THE FITZGERALD SITE:
A BESANT POUND AND PROCESSING AREA ON THE NORTHERN PLAINS

A Thesis

Submitted to the Faculty of Graduate Studies and Research

in Partial Fulfillment of the Requirements

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Master of Arts

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by

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Saskatoon, Saskatchewan

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Abstract

The Fitzgerald site is a Besant pound and processing area located in the Moose Woods Sand Hills 15 km southeast of Saskatoon, Saskatchewan. Two seasons of excavation resulted in the recovery of an extensive collection of 1200 year old faunal and lithic artifacts and the identification of numerous features. Analysis of these materials indicates that the site occupation was a fall event involving the slaughter of at least 49 bison. All ages and sexes are represented in the bison herd population; however, gender analyses indicate that the mature cows were more heavily processed than the bulls and juveniles. Application of economic utility indices shows that these animals were being selectively processed for grease.

The Fitzgerald site strongly resembles other sites from the Besant period. Most bison communal kills were large and involved the intensive butchering indicative of pemmican manufacture. Like a select few Besant sites, the assemblage is also dominated by the lithic material Knife River Flint. These patterns demonstrate that the Besant peoples were practicing a form of communal hunting that involved the mass production of pemmican stores for the coming winter.

Acknowledgments

Many people contributed both professionally and personally to the completion of this thesis. I must first thank Joe and Cathy Fitzgerald for allowing me complete freedom to excavate some enormous holes in what was in essence their own backyard. Their enthusiasm for the project was contagious and I am much indebted for their hospitality. The field crew of Todd Paquin and Jay Armstrong endured the elements without complaint and I thank them for their expertise and friendship. D'Arcy Fitzgerald, who volunteered a large part of his summer to the excavation of the site, must also be thanked for his interest and considerable help.

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I would like to acknowledge the tremendous amount of support that my committee provided in the writing of this thesis. I was allowed complete freedom to pursue whatever research interests I felt necessary. Dr. Ernie Walker and Dr. Richard Morlan were very helpful in the completion of the projectile point and the faunal analyses. Dr. Margaret Kennedy sat on my committee with little notice and many valuable comments. I would

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My family, especially mom and Nathan, is much loved and I thank them for their unquestioned support for this strange and exciting profession that I have been drawn in to. Finally, I would like to dedicate this thesis to my grandmother, Shena Baring-Gould. Her seven grandchildren have pursued incredibly diverent interests and careers, however, we will be forever linked by her considerable generosity and love.

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Chapter 1

Introduction

1.1 Introduction to the Fitzgerald Site

The Fitzgerald site (ElNp-8) is a Besant bison pound and processing area found in the Moose Woods Sand Hills 15 km southeast of Saskatoon, Saskatchewan. The site is named for the owners of the bison paddock where the site is located, Joe and Cathy Fitzgerald (Figure 1.1). During the summers of 1992 and 1993, the author conducted testing and excavation at the site. This thesis represents the final analysis of the materials observed and collected over the duration of the project.

The Fitzgerald site is a particularly fine example of the remains of a bison pounding operation. Excavations of sites of this nature have resulted in large samples of cultural materials, a pattern that continues at the Fitzgerald Site. Identifiable articles include a large assemblage of Besant projectile points, debitage, faunal remains and features. Similar to other sites from this period, 90% of the tools and debitage are made from Knife River Flint.

Besant sites are found across the Northern Plains having been identified in Alberta, Saskatchewan, Manitoba, Montana, North Dakota, South Dakota, and Wyoming (Figure 1.2). Many of these sites are examples of large bison communal hunting operations. George Frison (1991: 223) has called this period a "cultural climax" in terms of communal hunting on the Plains. A number of Besant kill sites on the Canadian Plains have extremely high frequencies of Knife River Flint. This material was likely quarried from the Knife River region of North Dakota. That these occupations on the Northern Plains apparently coincided with the adoption of the burial mounds in the Middle Missouri River region has led to considerable conjecture as to the relationship between

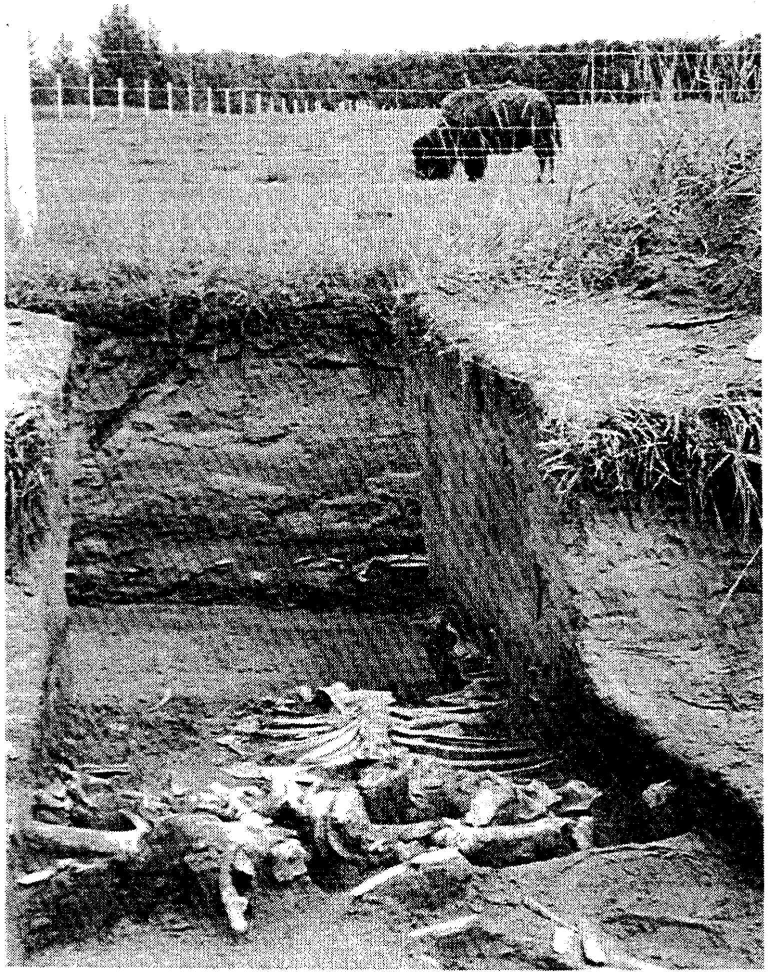


Figure 1.1: Excavations at the Fitzgerald Site. Note Bison Paddock in the Background.

the Besant hunters and the Sonota mound builders.

This thesis will explore the relationship between the Fitzgerald site and other Northern Plains and Middle Missouri River sites from the Besant period. Accordingly, analysis of the lithic and faunal remains from the Fitzgerald site will form a major part of this thesis. The goal is to determine the frequency and seasonality of occupation and the

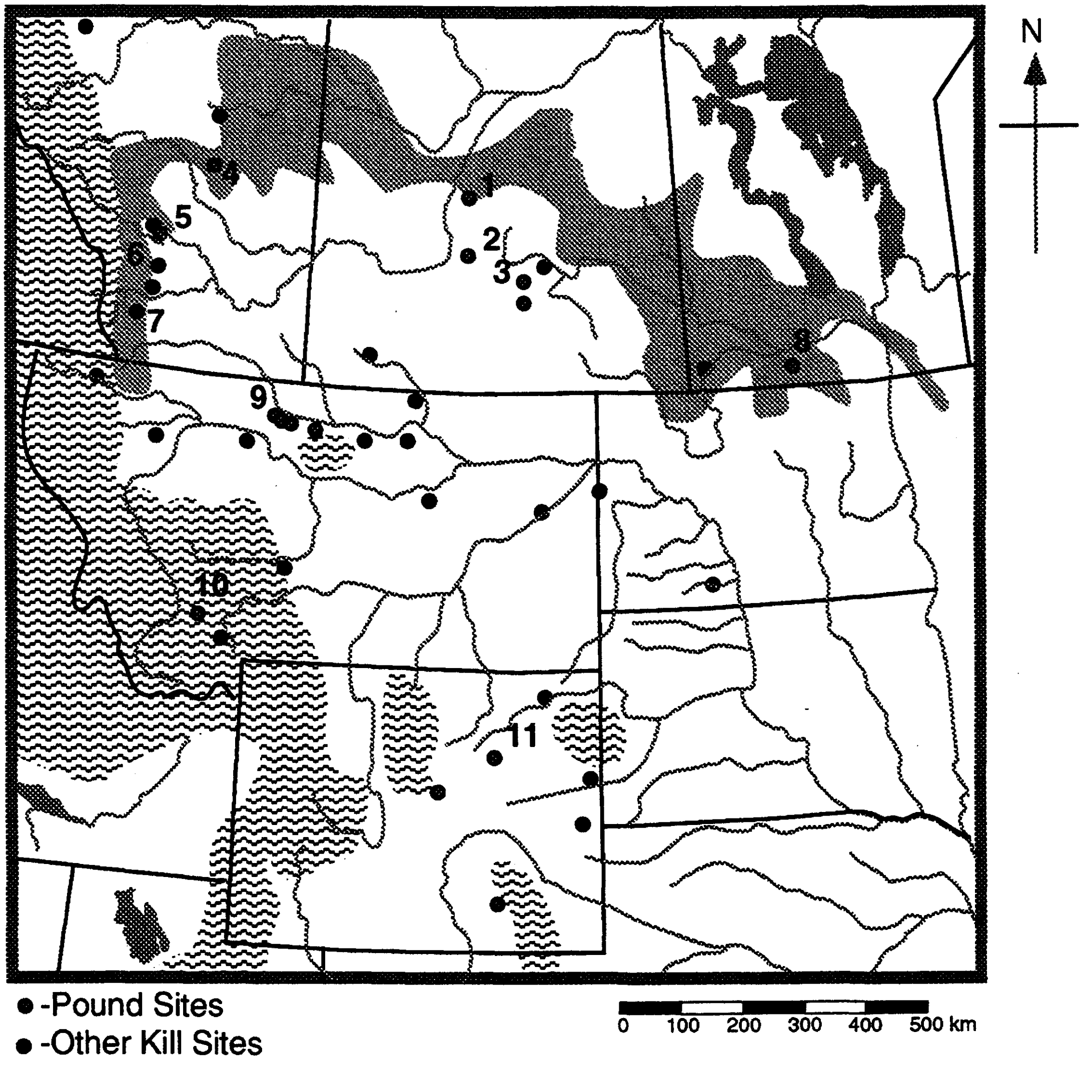


Figure 1.2: The Location of the Fitzgerald Site and Other Kill Sites With Besant Components on the Northern Plains (1 = Fitzgerald; 2 = Melhagen; 3 = Walter Felt; 4 = Muhlbach; 5 = Happy Valley; 6 = Old Women's; 7 = Head-Smashed-In; 8 = Richards; 9 = Wahkpa Chu'gn; 10 = Antonsen; 11 = Ruby).

hunting and butchering patterns at the site. These problems will be resolved using now standard gender and age analyses and economic utility indices. By comparing these results to other sites from the same period, differences in the way the bison were exploited can be derived. It can then be ascertained whether the Fitzgerald site was part of a standardized pattern representing a fluorescence of communal hunting across the Northern Plains.

One of the goals of this thesis is to determine the relationship of the Fitzgerald site to other Besant kill sites on the Northern Plains. The objective is to determine the similarities and differences between it and other sites from this period. As a result, analyses will seek to determine the cultural affiliation of the site.

1.2 Summary of Chapters

This thesis has been divided into 11 chapters. Chapter 2 examines the local and regional environment surrounding the Fitzgerald site. The local topography will be explored, as well as the associated stratigraphy. Emphasis will be placed on why this particular location was utilized when it was. A summary of the radiocarbon dates obtained from the site is found at the end of this chapter.

Chapter 3 provides an overview of field and laboratory techniques employed in the collection and analysis of the Fitzgerald site occupation. Chapter 4 contains the analysis and interpretation of the projectile points, tools and debitage recovered and the features observed from the Fitzgerald site. The main goal of this chapter is to place the site within the proper cultural context. Hence, these materials will be examined with regard to archaeologists current understanding of the Besant culture.

Chapters 5 to 9 are concerned with the analysis of the large sample of bison bone collected from the Fitzgerald site. Chapter 5 provides the results from the employment of faunal counts like NISP, MNI, MNE and MAU. Chapter 6 examines the taphonomic processes that may have effected the Fitzgerald site occupation materials. Emphasis will processes that may have effected the Fitzgerald site occupation materials. Emphasis will be placed on determining how the faunal sample was modified by natural processes. Chapter 7 provides a demographic profile of the bison herd at the time of death. Gender and age analyses are employed to determine the season in which the kill took place and the type of herds that may have been selected for during the hunt.

Chapter 8 and 9 are concerned with the cultural processes that produced the collected faunal sample. The first of these chapters investigates the butchering processes exhibited at the Fitzgerald site. Each element within the bison anatomy is examined to determine if selective patterns were employed and whether they bear resemblance to those observed at other kill and processing sites excavated on the Northern Plains. A reconstruction of how the bison may have been processed at the Fitzgerald site is provided at the end of the chapter. Chapter 9 employs recently developed utility indices by Emerson (1991) and Brink (1994) to determine whether hunting and butchering decisions were influenced by the age and sex of the bison.

Finally, Chapter 10 examines the Fitzgerald site within a larger context. It is determined whether the site fits into a larger hunting pattern that is somehow unique to Besant. It explores Frison's concept of the cultural climax and tries to explain why it developed at this particular time and location.

Chapter 2

Regional Setting, Environment and Site Stratigraphy

2.1 Introduction

This chapter examines the local and regional environment and topography surrounding the Fitzgerald site. Analysis will concentrate on reconstructing the conditions during the period of occupation some 1300 years ago. The purpose is to learn the reasons why communal hunting operations were successfully completed at this particular time and location. This chapter will also examine the stratigraphic profile of the site. Since a major goal of this thesis is to determine if there were distinct butchering practices undertaken in the kill and processing area, it is important to ascertain if these areas are temporally related. Close examination of the profile will establish if the site was used for a relatively short time (several years), or if separate occupational horizons can be delineated.

2.2 Regional Environment

The Fitzgerald site is located near the northern edge of the Northern Plains ecozone. This area comprises some 180,000 km^2 and is situated east-west between the foothills of the Rocky Mountains and the 100th meridian, and north-south between the boreal forest border and the North Platte River (Barker and Whitman 1988: 266). The Canadian Plains form the northern portion of this region and can be divided into three prairie steppes, the Manitoba Plain Region, the Saskatchewan Plain Region and the Alberta Plain Region (Ellis et al. 1970: 7). The Fitzgerald site is located near the center of the Saskatchewan Plain Region within the Saskatchewan Rivers Plain Section, an area of some "topographic variety, with ground moraine, lake plains, deep river valleys, spillways, dunes and other minor land forms" (Richards and Fung 1969: 41). The South Saskatchewan River flows south-north through this section. Nearby uplands include the Allan Hills and Hawarden Hills to the southeast and the Minichinas Hills to the northeast.

The Missouri Coteau Uplands that include the Beechy and Bear Hills are situated to the south and west. Sediments in the Saskatchewan Rivers Plain Section are dominated by "glacio-lacustrine sands, silts and clays and glacio-fluvial sands and gravels" (Ellis et al. 1970: 8).

The Canadian Plains region is known for its climatic extremes; the winters are long and cold, the summers hot and dry. Ellis et al. (1970: 15-16), in their analysis of the Rosetown map area show the mean temperature in January to be -14° C and 19° C in July. In this region there are approximately 105 frost free days; grasses grow on average from April 25 to October 16. Average precipitation is 355 mm per year. Records from the Saskatoon weather office (Glen Jusethin personal communication 1995) indicate that wind direction is quite variable, usually from the southwest or northwest at an average velocity of 17 km per hour with a maximum mean of 40 km per hour. During the months of October and November prevailing winds are from the south and southwest.

Conditions were probably somewhat better during the period in which the Fitzgerald site was utilized some 1300 years ago. The occupation coincided with the Neoglacial period, a time of glacial expansion in the western North American mountains (Vance 1991: 151). Vance's (1991) study of Chappice Lake in southeastern Alberta analyzes the paleoenvironmental history of the Canadian Plains during the last 8500 years. The date of the Fitzgerald site occupation coincides with an unnamed late Holocene climatic interval that ran from 2650 to 1060 years BP. Analysis of the pollen, plant macrofossil and sedimentological record indicates that conditions were cooler and moister than the present day while droughts were relatively rare, results consistent with other lake core records (Vance 1991: 141 and 155). The Canadian Plains during this period afforded "a dependable natural resource base" for human occupants in the region (Vance 1991: 155). This 1600 year interval provides the most ideal living conditions for hunter and gatherer populations for any time period during the Holocene.

The site is presently found in the Aspen Parkland Region approximately 20 km north of the present day boundary with the Mesic Prairie Region (Zoltai 1975; Archibold and Wilson 1980). The Aspen Grove Region is dominated by aspen *(Populus tremuloides)*, fescue (*Fescuta scabrella*) and spear grass (*Stipa spartea*) (Morgan 1979: 32). The nearby Mesic Prairie is dominated by mid-grasses like spear grass, wheat grass (*Agropyron dasytachyum*) and small amounts of short grasses like blue gamma (*Bouteloua gracilis*) and tall grasses like fescue (Morgan 1979; Acton and Ellis 1978: 12). The Aspen Parkland Region gives way to the Boreal Forest zone near the confluence of the North and South Saskatchewan Rivers. Examination of 18th and 19th century historic records (Archibold and Wilson 1980; Thorpe 1993) and field survey (Zoltai 1975) would seem to indicate that the position of the aspen parkland has changed little in the last hundred years.

The position of the site in relation to the Aspen Parkland Region is important because modern ecological studies have attempted to link bison migratory behavior with the presence of different ecological zones within the Canadian Plains (Ray 1974; Arthur 1975; Morgan 1979, 1980). Morgan (1979, 1980) first introduced the idea that the movement of the herds was closely allied with the foraging capacity of the three different ecozones in the Northern Plains: the Parklands, the Mesic Mixed Prairie (mixed grass) and the Xeric Mixed Prairie (short grass). Morgan suggested that the Mesic Mixed Prairie grasses were the first to begin growing in the spring, prompting the bison to exit the Parklands in search of these fresher and more nutritional grasses. Later in May, the growth of the species *Bouteloua gracilis* would have prompted the bison to disperse further south into the Xeric Mixed Prairies. This grass species is highly nutritious and preferred to other grasses by most ungulate species. Following the late summer rut (late July through early September) the bison, prompted by a lack of water and suitable forage in the Xeric prairie would have begun to migrate northwards again. The result was a "two field rotation system" where the bison would have remained in the Mesic Prairie "until adverse climatic conditions force[d] them to seek sheltered areas" in the Parklands and valley complexes (Morgan 1980: 54). As the Parklands are smaller in area than the Grasslands, bison would have formed larger herds in the winter than in the summer.

Chisholm et al. (1986) conducted an isotopic analysis of bison bone collected from sites in Alberta. Their analysis indicated that the $^{13}C/^{14}C$ ratio in bison bone can be used to determine those animals that have grazed on C_4 grasses. The parklands have little or no C_4 grasses while in the Xeric Prairie there are high levels of C_4 grasses. Faunal remains collected from the parklands have the same $^{13}C/^{14}C$ ratio as those from the Xeric Prairie. Seasonal migrations are inferred from this analysis.

While bison was likely the dominant food source for pre-contact groups on the Northern Plains, other plants and animals were also heavily relied on for food, clothing and other items. A list of other animal species native to the region would include various ungulates, carnivores, rodents, rabbits, birds, fish, reptiles and amphibians (see Atton 1969; Banfield 1974; Godfrey 1986; Gollop 1969). Consumable plant resources would include nuts, berries, roots, seeds and leaves (see Helleson and Gad 1974; Peacock 1991). In the region surrounding the Fitzgerald site, there are a number of archaeological sites with a well documented use of a considerable variety of animal and plant species. Recent excavations at the Hartley site, an Avonlea/Old Women's camp site 15 km northwest of the Fitzgerald site, has identified 22 vertebrate species, 14 of which are mammalian (Clarke 1995). Numerous animal species were also recovered in Besant components at the Sjovold site, 75 km southwest of the Fitzgerald site (Dyck and Morlan 1995).

