	3.4
39DW242-5	06-0086	complete point	brown chalcedony	29.96	19.98	6.14	18.29	14.14	3.4
39DW242-33	06-0086	complete point	brown chalcedony	26.62	19.71	4.92	18.8	16.53	2.5
39DW242-31	06-0086	complete point	brown chalcedony	25.23	20.3	5.3	18.06	14.42	2.9
39DW242-30	06-0086	complete point	brown chalcedony	25.12	19.31	5.73	17.07	14.28	2.5
39DW242-45	06-0086	complete point	brown chalcedony	23.26	18.53	4.85	18.24	15.07	2.2
39DW242-8	06-0086	complete point	chalcedony	30.36	21.25	4.9	20.44	16.09	3
39DW242-14	06-0086	complete point	chalcedony	30.24	18.97	5	16.64	14.59	2.8
39DW242-40	06-0086	complete point	chalcedony	28.67	19.07	6.44	18.53	13.7	3.2
39DW242-25	06-0086	complete point	chert	26.83	18.5	7.24	18.26	14.76	3.3
39DW242-35	06-0086	complete point	grey silicified sediment	42.18	18.72	6.45	16.84	13.82	5.8
39DW242-20	06-0086	complete point	grey silicified sediment	36.54	21.85	5.09	20.04	15.18	4.1
39DW242-6	06-0086	complete point	grey silicified sediment	29.96	18.85	5.6	17.62	14.04	2.9
39DW242-24	06-0086	complete point	grey silicified sediment	26.31	23.16	5.42	21.96	17.91	3.3

Catalogue #	Collection	Portion	Material	Max Length	Max Width	Thickness	Base Width	Neck Width	Mass
39DW242-1	06-0086	complete point	grey silicified sediment	25.71	17.44	4.93	15.78	12.11	2
A498736-0	Smithsonian	point base	brown chalcedony	13.56	25.44	5.7	23.88	20.3	
A498736-0	Smithsonian	point base	brown chalcedony	15.56	18.36	4.83	17.69	13.96	
A498753-0	Smithsonian	complete point	brown chalcedony	24.8	20.02	4.69	18.2	15.09	
A498754-0	Smithsonian	point base	brown chalcedony	12.79	21.66	4.95	20.68	16.8	
A498760-0	Smithsonian	point base	brown chalcedony	22.4	21.14	4.52	13.97	12.41	
A498762-0	Smithsonian	base, midsection	brown chalcedony	29.03	22.37	4.4	18.85	14.26	
A498775-0	Smithsonian	point base	brown chalcedony	13.67	20.81	5.64	19.19	15.27	
A498778-0	Smithsonian	complete point	brown chalcedony	31.6	17.62	4.1	13.95	13.5	
A498780-0	Smithsonian	midsection, notches	brown chalcedony	38.42	22.91	4.45		16.38	
A498818-0	Smithsonian	point w/o tip	brown chalcedony	23.86	18.72	4.67	19.96	14.31	
A498829-0	Smithsonian	complete point	brown chalcedony	30.7	20.25	4.47	14.34	12.15	
A498830-0	Smithsonian	point w/o tip	brown chalcedony	34.82	20.26	6.11	14.92	14.21	
A498895-0	Smithsonian	complete point	brown chalcedony	37.42	21.82	5.82	19.07	14.64	
A498911-0	Smithsonian	point base	brown chalcedony	10.37	20.16	5.21	20.16	15.8	
A498954-0	Smithsonian	base, midsection	brown chalcedony	20.19	19.45	5.3	18.85	15.08	
A498955-0	Smithsonian	point base	brown chalcedony	11.19	20.94	4.57	20.94	15.74	
A498955-0	Smithsonian	complete point	brown chalcedony	28.24	20.02	5.96	16.7	13.21	
A498959-0	Smithsonian	point base	brown chalcedony	9.16	20.06	4.44	20.06	15.38	
A498969-0	Smithsonian	point base	brown chalcedony	11.37	20.55	4.91	20.55	16.6	
A498969-0	Smithsonian	point base	brown chalcedony	12.25	19.91	3.77	19.91	15.66	
A498983-0	Smithsonian	point base	brown chalcedony	10.54	16.61	4.9	16.61	13.44	
A499010-0	Smithsonian	complete point	brown chalcedony	35.64	20.96	5.94	17.75	16.02	
A499032-0	Smithsonian	point base	brown chalcedony	20.6	22.68	5.06	19.18	15.36	
A499036-0	Smithsonian	complete point	brown chalcedony	30.73	19.22	7.58	16.55	15.63	
A499036-0	Smithsonian	complete point	brown chalcedony	32.98	20.43	5.13	15.72	15.19	