2.3 Local Environment

Locally, the Fitzgerald site is found in the Moose Woods Sand Hills (Figure 2.1). These hills stretch along both sides of the South Saskatchewan River from the south edge

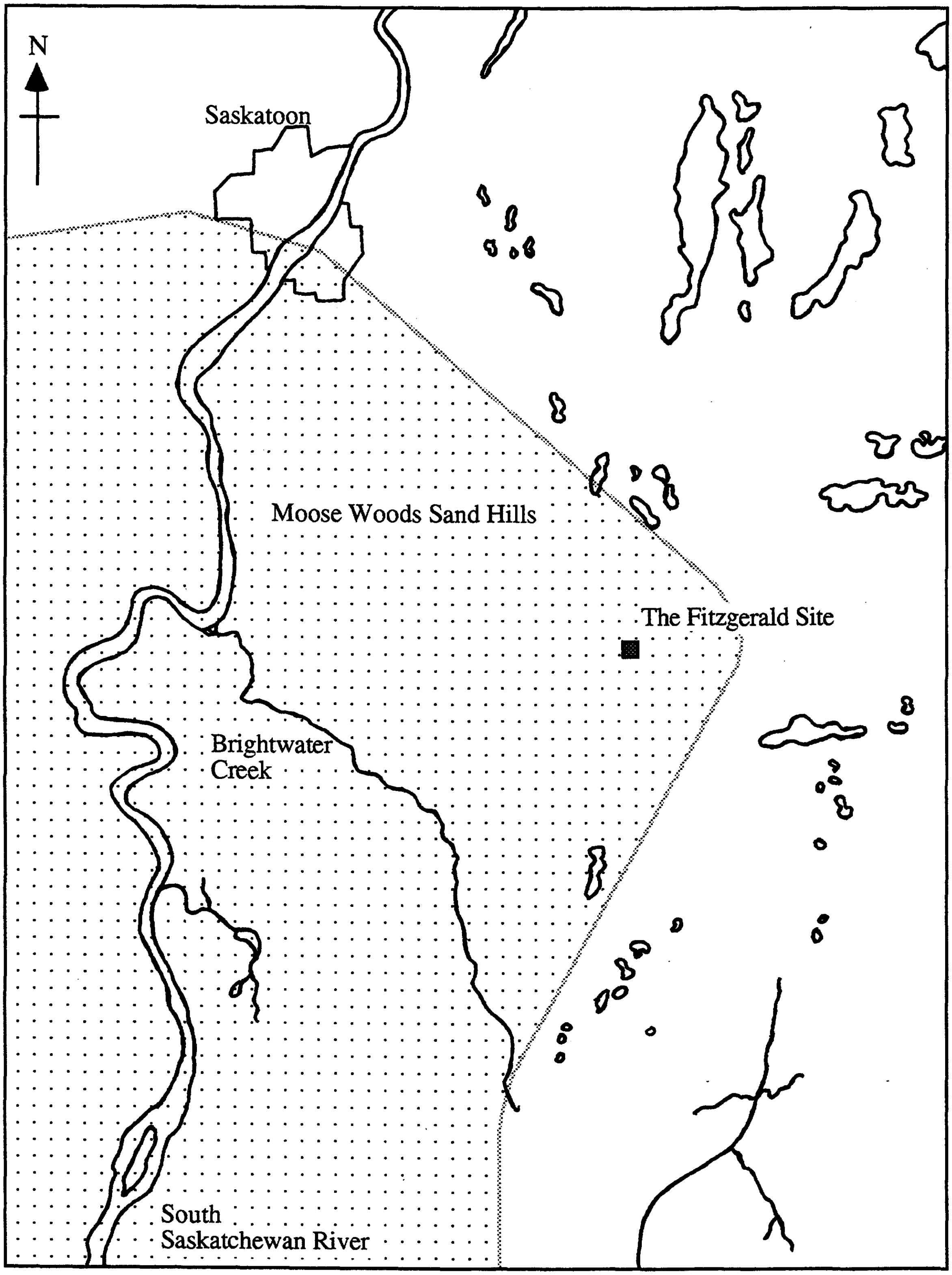


Figure 2.1: Local Environmental Setting at the Fitzgerald Site (Scale = 1:250,000)

of Saskatoon to Proctor Lake and from Vanscoy to Bradwell. This region slopes from a high of 520 m a.s.l. in the uplands to 490 m a.s.l. at the South Saskatchewan River. The Fitzgerald site is found at approximately 516 m a.s.l. These sand hills are characterized by "(s)trongly rolling sand dunes" and "(l)ocal undulating, wind-scoured sand plains and glacio-fluvial plains" (Acton and Ellis 1978: 6). These dunes consist chiefly of "coarse to moderately coarse textured regosolic soils developed on aeolian or wind-worked sandy glacio-fluvial and lacustrine deposits" (Ellis et al. 1970: 78).

Gravel and cobbles are not associated with this region. The closest available sources of coarse stone are Brightwater (Beaver) Creek and the South Saskatchewan River. For tool manufacture, silicified sedimentary, igneous and metamorphic rocks are locally available in exposed glacial till, fluvial and glacio-fluvial deposits (Ramsay 1993: 20). Other suitable lithic materials may be found in the glacial till that forms the Allan Hills to the southeast (Urve Linnamae, personal communication, 1995).

Little surface water is available in the Moose Woods Sand Hills due to the permeability of the sand deposits (Ellis et al. 1970: 78). There is limited external drainage to Brightwater Creek, the nearest available year-round water source some 8.5 km to the southwest (Ellis et al. 1970: 3). The site is approximately 14.5 km east of the South Saskatchewan River.

Water was available in the vicinity of the Fitzgerald site. A now dry slough depression that is some 50 x 50 m in diameter is located approximately 250 m west of the kill. Near this slough a considerable amount of debitage was recovered. As well, a concentration of bone and Knife River Flint Besant points (ElNp-) was found 10 m north of this location. It is very likely that in moister conditions this slough would have been a readily available water source.

2.4 Local Topography

The Fitzgerald site is found at the bottom of a small basin formed between two stabilized parabolic sand dunes (Figure 2.2 and 2.3). Examination of air photographs of the area reveals other such dunes in the vicinity (Figure 2.4). As the prevailing winds are from the northwest and southwest, the dunes would have drifted in from this direction and formed around a "topographic irregularity or obstruction" (Waters 1992:187). Indeed the east (.5 degrees) and west (.01 degrees) faces are relatively flat and open while the south dune rises at an angle of 4.1 degrees 4.29 m above the foot of the basin while the north dune rises 3.16 m at an angle of 1 degree. A small erosional area has formed between these dunes, a common feature in these types of land forms (Waters 1992: 195). This erosional area is likely modern in origin, a result of aeolian and cultivation processes during the drought years of the 1930s. Northwest of the kill area, the main part of this basin (70 m x 30 m) is filled with aspen *(Populus tremuloides)* and various non-native plant species (Yansa, personal communication 1993). The excavation of four test pits, including two to a depth of 3 m, failed to identify a paleosol within this area.

Examination of the stratigraphic profile indicates that the basin edges were much steeper at the time of the original occupation (Figure 2.5 and 2.6). Running from south to north in Area #1, the base of the paleosols drops on average 7.5 degrees between 87S 82E and 90S 82E and 6.2 degrees at 90S 87E and 87S 87E. From east to west in the kill area, the paleosol drops at an average of 4.5 degrees between 90S 81E and 90S 89E and only .9 degrees between 87S 73E and 87S 87E. Area #2 is in a relatively flat location, dropping only 4.2 degrees from south to north, and .6 degrees from east to west.

2.5 Stratigraphy

The Fitzgerald site stratigraphic profile is relatively straightforward (Figure 2.7, 2.8, 2.9 and 2.10). The surface horizon is approximately 5 cm thick and consists of a

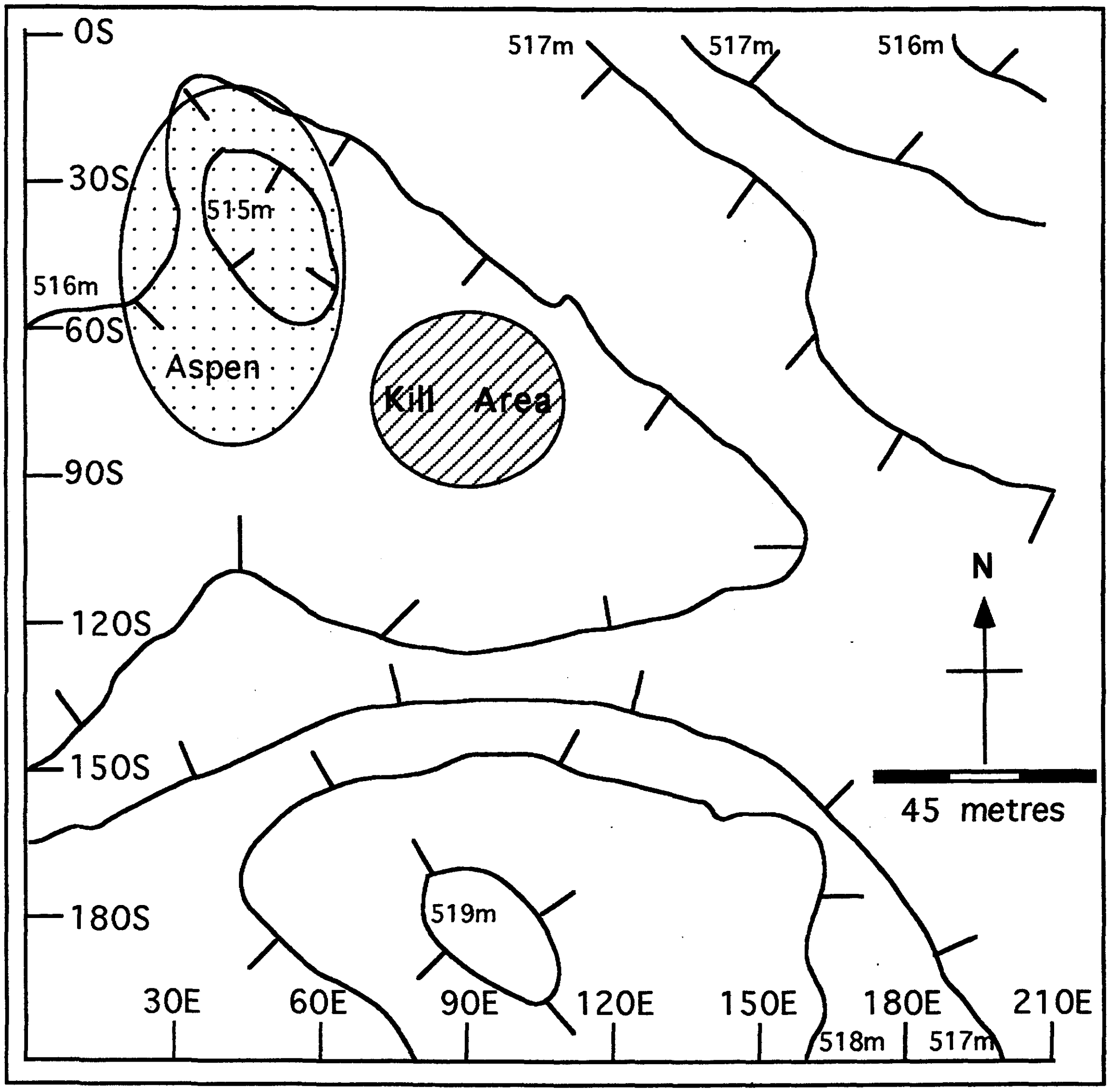


Figure 2.2: Contour Map of the Fitzgerald Site (Contour intervals in m.a.s.l.)

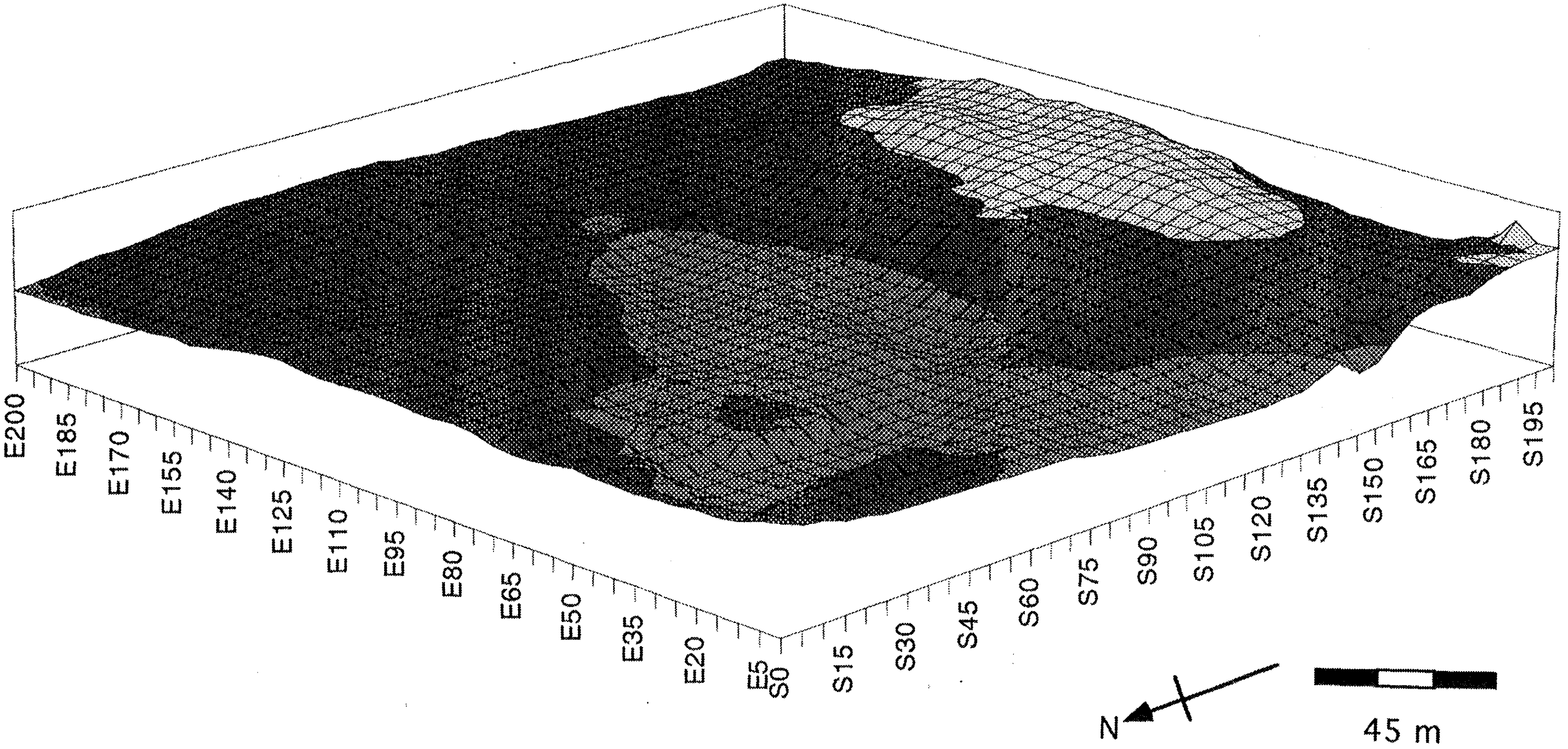


Figure 2.3: Three-Dimensional Contour Map of the Fitzgerald Site (Shading Represents 2m Contour Intervals)

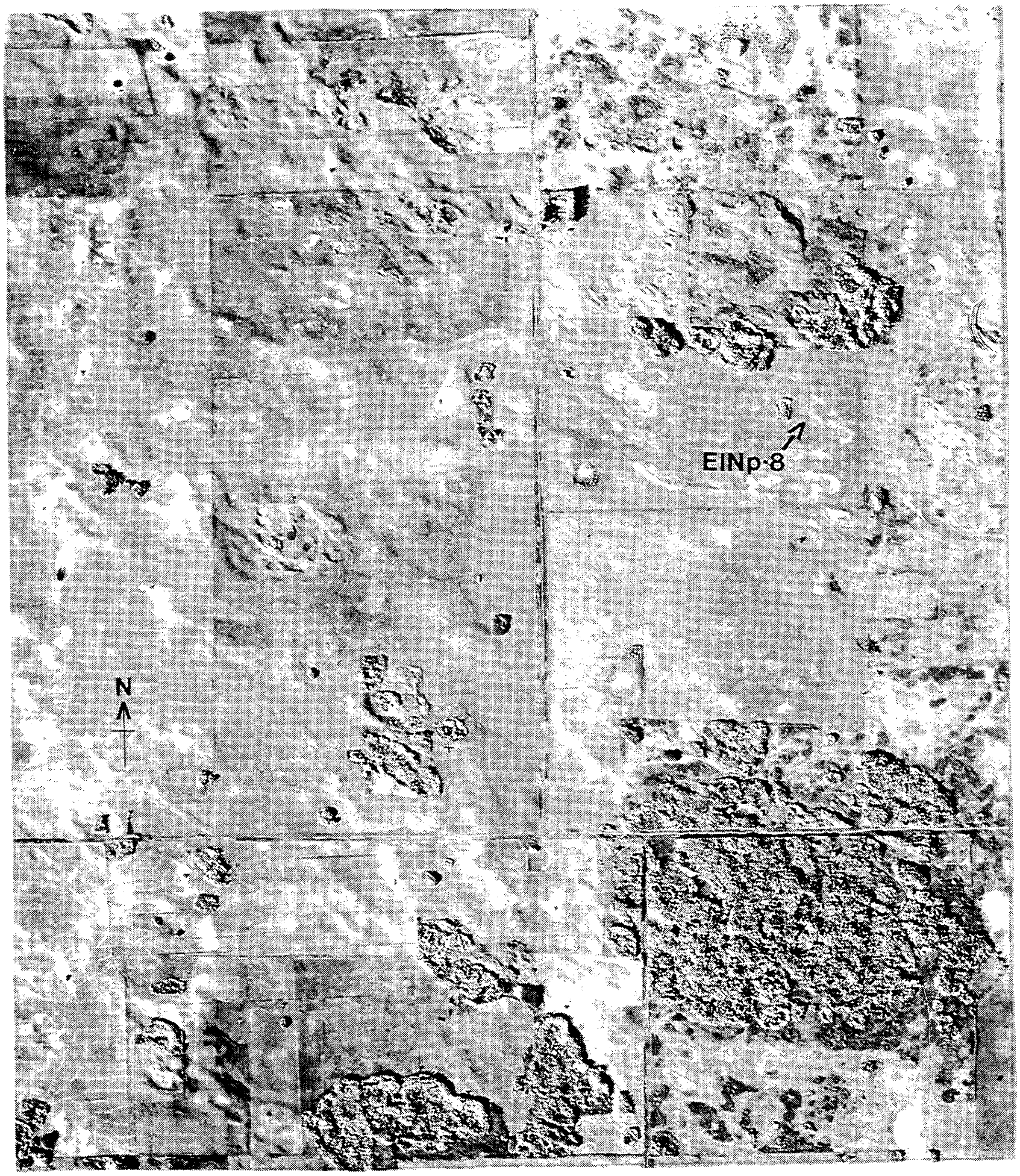


Figure 2.4: Air Photograph of the Fitzgerald Site Vicinity

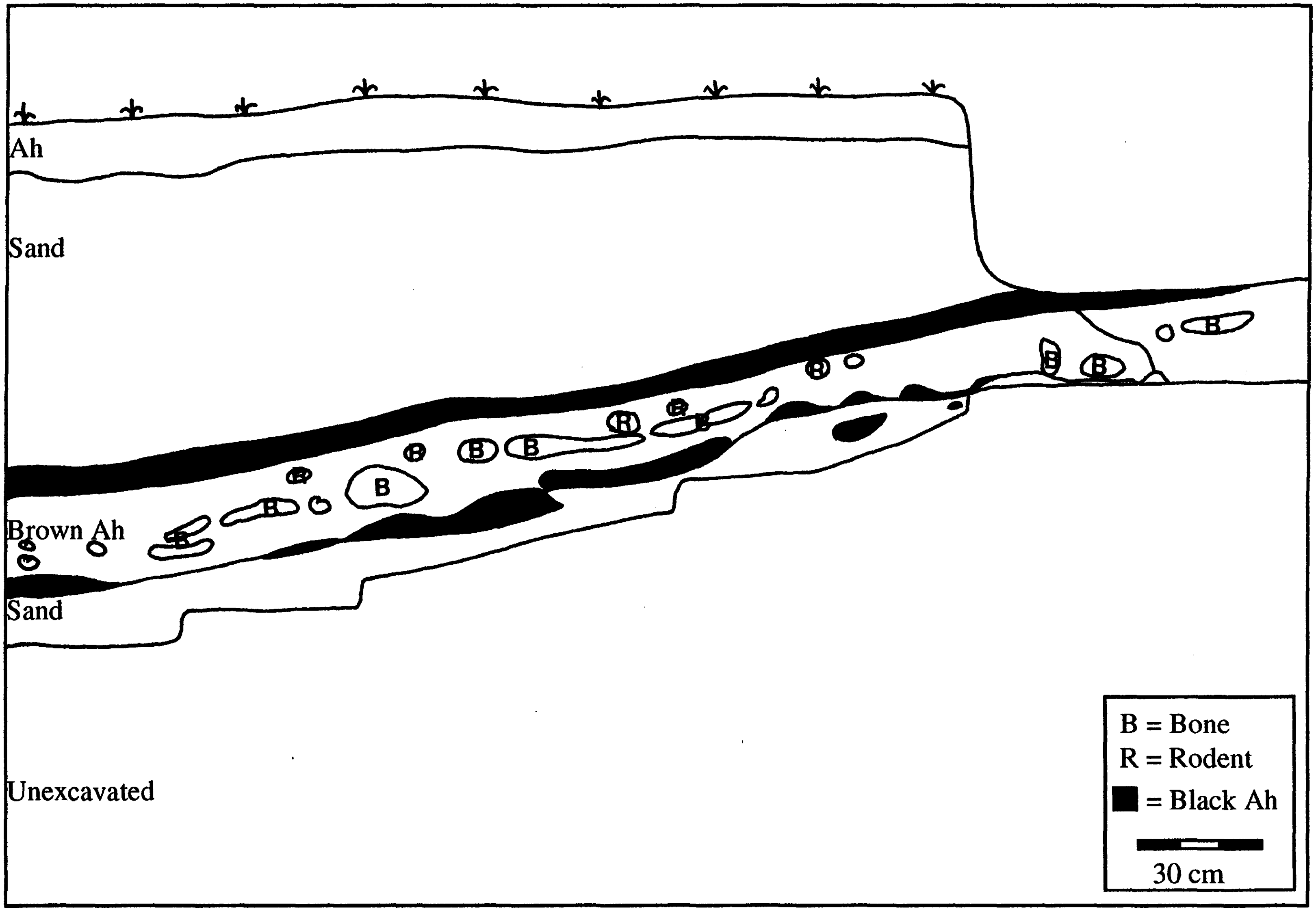


Figure 2.5: Profile of the East Wall Of Unit 87S and 90S 82E. Note the Angle of the Paleosol.

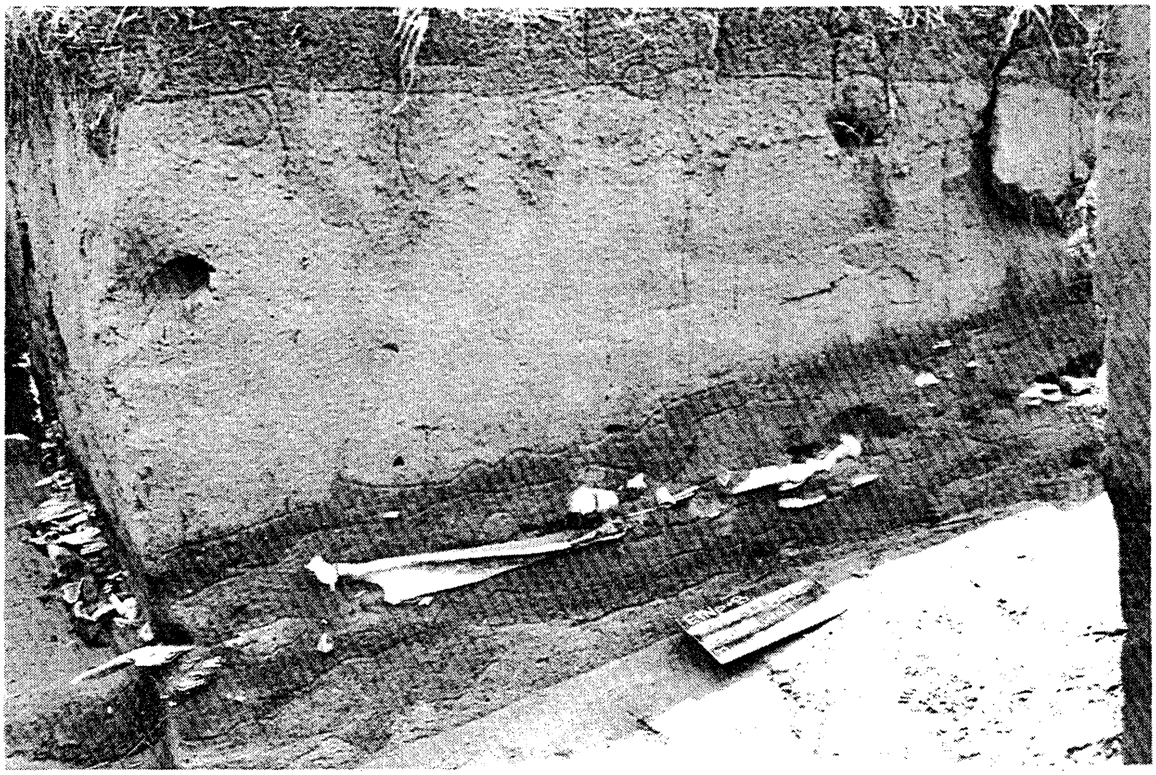


Figure 2.6: Photograph of the East Wall Of Unit 88 and 89S 82E. Note the Angle of the Paleosol

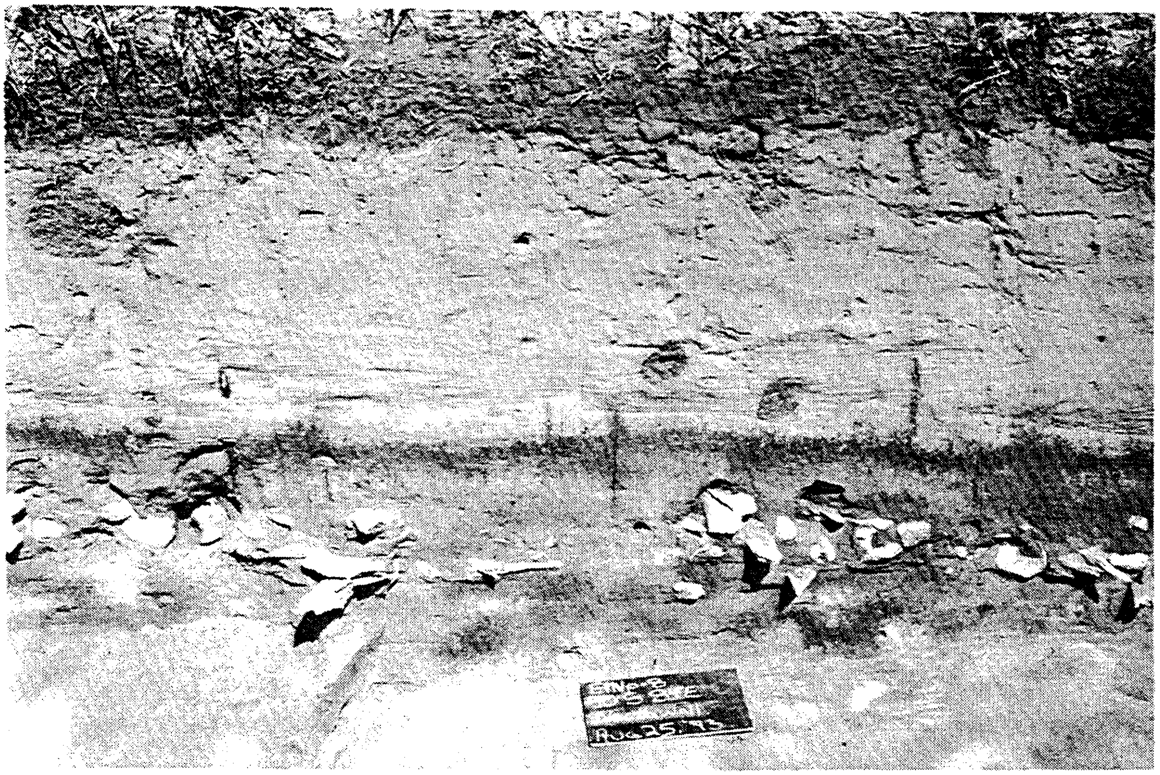


Figure 2.7: Photograph of the North Wall Of Unit 90 84E.

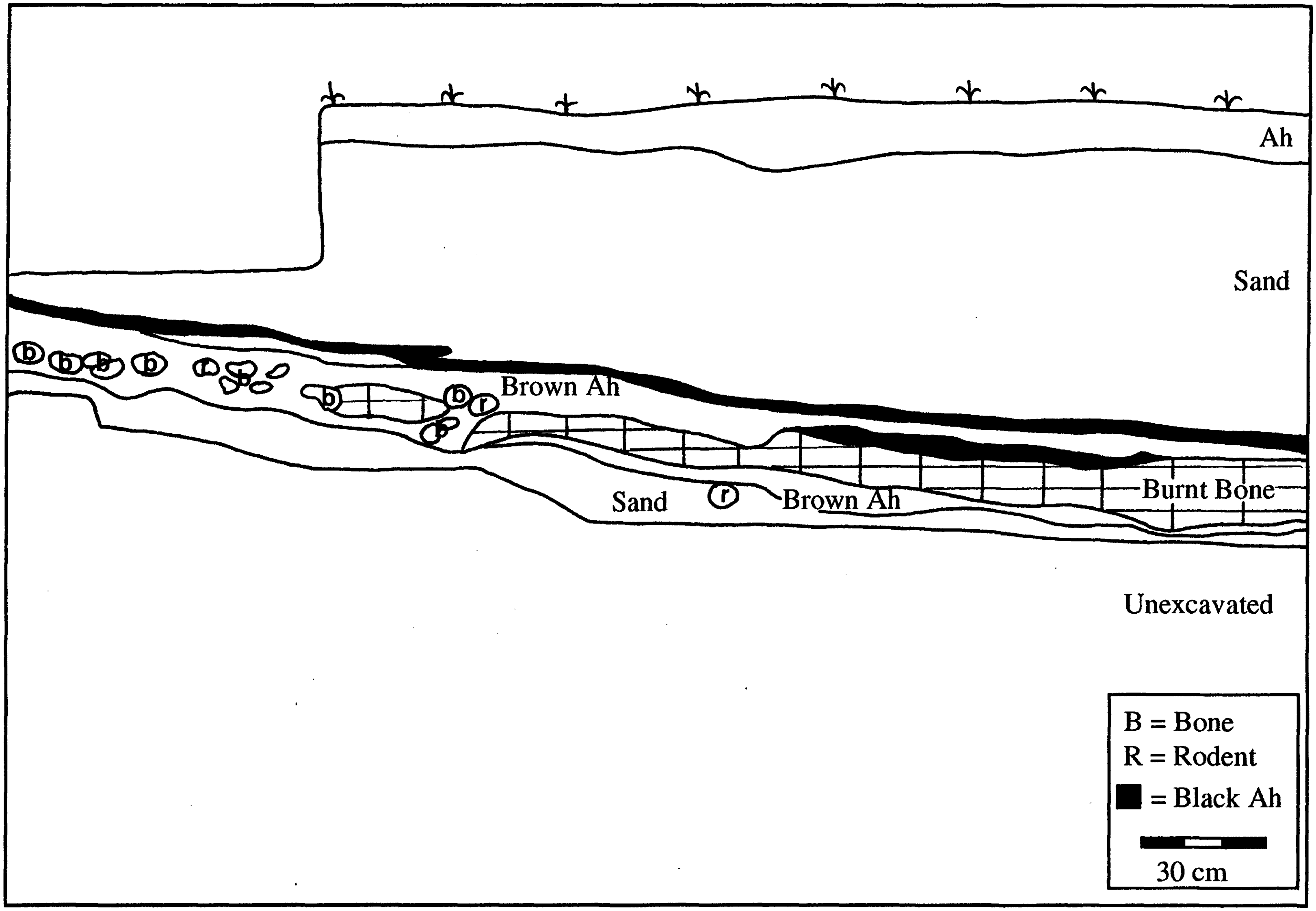


Figure 2.8: Profile of the West Wall Of Unit 87 to 90S 87E.

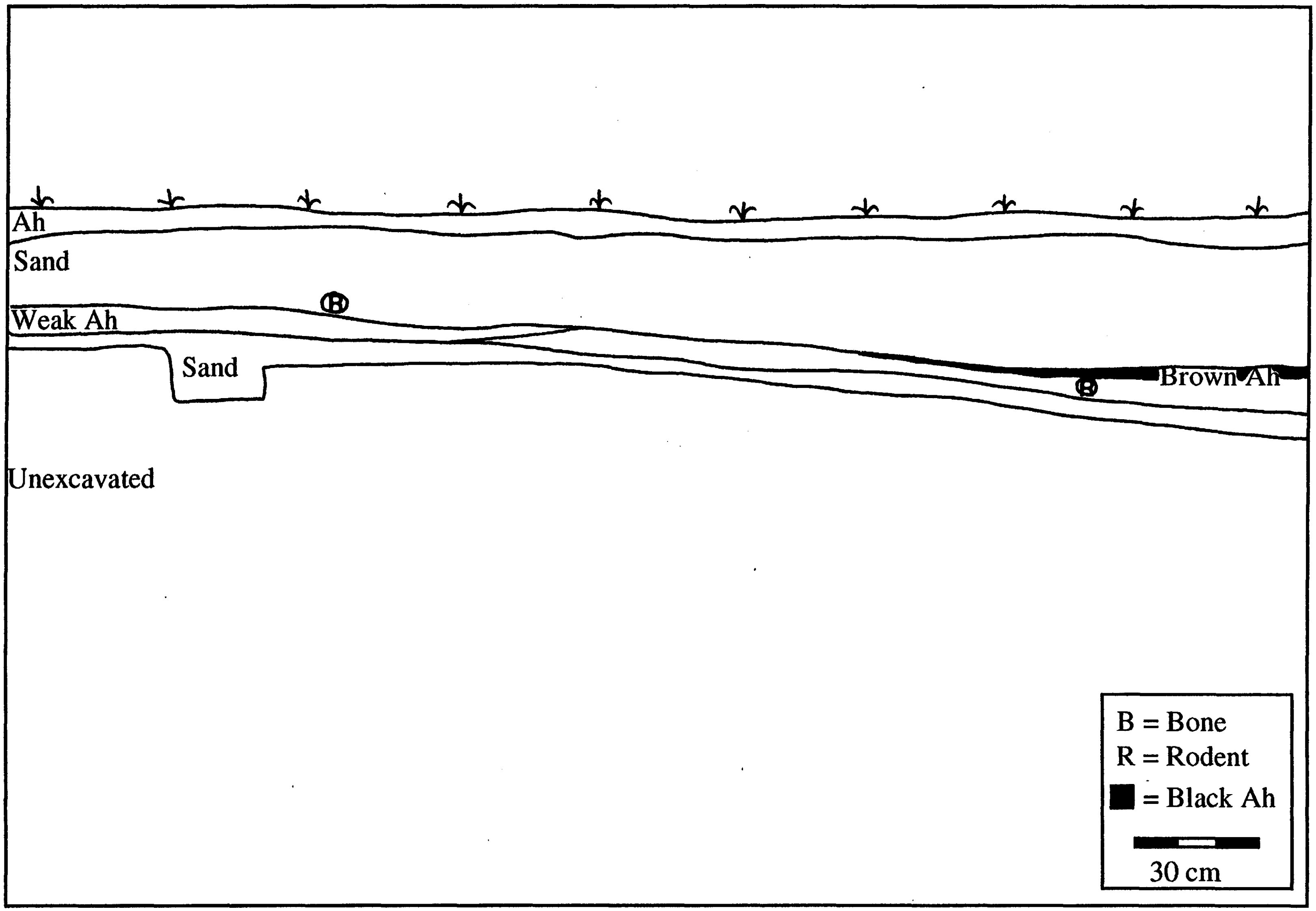


Figure 2.9: Profile of the North Wall Of Unit 91S 81 to 84E.

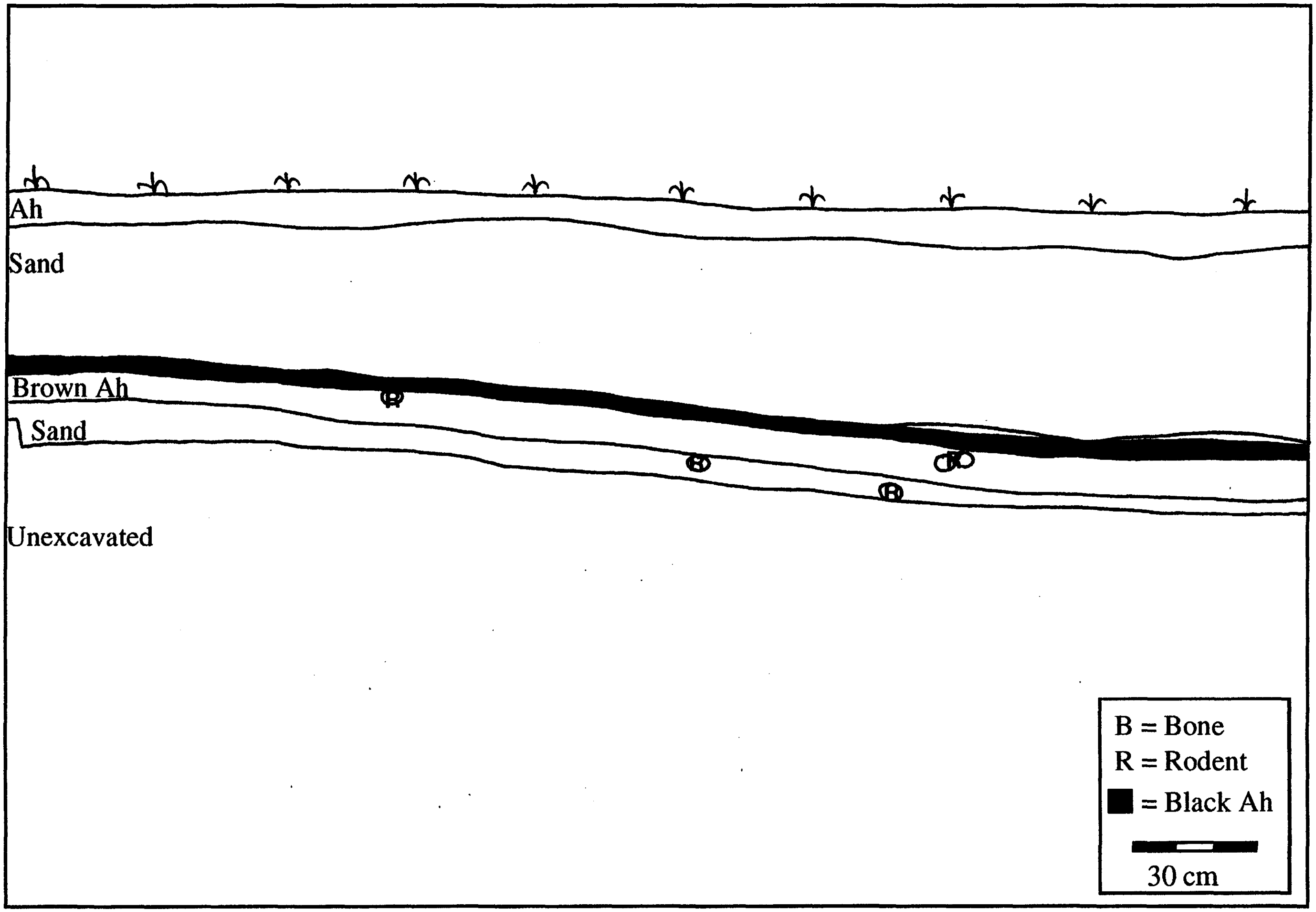


Figure 2.10: Profile of the North Wall Of Unit 91S 85 to 88E.

sandy loam containing various plant and grass roots. Beneath this loam is a light brown Ap sandy soil horizon that is some 10 to 15 cm thick. This soil was disturbed by cultivation (Joe Fitzgerald, personal communication 1993).

The Ah horizon overlays a deposit of yellow-brown sand. Samples of this sediment were examined under magnification. True of most aeolian deposits, the sands are of uniform size and shape. They are generally round and of very fine grain. All particles are between 0.1 and 0.84 mm in diameter, the optimal size for entrainment (Waters 1992: 186).

Within these sand deposits there is a 2 to 3 cm thick dark black paleosol overlying a 15 to 30 cm thick medium brown paleosol. These soils indicate that for an unknown length of time, a vegetation cover was allowed to grow over the site area. This growth would have stabilized the surrounding dunes, probably resulting in a parkland environment that was quite similar to that seen at the site today.

The upper black paleosol is found across the breadth of the site either directly on top, or one to two centimeters below the top, of the brown paleosol. It is always found 5 to 10 cm above the cultural horizon. This indicates that after the formation of the black paleosol, the cultural horizon was protected from natural taphonomic processes like erosion, slumping and weathering. Analysis of a sample from the black paleosol from the south wall of unit 87S 83E revealed the presence of high levels of silt and sand and a correspondingly low organic carbon content (4.8%) (Hirst 1993: 2). The soil was formed by vegetation and was poorly developed, consistent with minimal weathering (Hirst 1993: 2).

The medium brown soil is uniform in color and grain size. Sodium sulphate salts and organics from the black paleosol leached into this horizon sometime after it was formed. The organic carbon content is 2.9% (Hirst 1993: 2). This soil likely represents a "climatic transition from a sand dune environment to a vegetated environment" (Hirst 1993: 3).

The cultural deposits were found within a single 10 to 20 cm thick band midway through the medium brown paleosol. Considerable effort was expended to distinguish separate cultural events within the profile without success. Almost no cultural materials were located within the black paleosol.

Beneath the paleosols were wind deposited sands similar in description to those located above these two soils. The sediments continue to a depth of at least 2.5 m. No basal deposits, such as glacial till, were identified during the excavation or testing program.

The stratigraphic profile within the processing area (Area #2) mirrors that found in the kill area, although, the black paleosol was much less distinct (Figures 2.11 and 2.12). The brown paleosol was also on average only 5 to 10 cm thick. All cultural materials were found within the lower, brown paleosol. The north part of this excavation block (specifically units 100S to 104S 129 and 130E) had some evidence of load casting (Figures 2.11, 2.12 and 2.13). Here, the two paleosols are undulating and highly mottled, a pattern consistent with deformation by compaction. This is in response "to the collapse of pore spaces or voids between individual particles making up a soil or sediment due to the weight of overlying sediments" (Waters 1992: 305). Load casting can result in the "warping and breakage of bone" (Waters 1992: 305), but, fortunately, little cultural material was recovered from this portion of the site.

2.6 Radiocarbon Dates

With the assistance of the Canadian Museum of Civilization, Ottawa, four radiocarbon dates were obtained on samples collected from the Fitzgerald site. All radiocarbon dates were obtained on bone based on soluble collagen extraction. Radio-

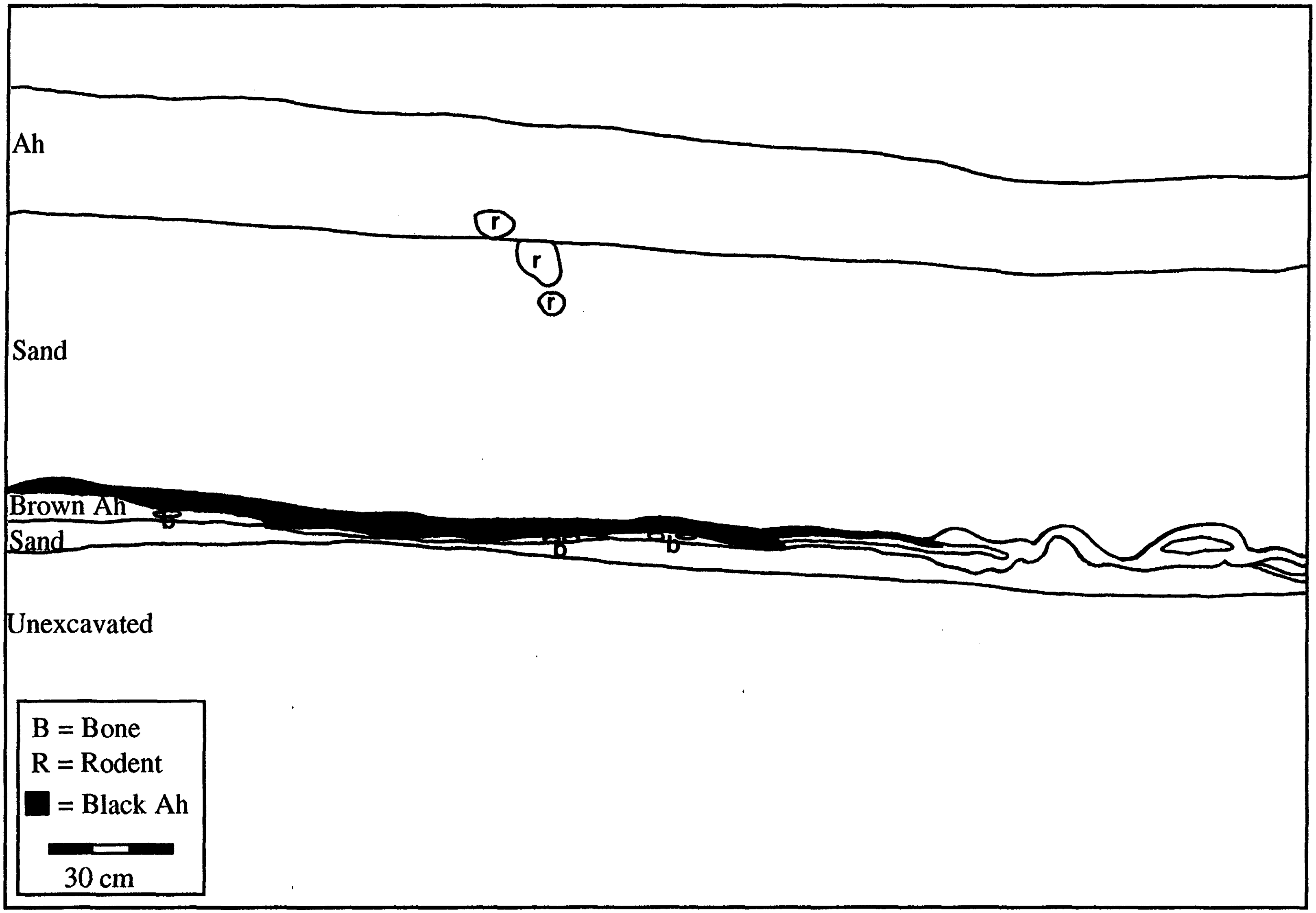


Figure 2.11: Profile of the West Wall of Unit 100 to 103S 130E.