Catalogue #	Collection	Portion	Material	Max Length	Max Width	Thickness	Base Width	Neck Width	Mass
A499048-0	Smithsonian	complete point	brown chalcedony	33.05	19.58	4.57	17.89	14.56	
A499048-0	Smithsonian	tip with notches	brown chalcedony	17.3	15.96	2.12		11.34	
A499052-0	Smithsonian	complete point	brown chalcedony	31.87	21.38	6.22	17.3	13.88	
A499056-0	Smithsonian	point base	brown chalcedony	10.74	14.41	4.37			
A499059-0	Smithsonian	point base	brown chalcedony	9.2	19.99	3.8	19.99	15.05	
A499059-0	Smithsonian	point base	brown chalcedony	25.83	19.51	4.74	18.6	12.99	
A499063-0	Smithsonian	complete point	brown chalcedony	32.86	20.95	5.34	17.36	15.87	
A499063-0	Smithsonian	point base	brown chalcedony	10.22	15.44	3.74	15.44	14.23	
A499063-0	Smithsonian	point base	brown chalcedony	10.2	22.11	4.67	22.11	15.95	
A499063-0	Smithsonian	complete point	brown chalcedony	28.01	19.59	5.97	18.5	16.93	
A499063-0	Smithsonian	point base	brown chalcedony	8.49	19.12	4.12	19.12	13	
A499070-0	Smithsonian	complete point	brown chalcedony	27.41	18.51	5.44	18.51	14.11	
A499075-0	Smithsonian	complete point	brown chalcedony	25.62	19.11	4.91	17.97	15.29	
A499081-0	Smithsonian	point base	brown chalcedony	23.8	18.52	4.76	15.29	11.99	
A499085-0	Smithsonian	point base	brown chalcedony	12.74	18.74	4.2	17.14	14.26	
A499119-0	Smithsonian	point base	brown chalcedony	14.13	22.73	5.37	20.12	15.98	
A499148-0	Smithsonian	point base	brown chalcedony	28.3	18.85	5.2	16.3	14.05	
A499150-0	Smithsonian	point base	brown chalcedony	64.3	20.52	5.26	18.96	14.87	
A499167-0	Smithsonian	point base	brown chalcedony	27.85	24.53	5.86	21.14	16.1	
A499185-0	Smithsonian	complete point	brown chalcedony	37.95	25.91	5.66	22.91	18.59	
A499185-0	Smithsonian	complete point	brown chalcedony	28.86	21.7	6	19.03	15.21	
A499224-0	Smithsonian	base, midsection	brown chalcedony	21.99	20.48	5.29	19.22	15.07	
A499224-0	Smithsonian	tip with notches	brown chalcedony	36.05	18.78	5.22		11.22	
A499229-0	Smithsonian	base, midsection	brown chalcedony	29.05	28.4	6.33	25.98	18.6	
A499230-0	Smithsonian	base, midsection	chalcedony	36.44	24.27	8.62	21.18	16.43	
A499248-0	Smithsonian	point base	chalcedony	9.1	17.19	5.21	17.25	14.71	

Catalogue #	Collection	Portion	Material	Max Length	Max Width	Thickness	Base Width	Neck Width	Mass
A499253-0	Smithsonian	complete point	chalcedony	32.68	18.17	4.75		11.47	
A499268-0	Smithsonian	complete point	chalcedony	27.93	20.21	4.73	16.39	15.46	
A499271-0	Smithsonian	base, midsection	chalcedony	25.87	20.99	5.59	19.03	14.8	
A499285-0	Smithsonian	point base	chalcedony	19.57	19.48	5.77	19.48	14.59	
A499293-0	Smithsonian	complete point	chalcedony	34.92	22	7.09	17.32	16.13	
A499293-0	Smithsonian	point w/o tip	chalcedony	30.88	21.25	6.07	17.89	14.96	
A499297-0	Smithsonian	point base	chalcedony	28.52	22.13	6.08	21.27	15.59	
A499302-0	Smithsonian	complete point	chalcedony	26.38	18.33	4.63	16.88	12.9	
A499307-0	Smithsonian	complete point	chalcedony	26.17	21.19	5.5	17.31	15.22	
A499310-0	Smithsonian	complete point	grey silicified sediment	33.45	21.74	5.18		16.99	
A499322-0	Smithsonian	base, midsection	grey silicified sediment	26.68	23.33	4.65	20.75	15.25	
A499325-0	Smithsonian	complete point	grey silicified sediment	39.25	19.26	7.22	17.19	15.86	
A499344-0	Smithsonian	complete point	grey silicified sediment	66.85	22.43	6.11	18.12	16.17	
A499347-0	Smithsonian	base, midsection	grey silicified sediment	42.83	21	5.68		13.65	
A499347-0	Smithsonian	base, midsection	grey silicified sediment	17.56	19.93	4.36	20.02	15.47	
A499359-0	Smithsonian	complete point	grey silicified sediment	30.09	20	5.64	19.64	14.81	
A499368-0	Smithsonian	point base	grey silicified sediment	13.22	22.85	5.36	21.47	16.94	
A499397-0	Smithsonian	base, midsection	grey silicified sediment	35.38	22.28	5.94	19.2	16.25	
A499403-0	Smithsonian	complete point	grey silicified sediment	57.85	20.08	8.86	16.69	13.84	
A499420-0	Smithsonian	base, midsection	grey silicified sediment	42.47	28.82	8.88	23.55	22.57	
A499432-0	Smithsonian	complete point	petrified wood	34.86	19.59	5.41	15.53	14.93	
A499444-0	Smithsonian	midsection, notches	red slicified sediment	31.86	20.07	5.78			
A499451-0	Smithsonian	preform	red speckled white chert	22.6	19.95	5.84	19.03	17.79	