Figure 2.12: Photograph of the North Wall Of Unit 100S 130E. Note the Load Casting.

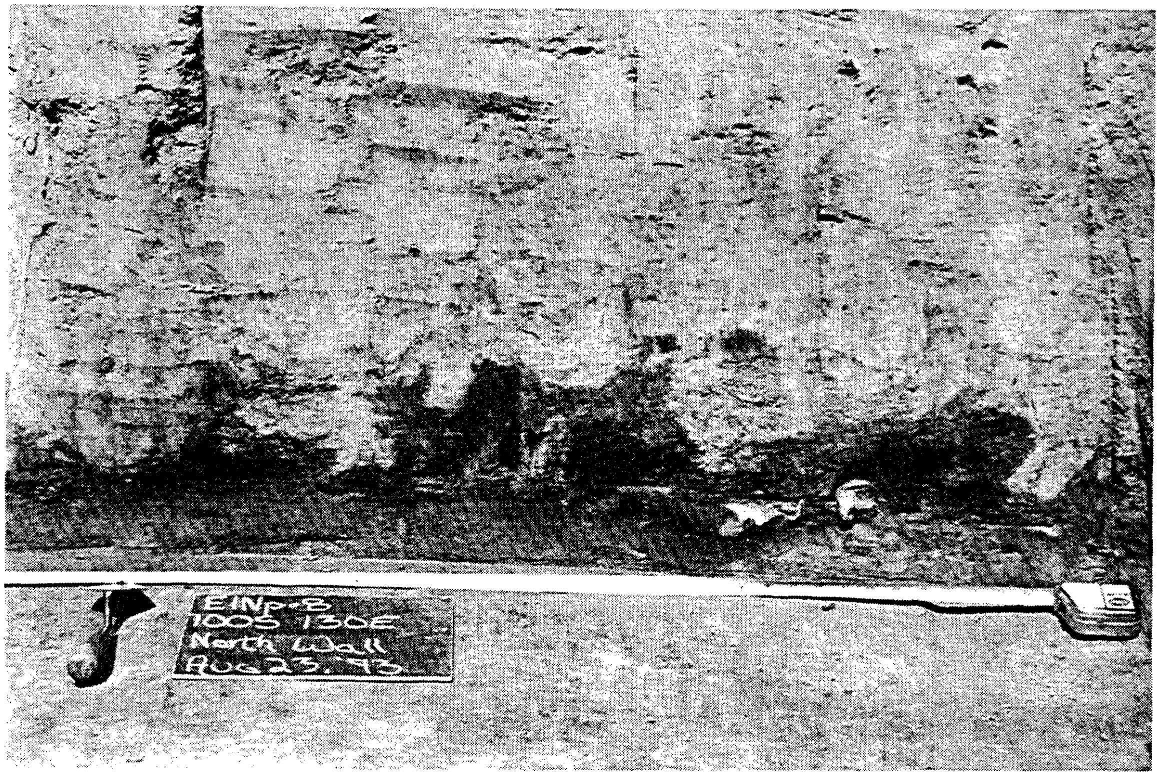


Figure 2.13: Close Up of the Load Casting on the North Wall Of Unit 100S 130E.

carbon samples were first identified during excavation so that no sample would be left exposed for more than 24 hours. All samples were handled with gloves and were stored separately in paper bags. Dr. Richard Morlan of the Museum of Civilization prepared the samples for dating by removing all roots and other contaminants.

Two samples from the kill and the processing area were submitted to both the Saskatchewan Research Council (SRC) and Beta Analytical (Beta) (Table 2.1). All samples were of a single bison bone element and were found in strong association with other cultural materials including Besant Series projectile points. The radiocarbon dates

Table 2.1: Fitzgerald Site Radiocarbon Dates

Lab No.	Date (rcybp)	Element	Provenience
Beta 69005	1490 +/- 90 BP	Bison cervical 4	Level 2 SE 86S 79E
S-3546	1270 +/- 140 BP	Bison cervical 6 or 7	Level 2 SE 90S 85E
Beta 69004	1340 +/- 60 BP	Bison left distal humerus	Level 1 SE 105S 129E
S-3547	1160 +/- 170 BP	Bison left metacarpal	Level 1 SW 105S 129E

Table 2.2: Fitzgerald Site Calibrated Radiocarbon Dates

Lab No.	Calibration of Radiocarbon Date	Calibration in Calendar Years
Beta 69005	1386 +133/-80 BP	AD 564 +133/-80
S-3546	1258	AD 692
	1251	AD 699
	1238	AD 712
	1202	AD 712
	1183 BP	AD 767
Beta 69004	1285 +23/-100 BP	AD 665 +23/-100
S-3547	1160 +216/-134 BP	AD 790 +216/-134

were calibrated using a computer program developed by the University of Washington (1987) (Table 2.2).

Of some concern are the somewhat different results obtained from the Beta and SRC laboratories. The Beta dates are on average 200 years older than the SRC dates. More significantly, the standard deviation of the Beta dates is about half that of the SRC dates. For instance, at a 95% confidence interval, the non-calibrated SRC processing area date falls between 1500 and 820 BP whereas the Beta date is between 1460 and 1220 BP. Considering the relatively late date of the site, a standard deviation of 170 years is considered unacceptable. As a result, the Beta radiocarbon dates should be considered a more accurate reflection of the age of the site.

Saying this, three of the four calibrated dates still overlap at one sigma (Figure 2.14) and all four calibrated dates appear to converge at 1300 BP (Figure 2.15). At two sigma, the four radiocarbon dates overlap at between 1366 and 1270 BP (calibrated). Long and Rippeteau (1974) have devised a probability test that can determine whether the variations between radiocarbon dates obtained from a single cultural horizon are significant enough to indicate multiple use over a number of decades or centuries. The result (F4 = 2.32) indicates that the differences between these four dates are not significant, the site represents a single instance in time (several years or less). This is consistent with the hypotheses that the site represents a single component kill and that the kill and processing area are contemporaneous. As a result, the weighted average can be

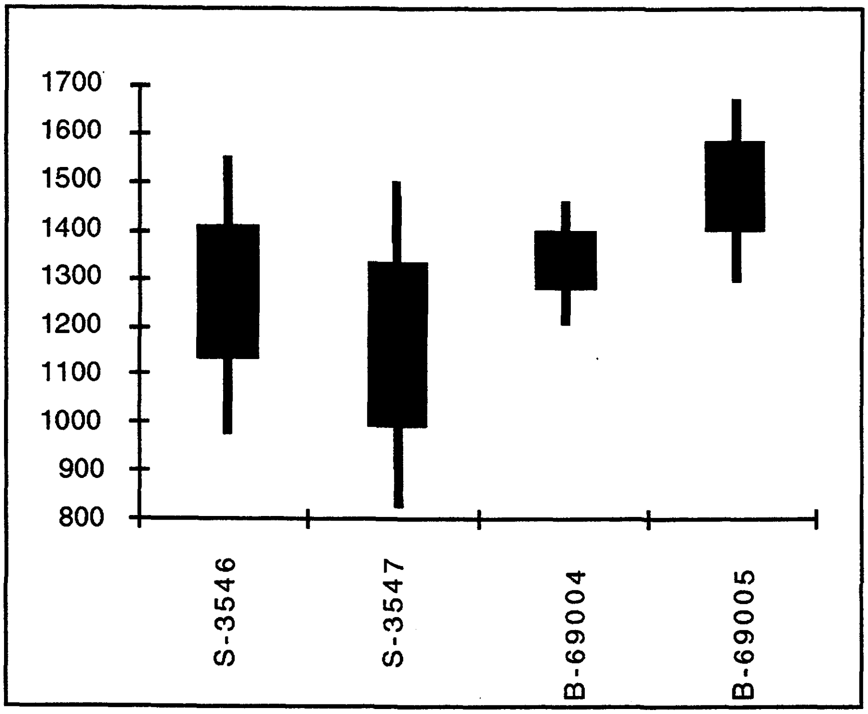


Figure 2.14: Non-Calibrated Age Charts with Solid Equal to One Sigma and Line to Two Sigma.

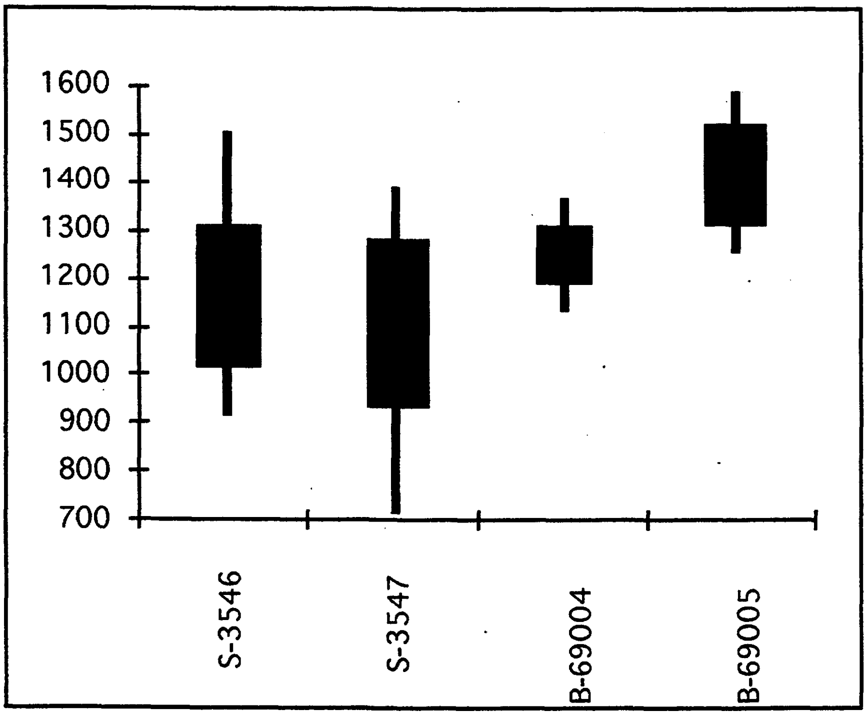


Figure 2.15: Calibrated Age Charts with Solid Equal to One Sigma and Line to Two Sigma.

applied with some confidence (Long and Rippeteau 1974); the calibrated age of the site is 1283 +/- 20 BP (non-calibrated = 1362 +/- 45 BP).

2.7 Discussion

The Fitzgerald site is located on the Saskatchewan Plains in the Aspen Parklands near the modern border of the Mesic Prairie. This area would be occupied by bison principally from the late fall to early spring to take advantage of the fescue grasses native to this region. Anticipating these annual migrations, hunters could begin communal hunting in this region in October or November.

As there is no topographic feature that could act as a bison jump, the Fitzgerald kill was almost certainly the result of a pound or surround operation. Ethnographic and historic sources (Verbicky-Todd 1984) and evidence from other archaeological sites (Frison 1971; Rollans 1987) suggest that drive lanes would have been constructed to help maneuver the bison herd into this location. The drive lanes would likely have stretched to the north or northeast from the pound, the opposite direction of the prevailing wind in the late fall. The main kill and processing area are located in a small basin formed between two parabolic sand dunes. This natural topographic feature was likely the principal reason for this particular location being chosen for the pounding operation. Locating a bison pound at the bottom of the basin would serve two purposes. First, it would keep the main structure out of view of the charging bison until they were practically within the corral (Verbicky-Todd 1984: 38). Second, this location would act as a natural trap, supplementing any built structures that would be in place.

The stratigraphic profile from the Fitzgerald site is not complicated. The cultural horizon was found in a weak paleosol positioned in the midst of aeolian sand deposits. This soil formed during a period of comparative stability, likely the result of the higher precipitation levels associated with the Neoglacial period. With more moisture, a vegetative cover was established stabilizing the dune and forming a natural basin in which to drive bison. The paleosol begins near the modern cultivated ground surface and slopes down to a depth of at least 1.25 m. Almost all cultural materials were situated within a single quite distinct level within this paleosol. As this cultural horizon continues across the breadth of the site, there is strong evidence that all materials from the kill and processing area are contemporaneous.

The site is considered to belong to the Besant Series which existed from 2300 to 1100 years BP. The four radiocarbon dates obtained from the Fitzgerald site would indicate that the occupation is approximately 1300 years old. The site age conforms to the latter portion of the Besant Series and is contemporaneous with other Besant kill sites. While the dates only overlap at a 95% confidence interval, analysis indicates that the site does represent a relatively short occupation of at most several years. The site is of a single component kill and processing area averaged to a calibrated age of 1283 +/- 20 BP.

Chapter 3

Field and Laboratory Research

3.1 Introduction

Twenty weeks of field work were completed over two summers at the Fitzgerald site. Investigations at the site began in May of 1992 and were concluded in August of 1993. Excavations were directed by the author with the assistance of Dr. David Meyer of the Department of Anthropology and Archaeology at the University of Saskatchewan. The field crew consisted of Todd Paquin (1992 and 1993), Jay Armstrong (1992) and D'Arcy Fitzgerald (1992). In order to facilitate community involvement in the project, numerous volunteers from the Saskatchewan Archaeological Society and the University of Saskatchewan also assisted in the excavation.

3.2 Site Discovery

The Fitzgerald Site is located in the SE corner of the NW 1/4 of Section 4, Township 35, Range 4, West of the Third Meridian and following the Borden grid system has been designated ElNp-8. Mr. Joe Fitzgerald discovered the site in the spring of 1991 while digging post holes on the property. Two small back hoe pits were excavated by Mr. Fitzgerald in an effort to ascertain the nature of the bone deposits recovered in his auger holes. Realizing the significance of his discovery, the site was reported to Dr. David Meyer of the Department of Anthropology and Archaeology at the University of Saskatchewan. Subsequent inspection of the disturbed portion, in company with Dr. Ernest Walker and Dr. Urve Linnamae, confirmed the presence of an intact cultural component located in a 15 cm thick paleosol some 50 cm below the surface. Observed materials included substantial amounts of butchered bison bone, several projectile points and lithic debitage.

3.3 1992 Field Season

3.3.1 1992 Research Objectives

Initial examination of the archaeological deposits and the surrounding geography led to the development of the following conclusions. First, the projectile points seemed to be of a uniform style and were assigned to the Besant culture as first defined by Wettlauffer (1955: 44) at the Mortlach site in southern Saskatchewan. Second, the density and composition of the faunal deposits were indicative of a large bison communal kill site. *In situ* faunal remains were lightly butchered and all were identified as belonging to the species *Bison bison.* Finally, the site's location within stabilized, undulating dunes suggested that the site represented either a pound or surround. The presence of Besant projectile points was consistent with recoveries from other excavated Besant bison pounds on the Northern Plains (Frison 1971; Gruhn 1971; Hlady 1967; Ramsay 1991).

When excavations began at the Fitzgerald site, few bison pound sites representing the Besant culture had been excavated across the Northern Plains. Only one of these sites was in Saskatchewan, the Melhagen Site (Ramsay 1991). Investigations at these sites have offered little information about kill and butchering patterns on the plains. For reasons often beyond the control of the investigator, emphasis has been placed on other aspects of analysis such as projectile point morphology. Only one Besant pound, the Ruby Site in Wyoming (Frison 1971), has an adequate description of the hunting and butchering techniques employed.

The Fitzgerald Site offered considerable potential for providing a better understanding of Besant communal hunting techniques. Since the bone bed seemed to be quite well preserved, there would be many significant opportunities for original research. Investigations began in hopes of meeting the following objectives. These included: 1) surveying and mapping the site; 2) determining the spatial boundaries of the site; 3) determining the number of occupations at the site; 4) recovering *in situ* projectile points to confirm the assigned Besant affiliation; 5) determining the method of procurement; 6) determining seasonality; 7) determining the number, age and gender of the bison procured; 8) determining butchering patterns; and 9) recovering samples of material suitable for radiocarbon dating. By comparing the results of the above analysis with other similar sites, especially the stratigraphically complex Melhagen Site, it was expected that a better understanding of Besant communal hunting techniques and butchering patterns would emerge.

3.3.2 1992 Testing Program

During the summer of 1992, ten weeks of survey and testing were completed at the Fitzgerald site. First, a permanent datum point was established using the foundation of a newly constructed house on the property. Using a professionally surveyed datum point located on the highway 2.5 kilometers to the west, this point was established as being 517 meters above sea level. This datum is located in the far northwest corner of the main occupation. All subsequent measurements are fixed on how many centimeters south and east from this datum and how many centimeters above sea level a point is located.

Following true north, a 200 x 200 meter grid was established across the breadth of what was believed to be the main occupation. Surface measurements were recorded every five meters along this grid and a contour map was produced from these data. Using the previously established grid as a reference, 105 auger and shovel tests were then excavated (Figure 3.1). All soil was passed through a 1/4 inch mesh screen in order to maximize artifact recovery. It was soon confirmed that almost all cultural materials were found in a single, very distinct brown paleosol located between 25 and 150 cm below the surface. Tests then were excavated to the depth of this cultural horizon or to two meters, which-

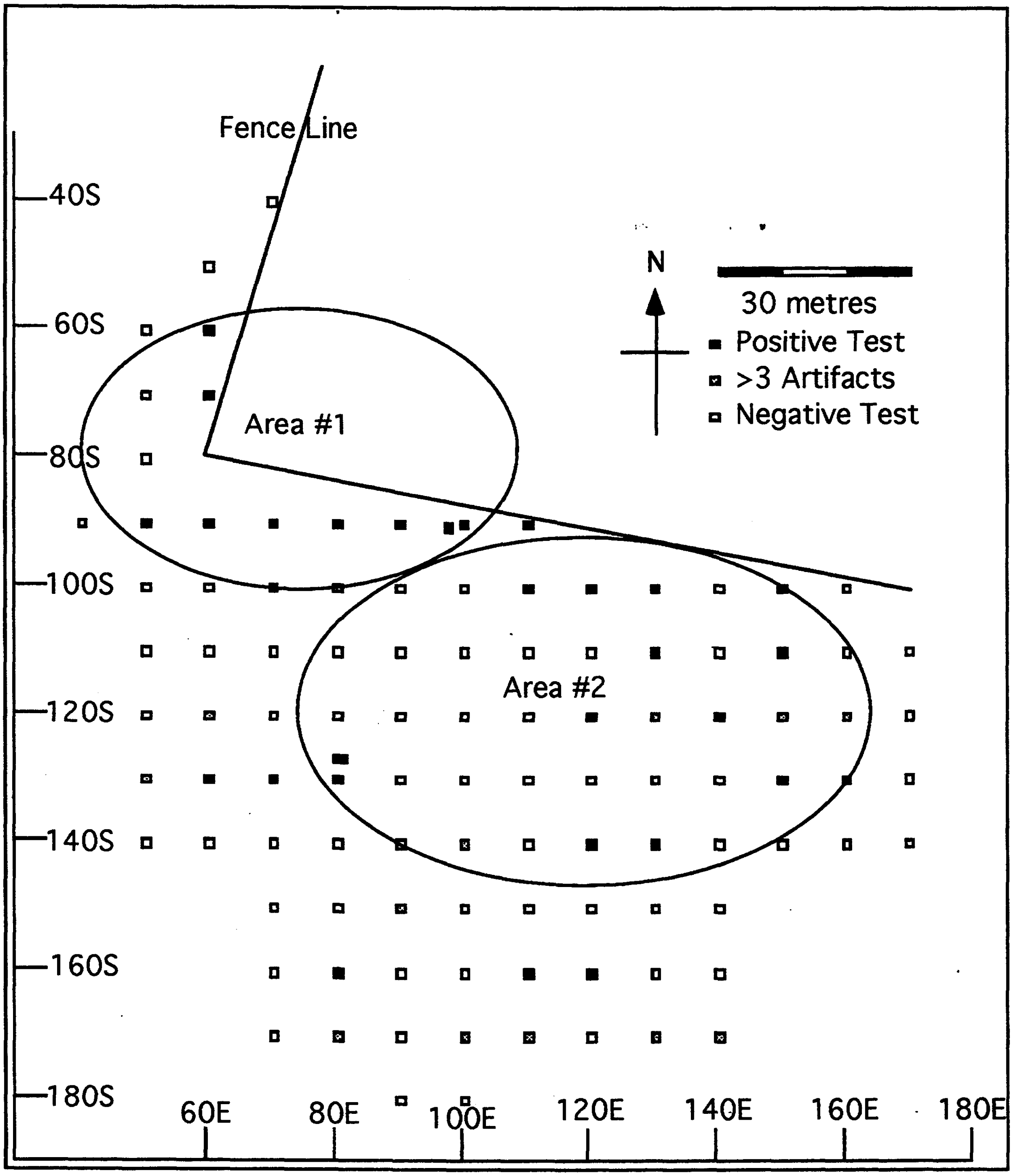


Figure 3.1: 1992 Fitzgerald Site Testing Program

ever came first. Every fifth test was excavated to a depth of 3 meters in hopes of identifying further cultural horizons, but with no positive results.

Test pits were placed every ten meters along the grid and radiated out in all directions from the central back hoe trench where Mr. Fitzgerald had first identified the site. Tests ceased in any one direction only when no cultural materials were recovered in two consecutive tests. Unfortunately, no tests could be excavated in the northeast part of the site area because of the presence of bison in Mr. Fitzgerald's corral.

Analysis of the cultural materials recovered from the testing program resulted in the formulation of two conclusions. First, that cultural materials were located within a single 20 to 30 cm thick layer of brown paleosol beneath 75 cm of fine-grained yellow sands. Second, testing suggested that there were two separate activity areas at the site. Area #1 was identified between units 50S 60E and 90S 110E (Figure 3.1). Large quantities of unburned bone were located in this area. In addition, a single Besant Phase projectile point was recovered from this region. As much of the faunal remains were nearly complete identifiable elements, it was believed that Area #1 represented the main kill area.

Area #2 stretches from 90S 110 E to 150S 130 E (Figure 3.1). Recovered materials included large quantities of unburned and burned bone fragments. Most of this burned bone was located in the three test units 90S 100 to 120 E. Lithic artifacts from Area #2 included a Knife River Flint end scraper and quantities of fire broken rock. In test unit 130S 70E, a bone boiling pit was identified. It was hypothesized that the southeast portion of the site was associated with secondary processing activities.

Because testing could not be conducted in the northeast portion of the site, it is very difficult to estimate the horizontal extent of the cultural component at the Fitzgerald Site. For instance, analysis of the recovered artifacts from the testing program would indicate that the northwest (unit 40S 60 E), southwest (unit 100S 40E) and southeast corners (unit 100S 90E) of the kill area have been identified. However, it is almost impossible to predict how far the site extends to the northeast. The main kill area could conceivably then be as small as 40m x 40m. While likely somewhat conservative, this estimate would conform well with what is known historically and ethnographically about the size of pounds (see chapter 5).

However, as has been previously mentioned, the site is located at the bottom of a small basin formed by stabilized dunes to the north, south and east. It is reasonable to assume that a similar landscape existed at the time of occupation. Subsequent stratigraphic profiles show that the edge of the site was on a slight incline. If this landform formed the natural boundary for the occupation, the kill area might then have been as large as 100m x 100m.

Determining the extent of Area #2 is even more problematical. If this portion of the site is the processing area, how far these activities may extend into the northeast portion of the site is impossible to predict. Operating a pound site took the efforts of literally hundreds of people. Subsequent butchering would likely have been spread over hundreds of square meters.

3.3.3 1992 Test Excavations

When the testing program had been completed, two 1m x 2m units were excavated in both Area #1 (Blocks 1 and 3) and Area #2 (Blocks 2 and 4) (Figure 3.2). All units were excavated to the depth of the cultural deposits using shovel-shaving techniques. Cultural deposits were excavated using trowels and brushes. All matrix was passed through a 1/4 inch mesh screen. The northwest quadrant of each unit was screened with an 1/8 inch mesh to garner samples of micro-debitage and smaller animal species like rodents and amphibians that can be useful paleoenvironmental indicators.

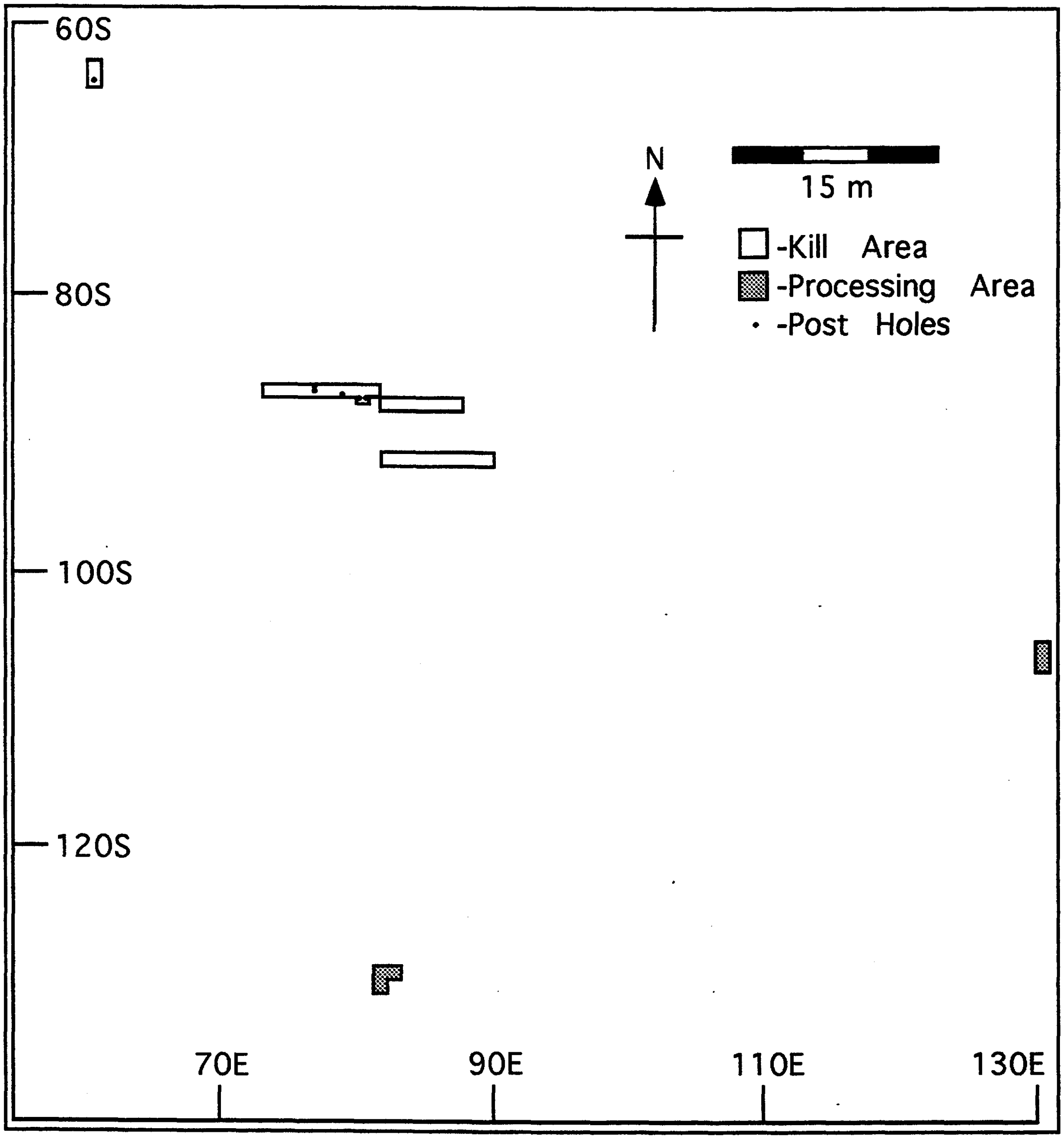


Figure 3.2: 1992 Fitzgerald Site Test Excavation

The stratigraphic profile, as identified in the original back hoe trench dug by Mr. Fitzgerald and in testing, was confirmed in excavation. Most cultural materials were located in the lower half of the brown paleosol. Excavations confirmed that the few cultural materials located above the clearly recognizable cultural horizon were the result of rodent disturbance. Because of the considerable depth of the deposits (up to 1.25m) the upper sterile, deposits of sand were not screened during the remainder of the excavations.

Four square meters were test excavated in Area #1 (Figure 3.2). Recovered cultural remains included lightly butchered bison bone and five associated Knife River Flint Besant Series projectile points. The bone was relatively complete, indicating that only primary butchering activities were completed in the kill area. Poor meat yielding bones such as the pelvis, skull and vertebral centra were also in abundance. There was also some evidence of overkill since a number of faunal elements were in articulation and exhibited no evidence of butchering.

Five meters of test excavation were eventually completed in Area #2 (Figure 3.2). In this area, large amounts of heavily butchered bison bone were recovered. Lithic remains consisted almost entirely of small pieces of fire-broken rock, Knife River Flint end scrapers and utilized secondary flakes. In contrast to Area #1, no articulations and only one Besant projectile point were recovered.

A boiling pit feature was first identified in the testing program and excavated as block #4. Excavations were expanded from 2 to 3 meters in order to fully expose the feature. Recovered materials from the pit feature itself included butchered bison bone and fire-broken rocks. Because of previous cultivation, few artifacts were recovered from the disturbed units around this feature.

The materials and features recovered from Area #2 were significantly different from those in Area #1. The boiling pit, the faunal remains and the lithic assemblage were suggestive of a secondary processing area.

3.3.4 1992 Excavations

Preliminary testing had confirmed that Area #1 was the location of the main kill. Twenty-five and a half square meters were subsequently excavated in Area #1 in 1992 where auger testing had identified what was likely the border between Areas #1 (the kill) and #2 (the processing area) (Figure 3.3 and 3.4). It was hoped that excavations might recover sufficient samples of the kill and processing areas to conduct an analysis of the different butchering activities that might be evident in these locales. This location would also be the logical place to find evidence of the corral structure.

Excavation results were similar those described previously for the original test excavations in this area. Faunal remains were lightly butchered and often in articulation. Nearly fifty Besant Series projectile points were recovered in excavation. All but one of these was made from Knife River Flint.

Somewhat enigmatic was the east end of the excavation. The main bone bed terminated near the east end and was replaced by a 20 cm thick deposit of burned bone fragments (Figures 3.3, 3.4 and 3.5). Whether these bone fragments are the remains of a previous kill site that was burned off, a processing area, or a dump of some sort remains open to question.

Identifiable features from Area #1 included seven post holes, four of which had bone uprights (Figure 3.3). These post holes were located along a transect moving southeast to northwest. It was concluded that they were the remains of the original corral structure.

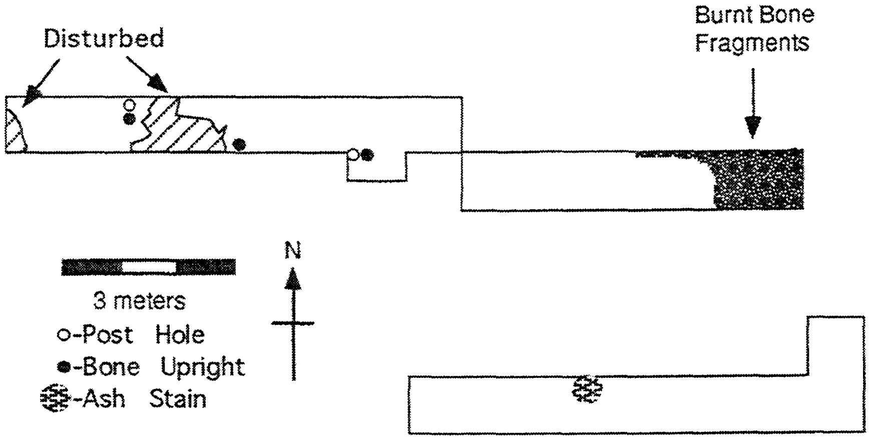


Figure 3.3: 1992 Fitzgerald Site Excavation Block 1 with Post Holes and Burned Bone

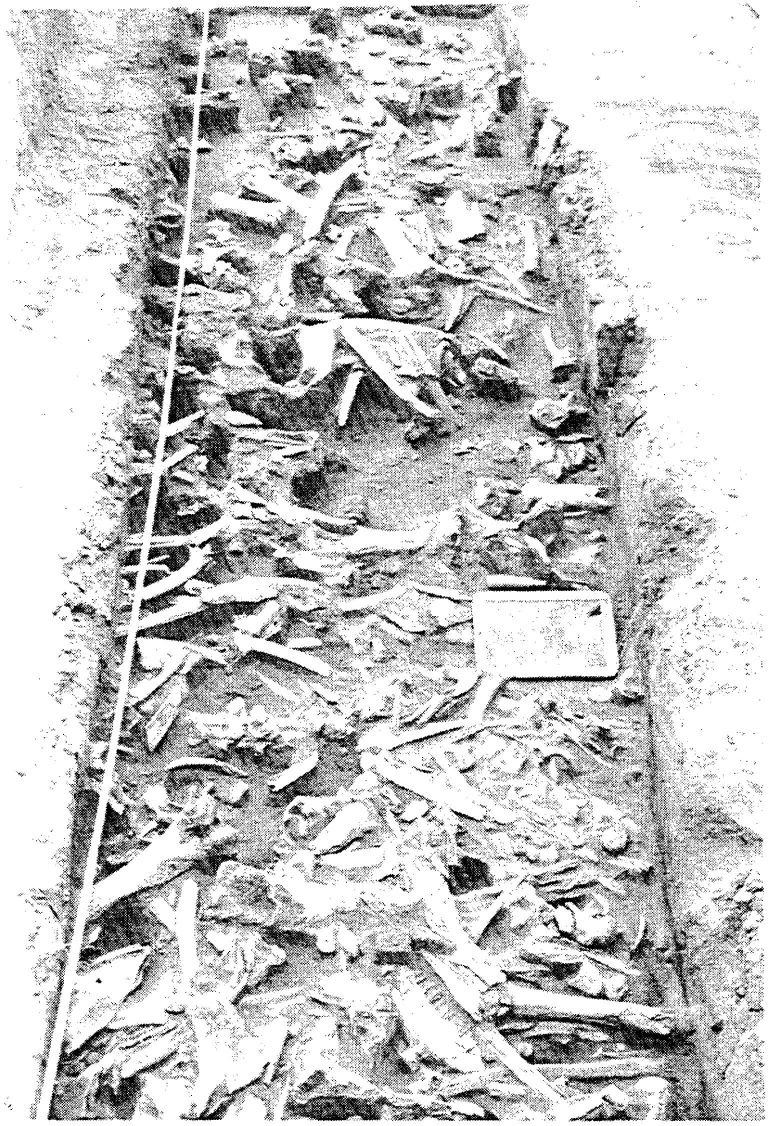


Figure 3.4: Photo of 1992 Excavations in Block 1 Bone Bed

Figure 3.5: Photo of 1992 Excavations in Block 1 Bone Bed and Burned Bone Area

Recovered cultural materials confirmed the hypothesis that the west portion of Area #1 represented a Besant kill site. The density of the faunal remains was consistent with other kill sites. The domination of the tool assemblage by Knife River Flint projectile points was also of considerable interest. It suggested that this site was of a type similar to other Knife River Flint dominated kill sites like Muhlbach (Gruhn 1971), Melhagen (Ramsay 1991) and Richards (Hlady 1967).

3.4 1993 Field Season

3.4.1 1993 Research Objectives

Preliminary analysis of the 1992 testing and excavation program results determined that further excavation was warranted at the Fitzgerald Site. Two major research objectives were identified that could contribute to a better understanding of pre-contact hunting and butchering practices. These objectives included identifying 1) the size and shape of the corral structure and 2) the relationship between the kill and processing area.

To obtain a sample large enough to complete the stated research objectives, it was determined that an additional 30m^2 would have to be excavated. Some of these units were placed in the area of the previously identified post-holes to gain a better understanding of the corral structure remains. As these units would be placed along the edge of the kill area, it was also expected that a large sample of bison bone from the kill event would be recovered. This would be useful in helping to gather the samples necessary to determine Besant phase primary butchering practices.

The rest of the allocated units were excavated 40m to the east in what was likely the main processing area. Excavations here would lead to the recovery of a faunal sample suitable for comparison with the remains from the kill site. Contrasts could then be made between expected and recovered faunal elements. This would give clues as to what carcass elements were preferred by the Besant people. With a sufficient sample of kill and processing materials, it also could be determined which elements might have been removed to the yet unidentified camp site area. This would give a complete picture of the three stages of bison processing that would occur on the Northern Plains, primary butchering; meat, marrow and grease processing; and camp site consumption.

Prior to excavation in the processing area, a magnetometer survey was conducted over a 25 x 25 m area. This survey was conducted to locate hearths, boiling pits and other features with concentrations of fire-broken rock. These features are usually associated with heavy processing activities.

3.4.2 1993 Excavations

One of the principal objectives of the 1993 excavations was to locate more post holes to help reconstruct the size and shape of the corral. Five square meters were excavated southeast of the postholes located the previous summer in Area #1 (Figures 3.6 and 3.7). Unfortunately, no other positive remains of postholes were identified. Because of the difficulties in locating more of these features, it was decided to concentrate efforts on answering other research objectives.

A further 10 m^2 was excavated in the eastern portion of Area #1. Much of this excavation was dedicated to identifying the activities that might have produced the large amounts of burned bison bone that formed the east edge of the bone bed. Further work was also needed to link the two trenches excavated the year before so as to produce an accurate north-south stratigraphic profile of the kill area. The result is that in two summers of field work, 42 m^2 were excavated in the kill area (Figure 3.6, 3.7 and 3.8).

The bulk of the 1993 excavations were conducted in what was identified as the processing area. Prior to excavation, a 25 m by 25 m area was surveyed over this section using a magnetometer. A single positive magnetometer reading resulted in the excavation of a 2m x 2m block (Figure 3.6). While some poorly preserved faunal remains were identified, no features were located in this block.

A further 22m^2 were excavated in the processing area in 1993 for a two year total of 31 m^2 (Figures 3.6, 3.9 and 3.10). The main excavation block (2 x 12m) was opened in an area 40 meters east of the main kill excavations (Figure 3.6). Cultural remains recovered from the main excavation block seemed to confirm the hypothesis that this was part of the processing area for the main kill site to the northwest. Faunal remains were heavily processed ($\leq$5 cm in diameter) and no articulations were observed. Lithics

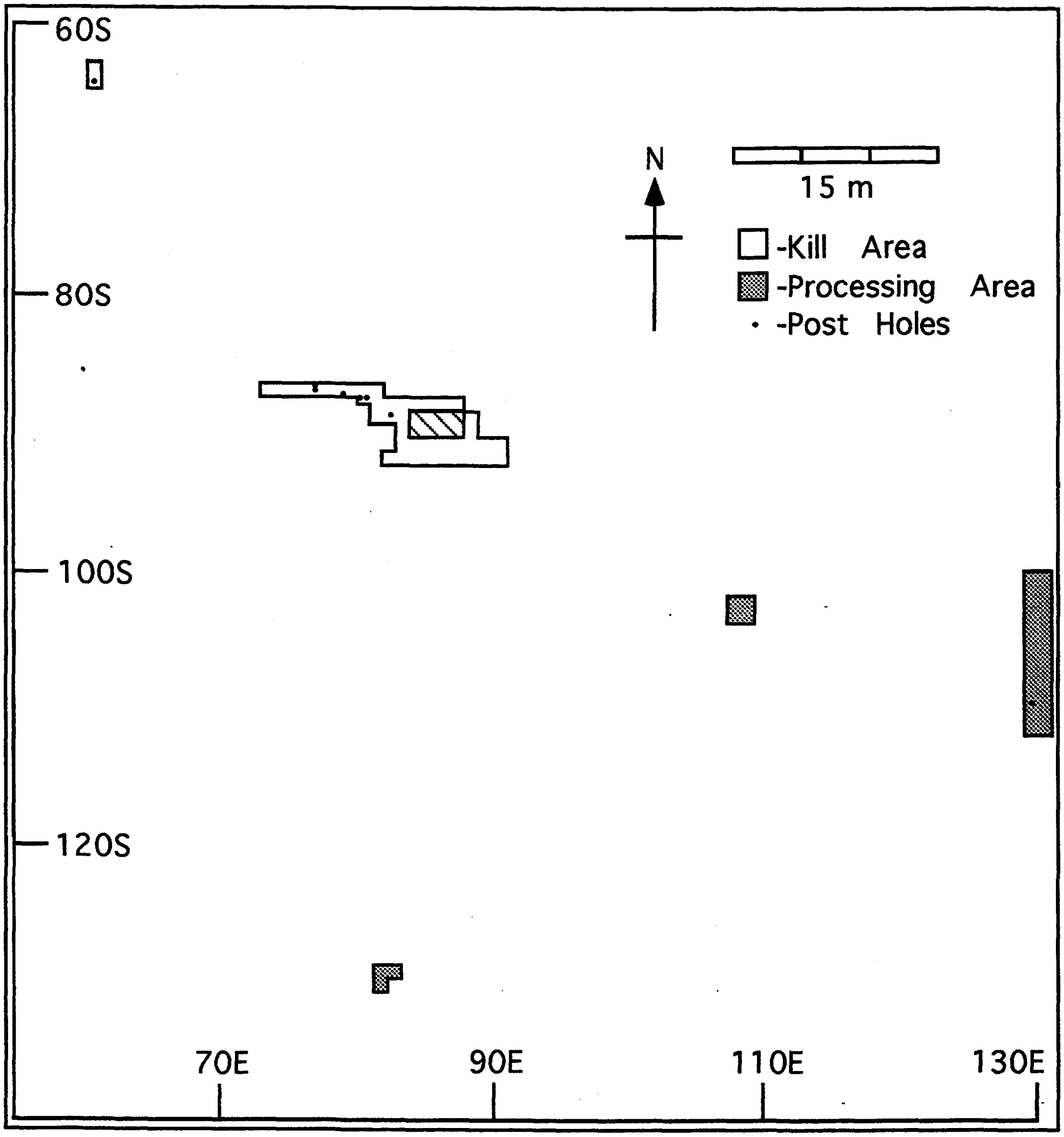


Figure 3.6 1992 and 1993 Fitzgerald Site Excavation Blocks

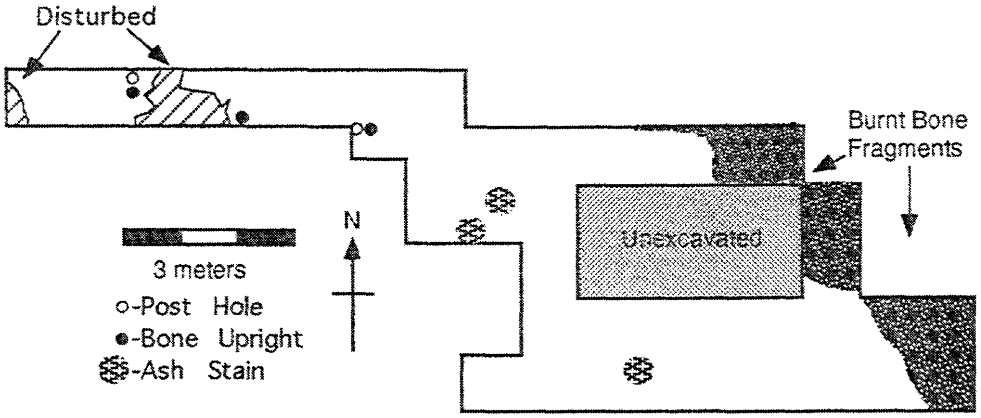


Figure 3.7: 1993 Fitzgerald Site Excavation Block 1 with Post Holes and Burned Bone

Figure 3.8: Photo of 1993 Excavations in Block 1 Bone Bed

Figure 3.9: Photo of 1993 Excvations in Processing Area

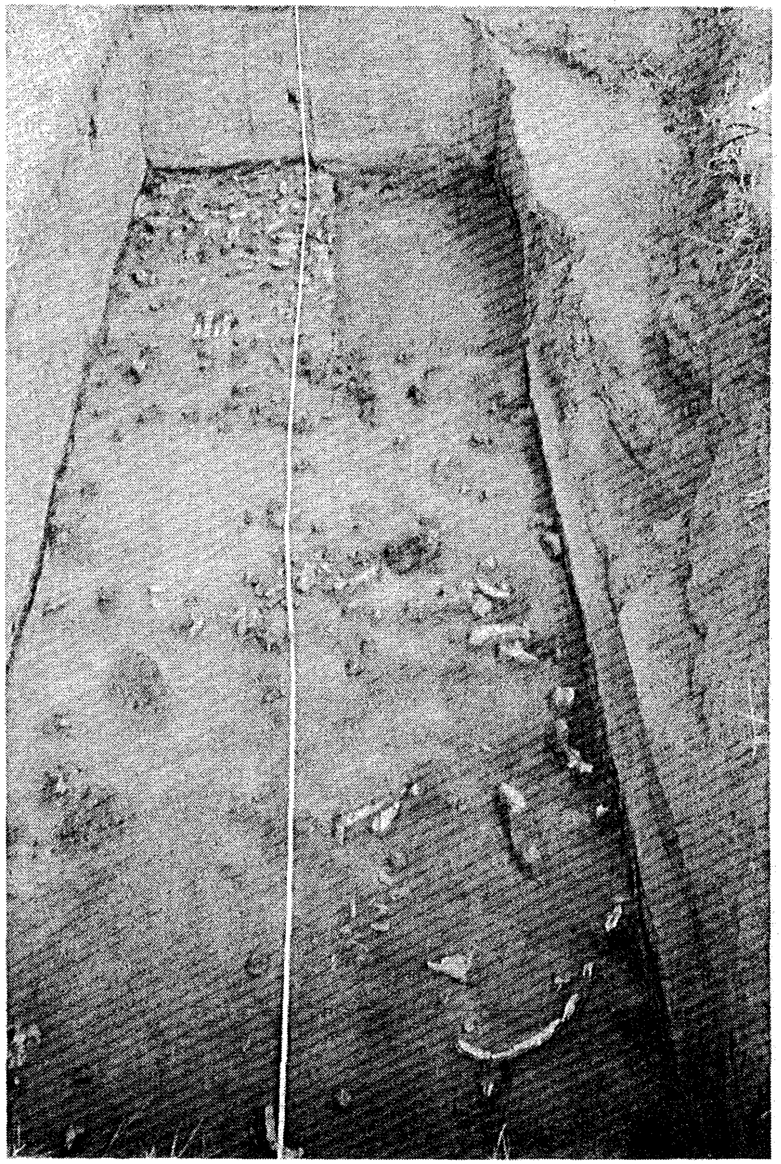


Figure 3.10: Photo of 1993 Excvations in Processing Area

consisted almost entirely of Knife River Flint end scrapers and utilized secondary flakes. There were also four Besant projectile points recovered from this area. A single multi-bone upright was located in the main excavation block (Figure 3.6).

3.5 Laboratory Analysis

All cataloguing, identification and analyses were conducted by the author. A preliminary analysis of the lithic debitage was conducted by Carrie Meyer, an undergraduate student completing a lithic analysis class in the Department of Anthropology and Archaeology at the University of Saskatchewan. Washing and sorting of the faunal remains was conducted by the author, Stacy Kozakavich and students from the 1993 and 1994 University of Saskatchewan field schools.

Cataloguing was completed using the MacADEM cataloguing program (version 10.6) developed by Western Heritage Services (Gibson 1991). Identifiable faunal materials were catalogued to element, element portion, side, species, weight and size. Unidentifiable materials were catalogued by weight and size. Taphonomic processes like burning, cut marks, canid chewing and weathering were noted on both identifiable and unidentifiable materials. Lithic artifacts were identified to material, type, retouch, utilization, weight and size. Metrics were obtained on all tools. All faunal and lithic measurements were taken with calipers to the nearest tenth of a millimeter; weight was measured with a mechanical scale to the nearest tenth of a gram. Analysis was completed on the Microsoft Excel spreadsheet program for Macintosh computers. Additional tables and figures were created by hand or on Adobe Illustrator.

3.6 Discussion

The Fitzgerald site represents an undisturbed Besant pound and processing area. A two year testing and excavation program resulted in the excavation of over 73 m^2 of cultural deposits (Figure 3.6). Excavation units were about evenly divided between the kill and processing areas. A large quantity of materials were eventually identified and catalogued. Faunal materials include some 261,658 (610,272 g) pieces of bison bone, 11,287 (492,818 g) of which proved identifiable. Lithic materials include 143 projectile points (68 of which are complete, near complete or bases), 22 other formed tools, and 2030 (438 g) pieces of debitage and shatter. These samples were considered large enough to make valid comparisons between kill and processing area activities.

Chapter 4

Artifacts and Features

4.1 Introduction

Archaeologists have long been interested in establishing a cultural chronology for the Northern Plains cultural area. With the collection of over 100 diagnostic projectile points, determining the cultural complex would not at first seem difficult. However, the Besant culture is in many ways the prehistoric equivalent of Churchill's Russia, "a riddle wrapped in a mystery inside an enigma." These difficulties are associated with the exact relationship between the Middle Missouri mound builders, the Northern Plains communal bison kill sites with high frequencies of Knife River Flint, and those Besant sites with locally available lithic materials. As the Fitzgerald site is dominated by Knife River Flint, an understanding of its place in the cultural sphere is crucial to interpreting the activities at the site.

4.2 Cultural Affiliation

The Besant culture was first defined by Wettlauffer (1955) from his excavations at the Mortlach site. The diagnostic feature of this culture was the Besant projectile point. It is described as:

> short and broad with shallow side notches and a slightly concave base. The base is thinned by striking a number of flakes off the base running towards the tip. This practice is the cause of the slight concavity in the base and creates 'lugs' or 'tangs' at the corner of the base (Wettlauffer 1955:44).

While Wettlauffer also recovered ceramic shards in Besant components at the Mortlach site, they were dismissed as intrusive.

Kehoe's (1966: 838) examination of the small side-notched points from the Late Prehistoric Period introduced a second diagnostic projectile point into the Besant assemblage, the Samantha Side Notched projectile point. This point was differentiated from the Besant point principally by size; it had many of the same attributes as the Besant point, except it was smaller. Kehoe believed that Samantha represents the introduction of the bow and arrow onto the Northern Plains. He later suggested that Besant points were found in the early part of the culture and were "transformed into the transitional Samantha point" around 1550 to 1250 BP (Kehoe 1974: 109).

Subsequent analysis by Reeves (1970) of a number of sites from this period prompted him to assign Besant phase status as defined by Willey and Phillips (1958: 22). It is important to note that by Reeves' (1983a: 39) definition, a phase does not necessarily have to "correlate with a locality, region, or even an area." Phase status was justified on the basis of a number of characteristic traits including Besant projectile points and conoidal pottery vessels. Reeves includes the Besant Phase within the NAPIKWAN Tradition that has links to the earlier Oxbow Complex and later Prairie Side-Notch Phases.

Reeves was also the first to suggest that the Besant phase had important ties with the Hopewellian culture of Illinois. Peoples of Hopewellian culture sought Knife River Flint, obsidian, grizzly bear teeth and perishables like bison hides and meat (Reeves 1983a: 191). In return, Besant received copper, antler pins, shell ornaments, pottery and perishables such as corn. He hypothesized that Besant also adopted the burial mound from the Hopewell. As a result of this interaction, Besant moved from an egalitarian to a ranked society (Reeves 1983a).

Many attempts have been made in recent years to sub-divide the Besant projectile points through functional and stylistic differences. Divisions have been made on the basis of basal morphology (Forbis 1962; Kehoe 1974; Dyck and Morlan 1995), material type (Neuman 1975; Syms 1977) and length and width (Ramsay 1991). If any of this research is correct, it may mean redefining what Besant represents.

From a re-examination of the Walter Felt, Mortlach and Long Creek site projectile point sample, Kehoe (1974: 108-109) defined two basic varieties of Besant points, Coteau and McLean. The Coteau Round-shouldered, convex-based variety has a "slightly convex and heavily ground" base; the McLean Round-shouldered, concave based variety has a slightly concave base (Kehoe 1974: 108-109). He distinguished these points from the previously mentioned straight-based Samantha varieties.

Unfortunately, much of Kehoe's work is based on an unpublished assemblage from the Walter Felt site. While Kehoe provided general qualitative descriptions of the point types involved in his discussion, quantitative data were not provided. He also did not account for variation within the style and provides no contexts for the styles under discussion.

In 1975, Neuman published the results of a decade of work on the Missouri River. His work focused primarily on a large array of burial mound sites located along the Middle Missouri River in North and South Dakota. These mounds are found on terraces overlooking the Missouri River and are "manifested by clusters of one or more low, domed earthen structures" ranging from 16.8 to 30.5 m in diameter and 0.4 and 2.1 m in height (Neuman 1975: 94). Primary and secondary bundle burials of between 8 and 50 individuals of all ages and sex were usually found within a single subsurface burial pit, often associated with different burial offerings, including complete bison carcasses. Despite the presence of projectile points that were clearly stylistically related to Besant, Neuman chose to interpret the material culture of the Missouri mound builders as a new complex he called Sonota. Neuman (1975: 96) defines the Sonota Complex as "a regional segment of a [Besant] cultural tradition." While the Sonota Complex contains many of the same artifacts and features as what he terms Besant Complex sites located in Alberta, Saskatchewan and Montana, it can be:

> amended by an increase in ceramics, along with a variety of specialized, regionally elaborate, and at times exotic stone, bone, shell, copper,

> vegetal, and pigmentary specimens, most of which are associated with the burial mound interments (Neuman 1975: 96).

These burial mounds and exotic artifacts are hypothesized to be the result of contact with the Hopewellian cultures to the east and southeast. The materials were traded north and west because of the Hopewellian desire for exotic lithic materials like obsidian and Knife River Flint.

Syms (1977: 92) separated what he termed the Besant Composite into two complexes, Besant and Sonota. A complex represents "a group with a shared lifestyle" while a composite "consists of a number of complexes which share a set of traits, technological and stylistic, that may be conceived as being sufficiently similar as to indicate a common and recent ancestor and sufficiently different that microevolutionary changes have taken place" (Syms 1977: 71). Syms concluded that the differences within the Besant Composite are partially defined by projectile point style and the frequency of Knife River Flint. Sonota Complex points are made from Knife River Flint and are long with deep notches; Besant Complex points are short with deep notches and are made from locally available lithic materials. Thus, Syms (1977: 90) included within the Sonota Complex, not only the Missouri burial mounds, but also the Muhlbach, Walter Felt and Richards Kill sites. According to Syms' definition, the Fitzgerald site would also be considered a Sonota Complex site.

Syms' inclusion of some Alberta, Saskatchewan and Montana Besant Complex sites in the Sonota Complex raised considerable controversy. Reeves (1983a: 11), in an update to his 1970 dissertation, took particular exception to this "artificial separation." His own "hands on" analysis of Besant projectile points found no quantitative and qualitative differences between Syms' Besant and Sonota projectile points. Reeves (1983a) and Ramsay (1991: 89) identified numerous sites (Steltzer, Kenney, Old Women's, Wahkpa Chu'gn, Long Creek and Mortlach) that have varying projectile point lengths and frequencies of Knife River Flint that Syms omitted from his analysis. Reeves (1983a: 13) argued then that because Besant has terminological precedent in the literature over Sonota, "the Sonota Complex is the Besant Burial Mound Complex of the Middle Missouri." Subsequently, Reeves (1983a: 140-141) outlined ten characteristics of the Besant 'Phase':

> 1. Low frequency of unnotched points (usually one type)
> 2. Besant Side Notched (atlatl) and Samantha Side Notched (arrow) projectile points. No stemmed forms and few of Pelican Lake Corner Notched points. Flake points are common.
> 3. Few discrete types of bifaces with modified hafting elements.
> 4. High frequency of asymmetric ovate bifaces
> 5. High frequency of small, dorsally finished end scrapers.
> 6. Distinctive drill types - pentagonal and triangular.
> 7. Absence of unifacial flakes, domed side scrapers, and pointed unifaces; few bifacial choppers.
> 8. Rare and localized cord-marked, bossed, and/or punctated conoidal pottery vessels.
> 9. Presence of excavated basin-shaped earth-filled hearths but absence of excavated basin- or bucket-shaped rock-filled hearths. Surface hearths are common. Presence of cache pits, house structures (two sites), and bone uprights.
> 10. Secondary burials, usually accompanied by many grave goods, in central subfloor log-covered tomb, under an earth mound.

This list includes many features that Neuman and Syms would classify as Sonota, including the use of burial mounds.

In his review of Saskatchewan Plains prehistory, Dyck (1983) defines Besant as a Complex included within the Late Plains Indian Period. His definition of a complex is somewhat different than Syms'. Dyck defines a complex as:

> a large composite archaeological unit. It consists of interconnected sites, features and artifacts, tied together by similarities in function, style, technology and subsistence-settlement system. The parts of a complex are found within a common geographical distribution and within a common segment of time (Dyck 1983: 69).

The basis of the inclusion of Besant in the Late Plains Indian period was the presence of pottery. Dyck goes on to define many of the prevalent artifacts and features associated with this complex. Included in this list are the Middle Missouri burial mounds which he concludes are nothing more than a "mortuary expression of the [Besant] complex" (Dyck 1983: 115). He also agrees that the preponderance of Knife River Flint in some sites is "a hallmark of [the] Illinois Hopewell complex" (Dyck 1983: 115).

Previous to Dyck's article, considerable debate occurred over whether Canadian Besant sites included pottery (Byrne 1973: 449; Kehoe 1964; Reeves 1970: 64; Morgan 1979: 219). However, enough ceramic-bearing Besant components have now been excavated that any arguments centering on this issue have been resolved (Meyer and Rollans 1990; Ramsay 1991: 81-83). The pottery recovered at the Garratt site is now acknowledged as the oldest (1990 BP) on the Canadian Plains (Dyck 1983: 120). Besant pottery vessels are conoidal and have cord-roughened (diagonal, horizontal and vertical) or occasionally smoothed exteriors. Rim decoration includes punctates and/or bosses with occasional dentate impressions (Neuman 1975). It is a diagnostic artifact of Besant.

The presence of ceramics has been construed as further evidence of a southeast influence on Besant. Johnson (1977a: 38) concludes that pottery technology diffused northward along with the idea for burial mounds from the Hopewellian culture in Iowa and Illinois. Gregg (1985: 119) has identified a number of eastern Laurel characteristics in Besant pottery including conoidal vessels and "dentate stamp and punctate ceramic decoration." Meyer and Rollans (1990) note that Besant pottery seems to decrease as one moves north and northwest of the Middle Missouri. Thus, it is difficult to ascertain whether ceramic technology had diffused northwards, or whether the vessels themselves were being traded or carried northwards by a population originating in the southeast.

Reeves and Dyck's arguments did not diffuse the controversy surrounding the relationship between the Middle Missouri sites and the Canadian Plains sites. Joyes (1984) and Duke (1991) have constructed a third hypothesis, an amalgamation of Reeves and Syms hypotheses. Duke agrees with Syms that Besant and Sonota form two distinct Complexes. He argues that Syms' Besant Complex was created by contact with the

Sonota Complex. Alberta and Saskatchewan sites with high amounts of Knife River Flint represent people who "acted as traders or contacts within an existing indigenous society (representing Syms' Besant horizon sites) that had, following Reeves initial hypothesis, entered the Hopewellian interaction sphere" (Duke 1991: 93). "These indigenous western Besant groups may have been acculturated to some degree" by this trade network (Duke 1991: 93).

In an effort to resolve arguments on whether or not there were two distinctive Besant projectile point types, Ramsay (1991) conducted discriminant function analysis on the Besant points recovered from the Melhagen site. As the site contained both Knife River Flint and locally quarried materials, she hoped to distinguish quantitative differences within her measurement series. Ramsay found that variation within the Melhagen collection was high, especially in length. These differences were thought to be functional; they represented nothing more than differences between arrow, atlatl and spear points (Ramsay 1991: 223-224). No evidence was found to support Syms' argument that there were two projectile point styles within Besant.

Other archaeologists have been critical of using length as a diagnostic feature in projectile point typologies. For instance, while Duke (1991) agreed that some Besant points may be longer than others, he argued that this variation may partially be the result of reworking of the points. Ramsay (1991: 90) acknowledges this problem, noting that because Knife River Flint is vitreous, it was easier to work, and, as a result, a skilled knapper could make longer and better quality points. If these points were then reworked, previous differences would be masked.

Vickers (1986, 1994) has been critical of Reeves' arguments that Besant ties with the Hopewellian Interaction Sphere had resulted in an increase in cultural complexity. He noted that the frequency of Knife River Flint and obsidian in Hopewellian sites is small and can be explained by a single event (Vickers 1994: 14). While he agreed that the burial mounds were borrowed from Woodland cultures, he thought "the concept was reworked; the Sonota mounds appear to be unranked group repositories of the dead, rather than evidence of a ranked society as postulated by Reeves" (Vickers 1994: 14). So while there were strong ties to the east, it is difficult to ascertain what influence these changes might have had on social organization.

Dyck and Morlan (1995) have recently reassessed Dyck's (1983) original idea of the Besant Complex and redefined Besant as a Series. A Series is defined by Dyck (1983: 69) as:

> a sequence of archaeological components sharing a common geographical space (sometimes within a single site, sometimes within a region), but belonging within a separate segment of time. A series is a crude unit of archaeological analysis used for convenience before sites, features, and artifacts are ready for reclassification into complexes and traditions.

Using this definition, the controversy surrounding the relationship between Sonota and Besant is acknowledged. It serves as a useful definition until further research can resolve the debate surrounding these separate 'complexes'. In their work at the Sjovold Site, Dyck and Morlan (1995: 435) have refined Wettlauffer's 1955 definition of the Besant point to include:

> lateral edges which are convex (most common) to straight (rare); maximum width at the shoulder and/or base; cross sections of which are biconvex to plano-convex; notches are broad shallow "u" or "v" shaped; basal thinning and grinding is very characteristic; bases may be convex, straight (most common), or concave; bases may be wider, the same width as, or narrower than shoulders; primary retouch usually covers all surfaces, although some plano convex specimens show minimal modification of the ventral surface; and quality of workmanship seems variable.

Part of the reason for identifying Besant as a Series is that excavations at Sjovold have identified within Besant occupations three separate projectile point styles - Outlook Side-notched, Bratton Side-notched and Sandy Creek. The basis for this division rests almost entirely on basal morphology. Outlook Side-notched points are described as being straight-based: "the basal edge in plan view forms either a straight line or a slightly concave or convex line in which depth of concavity or the height of convexity does not exceed 1mm" (Dyck and Morlan 1995: 437). The Bratton type has a "convex base for which depth of convexity (the perpendicular distance between a line joining the two points of basal juncture and the apex of the basal edge) is more than 1mm and less then 7mm" (Dyck and Morlan 1995: 379). Sandy Creek are "side-notched basally concave" points with symmetry in depth and width of notches (Dyck and Morlan 1995: 398). Following their definition of a series, no temporal or spatial boundaries are proposed for these individual point styles beyond the general parameters of the Besant culture.

For this thesis, the Northern Plains cultural sequence first outlined by Mulloy (1958) will be followed. In this chronology, there are three archaeological periods: Early, Middle and Late Prehistoric. These periods are defined by major changes in cultural technology, such as the introduction of the atlatl or pottery. In turn each of these periods is divided into several phases, where similarities in style, function and technology are found within a limited distribution through time and space. Following Dyck and Morlan (1995), Besant is defined as a Series. The accepted diagnostic artifacts of the Besant Series are the Sandy Creek, Outlook, Bratton and Samantha projectile points and Besant pottery (Dyck and Morlan 1995).

This thesis will determine if the Fitzgerald site projectile points correspond to any or all of the new Besant Series assemblage. By assigning these points to the typology proposed by Dyck and Morlan (1995), the process of testing their definitions can begin. The validity of these styles will be tested against a collection of nearly 70 diagnostic points. If the style corresponds to a specific variety, it may be possible to link this type to a particular time period by comparisons with other known projectile points from different sites within the Series.

Part of this chapter will explore the relationship between Knife River Flint and Besant Series sites. In the context of the Fitzgerald site excavations, this thesis will investigate what significance the presence of this material might have. This will be examined with regard to testing the extent of the relationship between Besant Series sites on the Canadian Plains and along the Middle Missouri River. Finally, this chapter will analyze the other artifacts and features from the Fitzgerald site in light of these same arguments. For instance, Reeves argues that features like post holes and bone uprights are significant traits in Besant. The functions of these features will be explored.

4.3 Projectile Points

Analysis of the projectile points can be divided into two approaches, qualitative and quantitative. Analysis was devoted to testing the following conclusions: first, that the projectile points conform to one or more of the types within the Besant Series (Dyck and Morlan 1995); second that they were used both as dart tips and as cutting tools.

Following Gruhn (1971), the projectile points were first divided into two classes, bifacially flaked points and trimmed flake points. Conclusions regarding stylistic differences were for the most part based on the bifacially worked points as more care had been taken in their manufacture. Flake points can be considered to be expedient tools.

All projectile points underwent full quantitative and qualitative analysis. Reeves has criticized archaeologists for presenting often incompatible data when conducting projectile point analysis. To present results that are consistent with other research, methodology followed Ramsay's (1991) work with the Besant projectile points recovered from the Melhagen Site.

4.3.1) Qualitative Analysis

Qualitative analysis was conducted using a hand lens (4 power) and a 10 power microscope. Following Ramsay (1991), the following variables were examined: body shape, body symmetry, transverse section shape, longitudinal section shape, left and right shoulder shape, left and right notch orientation, left and right notch shape, left and right notch modification, basal shape, basal modification, left and right basal edge shape, retouch and utilization. The results of these analyses can be found in Appendix 1.

Few of the points are complete. Of the 122 bifacial points, there are only 21 complete and 20 nearly complete points (Table 4.1; Figures 4.1 to 4.6). There are 10 complete and nearly complete flake points. As well, 15 bifacial and 2 flake bases were recovered. Despite the fact that the basal portion of the point is diagnostic, only 56 (39%) of the bifacial points and 12 (57%) of the flake points can then be considered identifiable to type.

Table 4.1: Biface and Flake Projectile Point Completeness

	BF #	FL #	BF %	FL %
Complete	21	6	17.2	28.6
No Tip	18	3	14.8	14.3
No Side	2	1	1.64	4.76
Base	15	2	12.3	9.52
Body	19	3	15.6	14.3
Mid-Sect	24	2	19.7	9.52
Tip	23	4	18.9	19
SUM	**122**	**21**	100	100

Over half (52%) of the points are broken at the base and technically should be considered bifaces. However, a close examination of the quantitative and qualitative analysis would suggest that these tools are projectile points. They are of the same length, thickness and width as the rest of the points. Coupled with the fact that only a single unhafted bifacial tool was recovered from the site, it seems reasonable to include these elements in the projectile point analysis.

Of the 88 points that could be studied for utilization patterns, nearly 60% (N = 51) showed evidence of use wear. Considering the fact that no bifaces or other cutting tools beyond 39 utilized flakes were recovered from the kill area, this number should not be surprising. Use wear is not the only characteristic associated with cutting tools. Christenson (1986: 111) identifies three other attributes that can be used to identify

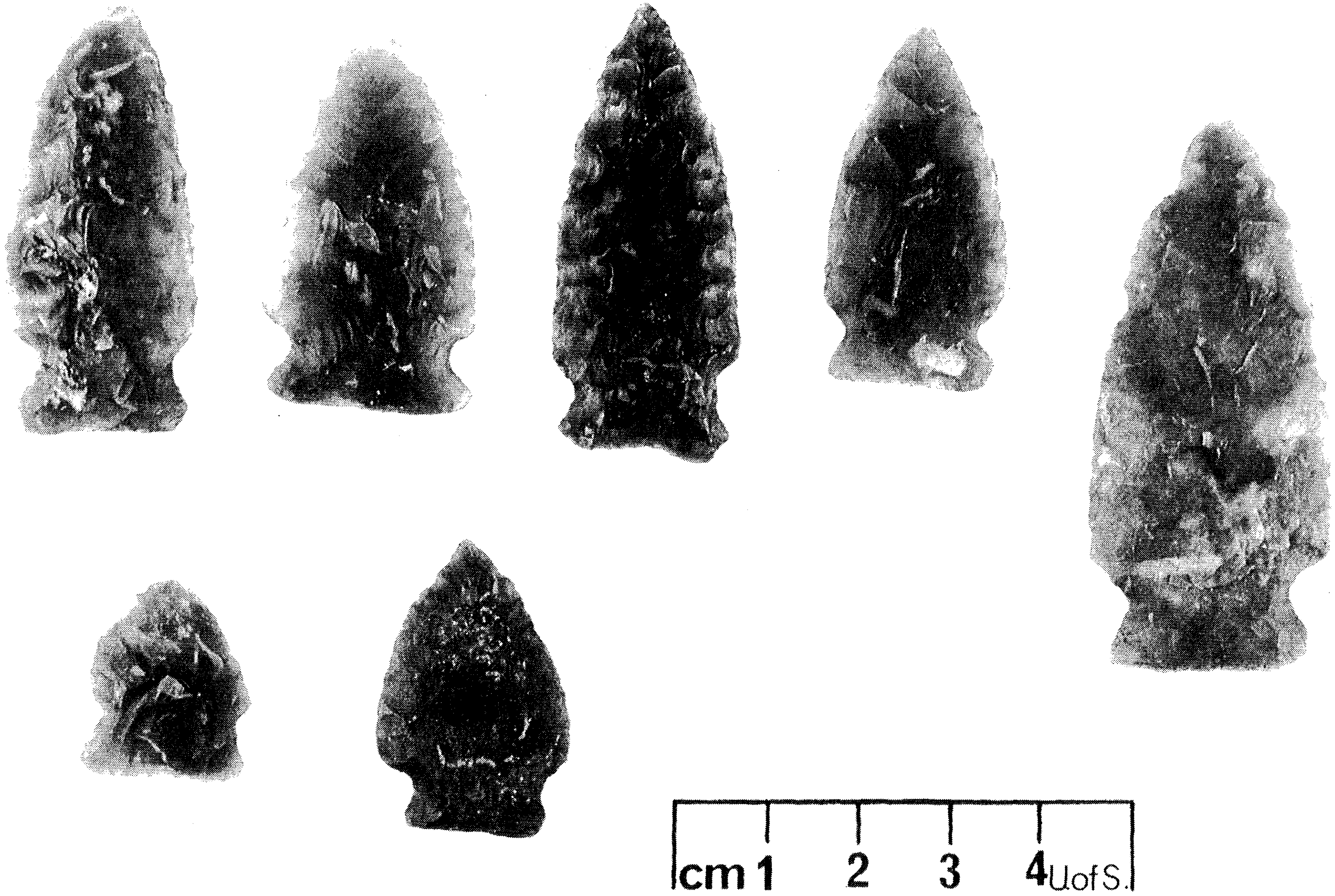


Figure 4.1: Besant ("Outlook") Side-Notched Projectile Points

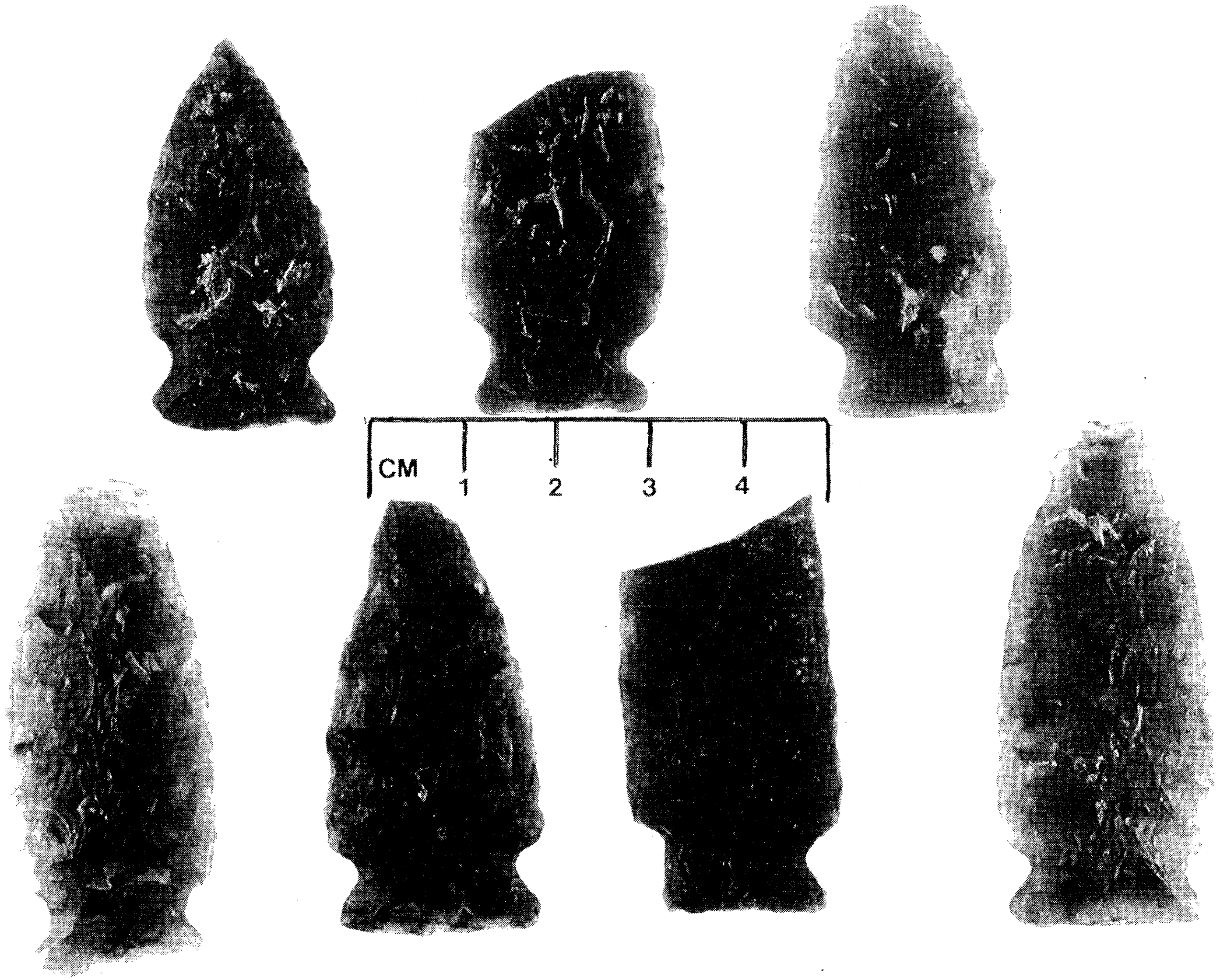


Figure 4.2: Besant ("Outlook") Side-Notched Projectile Points

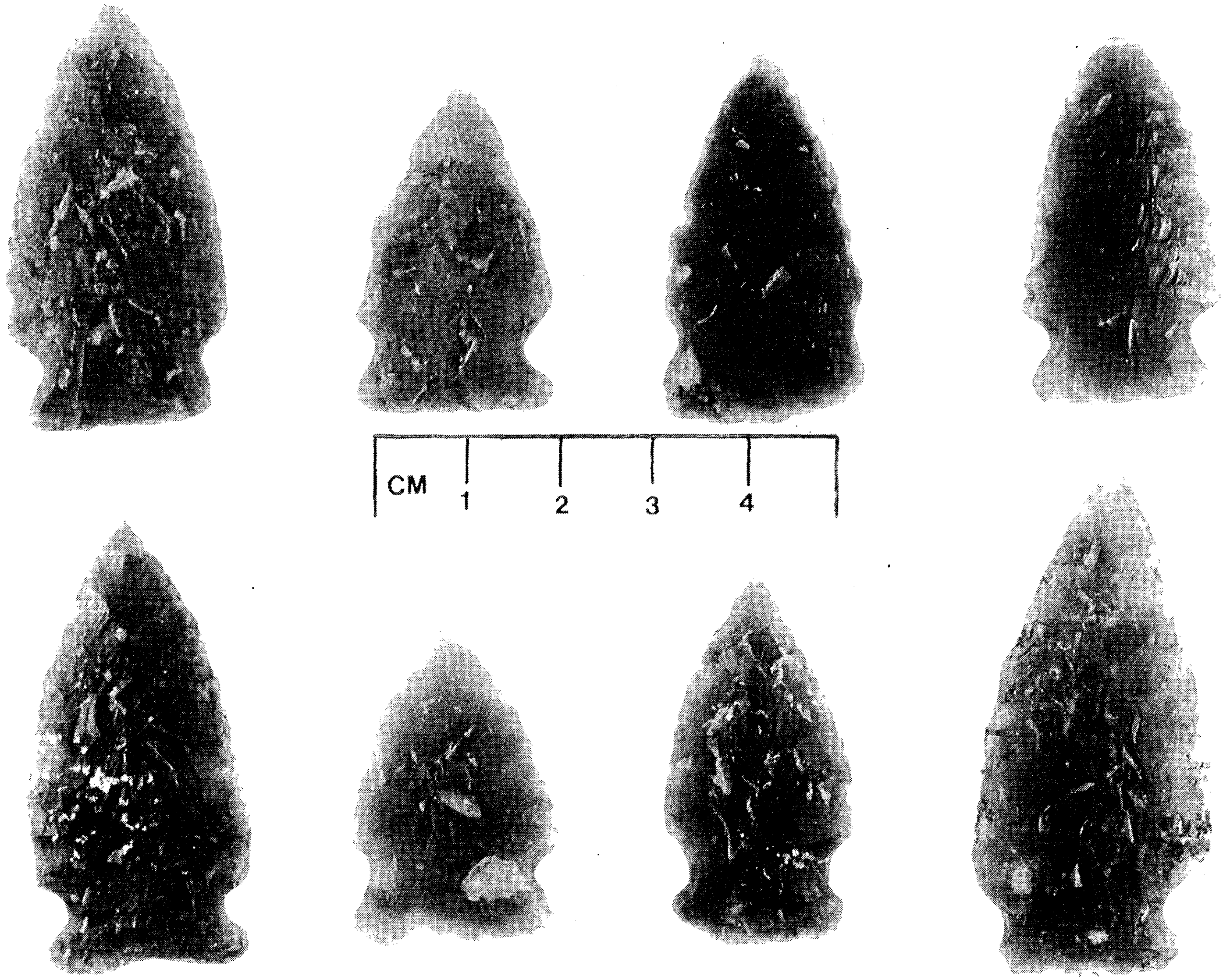


Figure 4.3: Besant ("Outlook") Side-Notched Projectile Points

Figures 4.4: Besant ("Outlook") Side-Notched Projectile Points

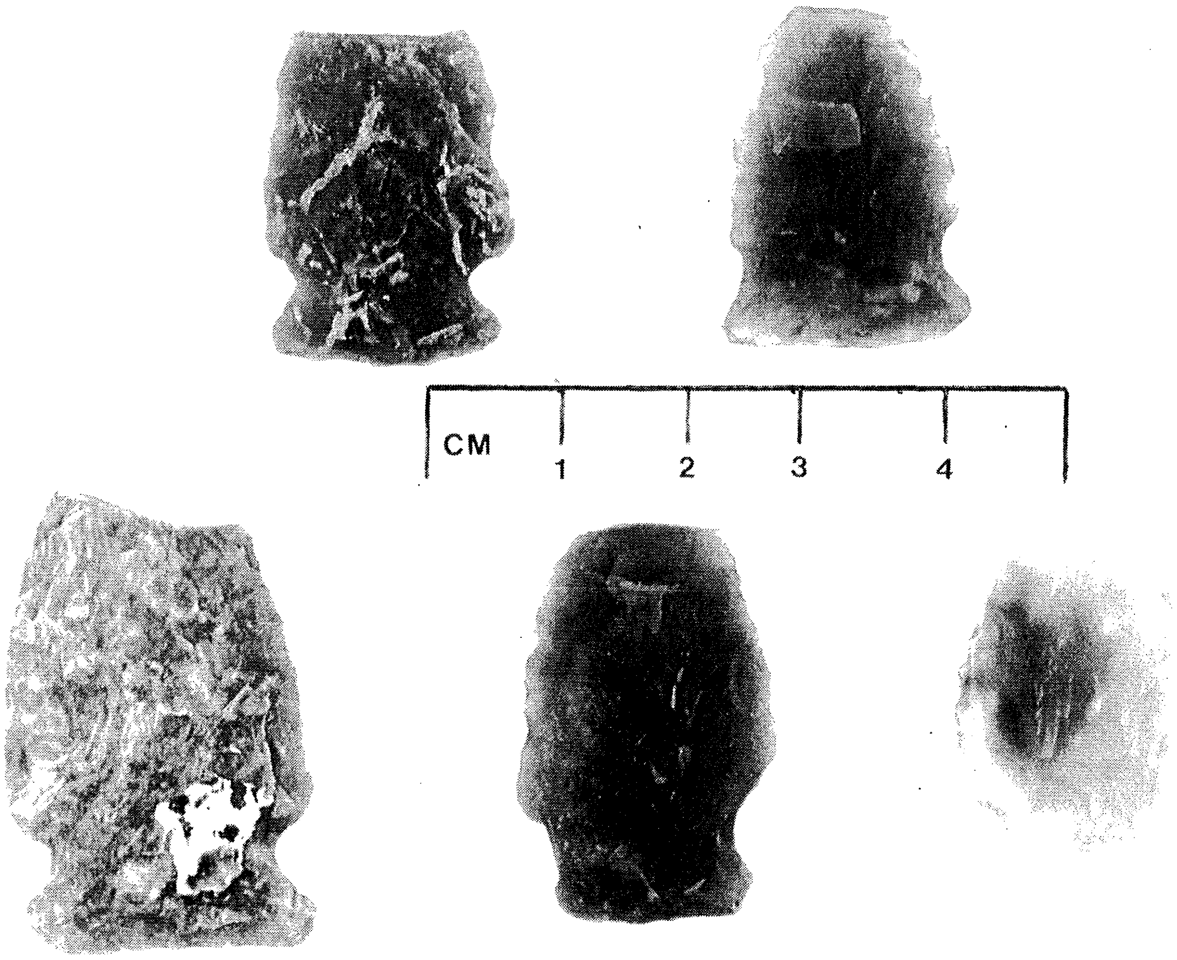
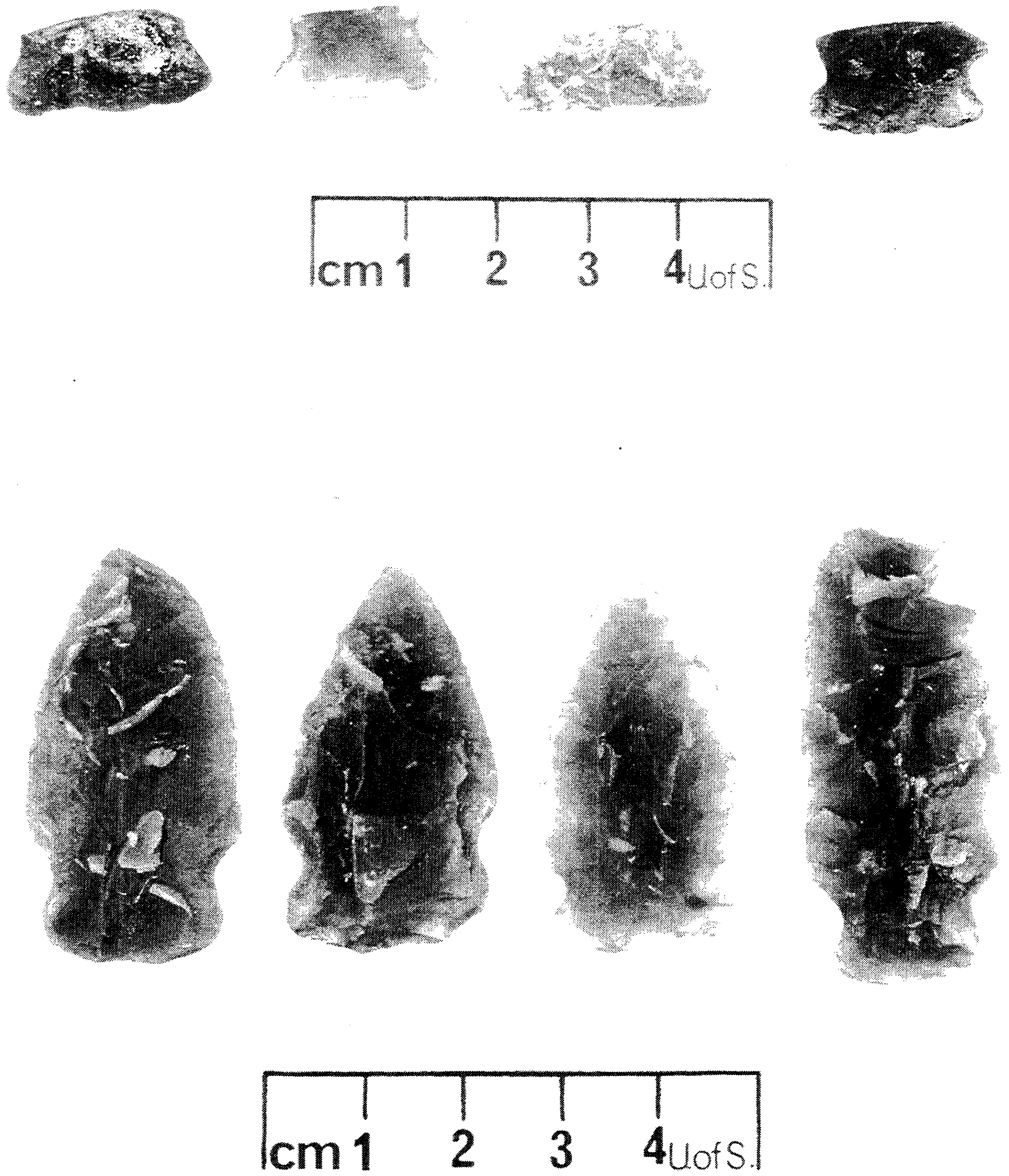


Figure 4.5: Besant ("Outlook") Side-Notched Projectile Points



Figures 4.6: Besant ("Outlook" and "Bratton") Side-Notched Projectile Points

knives - beveling, stem grinding and blade serration. Beveling is "the result of careful resharpening of the blade edges from dulling after use as a knife" (Christenson 1986: 111). Stem grinding likely occurred for two reasons, "to reduce the possibility of the biface edges cutting the binding material" and to reduce the risk of splitting the shaft or breaking the point (Christenson 1986: 111). Finally, blade serration is viewed as a "way of preparing a sharp edge for cutting bone or butchering" (Christenson 1986: 111).

A large number of the projectile points from the Fitzgerald site exhibit one or more of Christenson's attributes. Two points (2%) have beveled edges; 32 points (58%) have grinding on the base and/or notches; and 14 points (14%) have serrated edges. Five of the seven points from the processing area exhibit at least one of these three characteristics.

4.3.2) Quantitative Analysis

To eliminate error and bias in the analysis, measurements were conducted in two separate sittings some six weeks apart. Inconsistencies between measurements were relatively minor and were usually changed only after a third examination. All measurements were taken with calipers to the nearest tenth of a millimeter. Measurements taken include length, thickness, shoulder width, neck width, basal width, left and right body length, left and right basal height, left and right notch depth and left and right notch width. Maximum body width was not recorded as in most cases it did not exceed shoulder width.

Results of the quantitative analysis can be found in Appendix 3 and 4 and can be summarized as follows. In all there were 143 projectile points recovered from the site, 94% of which were recovered from Block 1 and less than 5% from Block 2. No projectile points were recovered from Block 4. About 85% (N=122) of the Fitzgerald site projectile points were bifacially worked, 15% (N=21) were flake points.

The basal portion of the bifacial points shows little variation. Standard deviation for shoulder, neck and base width is less than or equal to ten percent of the mean (Table 4.2). Standard deviation for basal height is under fifteen percent of the mean. The main variation within the bifacial points is in the length of the body with a standard deviation over 25% of the mean.

Table 4.2: Projectile Point Metric Means and Standard Deviation (in mm)

	LGTH	THCK	SHLD	BASE	NECK	LBDY	RBDY	LBSL	RBSL	LNL	RNL	LND	RND
BF Mean	40.8	5.52	21.7	19.6	15.5	31.7	31	10.1	9.93	7.1	6.9	2.1	2.1
FI Mean	25.7	3.91	17	14.8	13.1	22.1	21.8	8.75	8.55	5.7	5.8	1.5	1.4
BF No.	16	82	69	48	56	50	48	41	39	44	42	44	42
FI No.	5	18	17	13	15	10	9	10	11	11	11	11	12
BF SD	9.84	1.16	2.15	1.96	1.38	8.34	8.5	1.47	1.47	1.3	1	0.6	0.6
FI SD	11.7	1.24	3.66	3.35	3.31	8.67	9.32	1.7	1.91	1.3	1.4	0.5	0.7

Notch length and depth varies considerably. This is due in part to the fact that the notches are offset, a previously ignored diagnostic characteristic of Besant points. In nearly three-quarters of the 39 bifacial points with both notches still intact, one notch is long and shallow and the opposite is short and deep. The reason for this is unclear. It may be a result of trying to use these points as cutting tools; the notches would be offset to help stabilize the point within the shaft.

The main variation within the bifacial points is in the body length with a standard deviation over 25% of the mean (Table 4.2). These differences are likely the result of the points being repeatedly reworked (Duke 1991). Two projectile points also show evidence that the basal portion was renotched after the original base was snapped off.

There is also considerable variation in the basal morphology of the Fitzgerald points (Table 4.3). Using Dyck and Morlan's defining characteristics, 52 (93%) of the diagnostic points would be considered to be Outlook Side-notched projectile points, only 4 (7%) would be Bratton Side-notched points. No Sandy Creek or Samantha projectile

Table 4.3 : Biface and Flake Projectile Point Basal Morphology

	BF #	FL #	BF %	FL %
All	1	0	1.89	0
Straight	20	4	37.7	33.3
Str/Cvx	5	0	9.43	0
Convex	15	8	28.3	66.7
Str/Ccv	8	0	15.1	0
Concave	4	0	7.55	0
SUM	**53**	**12**	100	100

points were identified at the Fitzgerald site. Considering the early radiocarbon dates from the Sjovold site, the presence of Outlook and Bratton points at the Fitzgerald Site would confirm Dyck and Morlan's hypothesized temporal span of 1900-1200 BP.

4.4 Formed Tools

Other than the projectile points, there were only 22 formed tools recovered from the Fitzgerald Site. Only six of these were found in the kill area. Even considering that the projectile points were extensively utilized as cutting tools, this number is surprisingly small. Quantitative descriptions of all tools can be found in Table 4.4.

The tools identified from the kill area include one relatively small biface, a pièce esquillèe, two end scrapers and two unifaces. The biface (artifact number 17043) is manufactured from quartzite and is relatively small (14.2 x 17.9 mm) (Figure 4.7). The shape is generally convex, and in profile it is bi-convex. The tool is notched. No evidence of use wear is present. The pièce esquillèe (artifact number 17042) is manufactured from Knife River Flint (Figure 4.7). The edges vary from straight to convex. Along two of these edges there is evidence of both utilization and retouch. In profile the tool is bi-convex.

Another class of tool represented in the kill area is the end scraper (Figure 4.8). Artifact number 17040 is a Knife River Flint end scraper made from a large secondary flake. A striking platform and a bulb of percussion are visible at the distal end. As a

CatNo	South	South	East	East	Quad	LVL	MAT	Tool	UTIL	POL	RET	LGTH	WDTH	THCK
17043	91	0.17	86	0.32	NW	2	QTZ	Biface				142	179	52
17042	91	0.65	88	0.88	SE	1	KRF	Piece D'Esquilee	1		1	290	335	93
17046	102	0.7	130	0.45	SW	1	KRF	End Scraper	1			367	339	76
17047	106	0.35	129	0.93	NE	1	KRF	End Scraper	1		1	237	230	63
17049	106		129		NW	1	KRF	End Scraper	1		1	*231*	196	53
17044	107	0.07	130	0.22	NW	1	KRF	End Scraper	1	1		249	211	68
17057	108	0.17	129	0.52	NE	1	KRF	End Scraper	1	1	1	198	219	56
17058	108	0.54	129	0.39	SW	1	KRF	End Scraper	1		1	344	190	62
17059	108	0.55	130	0.08	SW	1	KRF	End Scraper	1		1	*141*	198	56
17037	64		59		NE	1	KRF	End Scraper	1		1	155	169	46
17040	88		81		SW	1	KRF	End Scraper	1		1	*135*	220	49
17048	106	0.72	129	0.47	SW	1	KRF	End Scraper	1		1	182	249	42
17053	107	0.15	129	0.15	NW	1	KRF	End Scraper	1		1	301	192	30
17054	107	0.52	129	0.33	SW	1	KRF	End Scraper	1		1	*216*	286	39
17052	107	0	130	0.07	NW	1	KRF	End Scraper	1		1	242	194	47
17045	102	0.97	130	0.35	NE	1	KRF	Side Scraper	1		1	562	338	80
17039	88		81		NW	3	KRF	Uniface	1	1	1	130	114	31
17041	89		82		SE	2A	KRF	Uniface	1		1	242	374	79
17055	107		129		SW	1	KRF	Uniface				88	188	43
17050	107		130		SW	1	KRF	Uniface	1			165	122	61
17051	107		130		NE	1	KRF	Uniface	1			105	132	31
17056	108	0.18	130	0.03	NW	1	FSH	Uniface				196	158	45

Table 4.4: Fitzgerald Site Lithic Tools

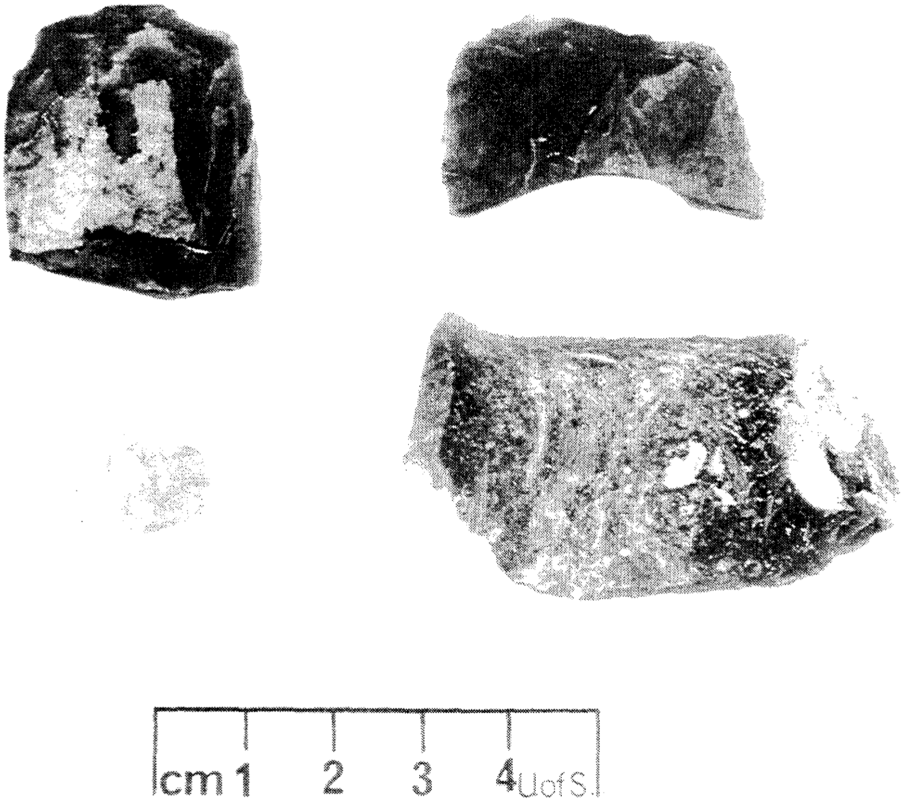


Figure 4.7: A Pièce Esquillèe (#17039), Uniface (#17042), Bifacè (#17043) and Side Scraper (#17045) from the Fitzgerald Site

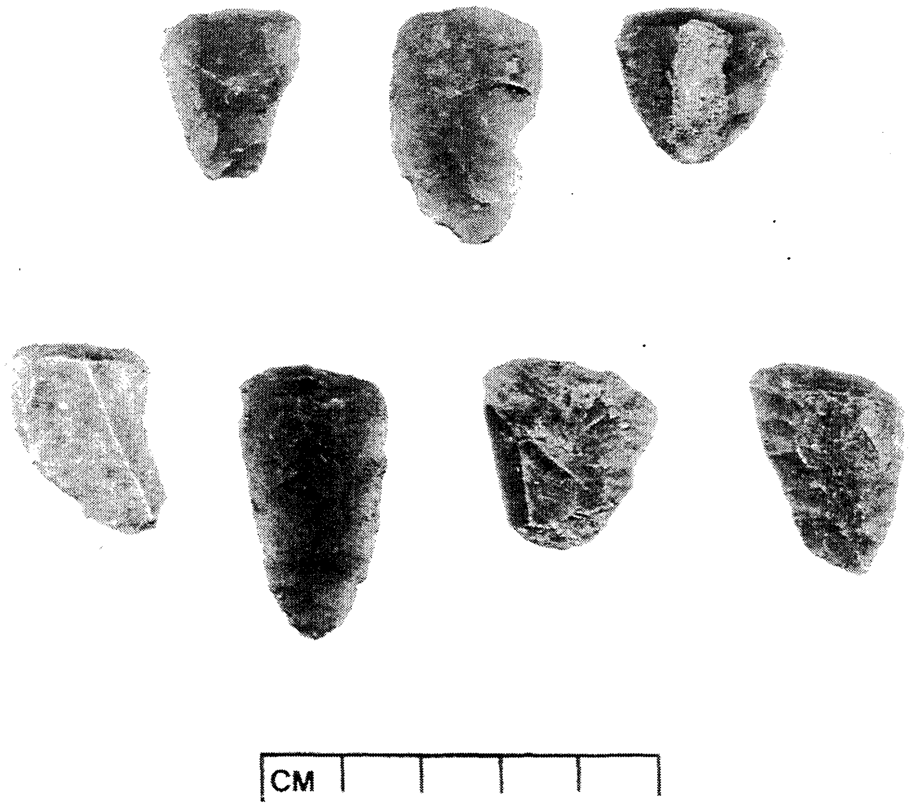


Figure 4.8: End Scrapers from the Fitzgerald Site

result, the proximal end is fairly thin, not typical of the classic hump-backed variety. This edge is convex and evidence of utilization and retouch is exhibited. A second end scraper of similar description was found in Block 2 (artifact number 17037).

All debitage was examined with a hand lens for evidence of use wear and retouch. Recorded attributes include utilization, polish, striations and nicks and the number and shape of the utilized and retouched edges. A large percentage of the 131 secondary flakes recovered from the kill area show signs of utilization (28%) and/or retouch (10%). As well, one piece of shatter was utilized and will form part of this analysis. As would be expected, most of the debitage that was utilized is fairly large (12+mm). Most are worked along either one or two of the edges; only 6 (15%) pieces were found with wear along 3 edges. Wear can also include striations (12) and polish (4). Of the 62 utilized edges, most are straight-edged (42%), followed respectively by concave- (26%) and convex- (19%) edged flakes. The wear patterns are consistent with use as a cutting or slicing tool.

Unlike kill sites, processing areas usually contain large quantities of formed tools (e.g. Frison 1973). In a kill area, the expected artifact assemblage would be dominated by projectile points with a limited presence of bifaces and hammerstones. In the processing area, the assemblage should be dominated by end scrapers and side scrapers, with only limited recoveries of bifaces, projectile points, choppers and to a lesser extent specialized processing tools such as drills, gravers and burins. This was the case at the Fitzgerald site; the processing area tool assemblage is substantially different from that of the kill area. As has been previously demonstrated, there are few projectile points located in the processing area. Of the seven bifacial points recovered from this block, only two (35%) have evidence of utilization as a cutting tool. This is in contrast to the 49 points (58%) collected from the kill that were used as knives. However, while there were only 6 formed tools (27%) recovered from the kill, 16 (73%) such tools were located in the processing area. These include 11 end scrapers, 1 side scraper and 4 unifaces. All 17 of these tools were manufactured from Knife River Flint.

The end scrapers are triangular and quite small; the mean length is 25.3 mm and the mean width is 22.3 mm (Figure 4.8). Along the convex proximal edge, the retouch scars are located at a steep angle to the edge. Utilization, and less often polish, is often evident along this edge.

There were 13 end scrapers recovered at the Fitzgerald Site. The proximal ends vary in thickness from 7.6 to 3.0 mm. There is some variation in body shape. Some forms (N=11) are quite symmetrical and form a distinctly triangular shape. Other end scraper bodies are asymmetrical and form a right angle triangle (N=2). Ten of the symmetrical scrapers and one asymmetrical scraper were identified in the processing area.

One side scraper (artifact number 17045) and four unifaces (artifact numbers 17050, 17051, 17055 and 17056) were identified in the processing area (Figure 4.7). The side scraper is made from a large secondary flake. Distinct retouch along both sides of the tool have produced a straight, steep edge. Evidence of utilization can be found along both these edges.

A large number of utilized (N=56) and retouched (N=12) secondary flakes were recovered from the processing area. Most use wear seems to have occurred along one or two edges of the flake; only five (2%) flakes exhibit use wear on three or more edges. In total, there are 99 edges that show evidence of use wear. These edges are for the most part either straight (36%), concave (25%) or subconcave (12%). A number of these utilized flakes also showed signs of striations (N=15) and polish (N=11).

4.5 Debitage

Analysis of the 2030 (594.1g) pieces of debitage collected from the Fitzgerald site concentrated on identifying differences in debitage type and use between the two major blocks of excavation. Thus some emphasis was placed in identifying types of debitage that existed in the two major blocks. A second component of the analysis was concerned with identifying the quarry sources from which the lithics were derived.

Analysis proceeded in three stages. All materials were separated by size and lithic material type and then counted and weighed. The debitage was then examined for evidence of cortex, patination, breakage, curvature, platform preparation, retouch and utilization. Debitage was separated into six major types based loosely on this visual analysis: primary and secondary decortication flakes, secondary flakes, shatter, thinning flakes and retouch/resharpening flakes. The division between the latter two tertiary debitage types was difficult to ascertain through the analysis of individual flakes. Following Ahler (1989), tertiary flakes were arbitrarily divided into separate categories on the basis of size: retouch/resharpening flakes are considered to be 2-6mm wide and thinning flakes are 6-12 mm wide. This method was used as there is an "apparent correlation between flake type and flake size" (Ahler 1989: 87). Size analysis is considered a more objective form of inquiry as "emphasis is shifted from features on individual flakes to characteristics of the complete group or aggregate" (Ahler 1989: 86). This removes much of the subjectivity associated with the application of different forms of classificatory schemes in individual flake analysis. It also offers the advantage of the rapid analysis of large lithic data sets such as recovered at the Fitzgerald site. Results are graphed in Figures 4.9 and 4.10.

There are no cores, decortication flakes or notching flakes found in the main kill area. Secondary flakes and shatter are uncommon. Of the 798 pieces of debitage, there are 131 (16%) examples of the former and 14 (2%) of the latter. By weight, there are 132.2 g (60%) of secondary flakes and 27.5 g (12%) of shatter.

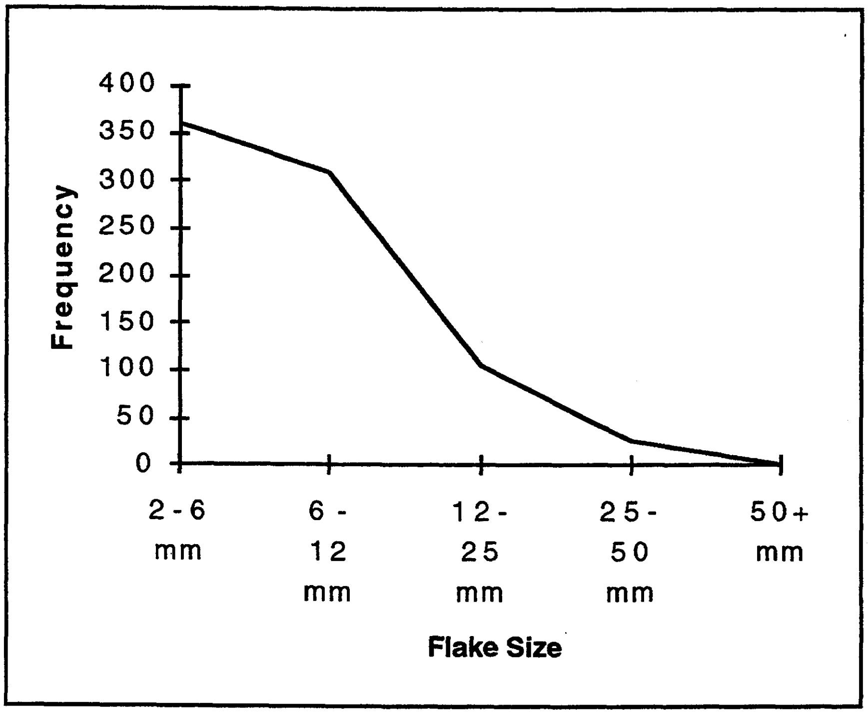


Figure 4.9: Kill Area Debitage Frequency by Size

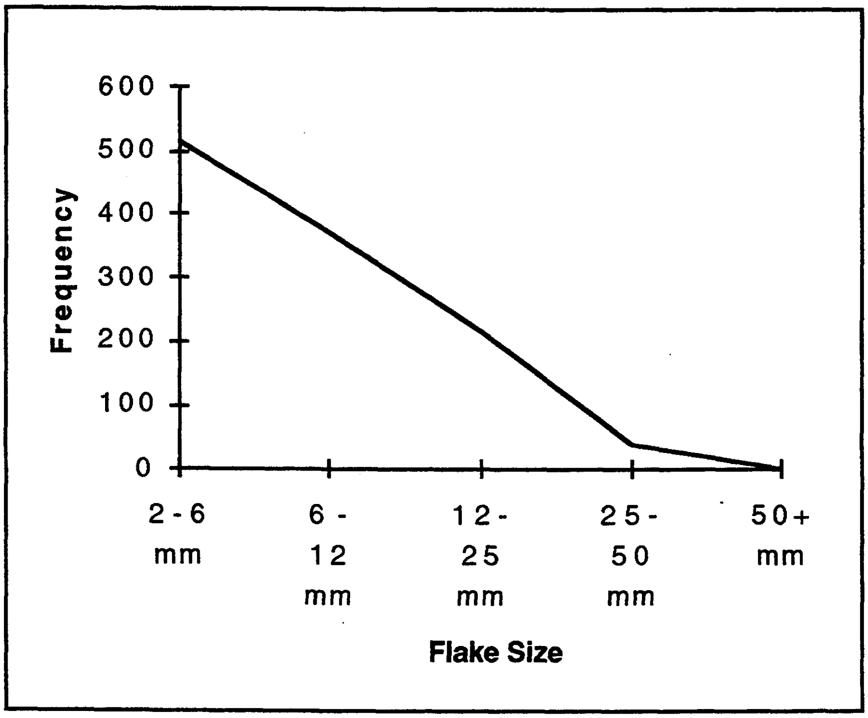


Figure 4.10: Processing Area Debitage Frequency by Size

The debitage from the main kill area is dominated by tertiary flakes. In all there are 359 (45%) retouch/resharpening flakes and 294 (36%) thinning flakes. By weight this debitage is less dominant: 21.7g (10%) are retouch/resharpening flakes and 38.6g (24%) are thinning flakes.

The large amount of tertiary (2-12mm) debitage is not surprising. In a kill area, most work would centre on tool maintenance rather than manufacture. Many of these thinning flakes are likely from the repair and resharpening of the projectile points/knives. The small number of larger secondary flakes and the almost complete absence of cortex (N =23) is typical of "late stage and complex manufacturing processes" (Ahler 1989: 90).

Interestingly, it has been suggested that the Besant people used percussion flaking methods almost exclusively for the creation of tools (Bradley 1993: 395). The large numbers of retouch/resharpening flakes would argue against this scenario. While percussion flaking techniques may have produced many of the tools, tool maintenance was dominated by the more specialized pressure flaking technique.

In the main processing area there were 1144 pieces of debitage weighing some 218 g. This debitage is also dominated by retouch/resharpening flakes and thinning flakes. There are 517 (45%) of the former and 382 (33%) of the latter. By weight there are 35.5g (16%) of retouch/resharpening flakes and 56.3g (26%) of thinning flakes. There is a large number of secondary debitage in this part of the site, some 245 (21%) pieces or by weight 126.2g (58%). No cores, decortication flakes, notching flakes or shatter were recovered.

The Fitzgerald debitage sample is dominated by debitage under 12 mm in size. This is consistent with tool retouch, resharpening and shaping activities. There is almost no evidence of tool manufacturing by-products like cores, primary and secondary decortication flakes, notching flakes or shatter. Only 14 flakes had evidence of cortex.

While there is a relatively large amount of secondary debitage, it is more likely that these items were deliberately manufactured to be used as expedient cutting tools rather than waste flakes from tool manufacture.

4.6 Fire-Cracked Rock

A considerable amount of fire-cracked rock (fcr) was recovered from both the kill and processing area. In the kill area there was a total of 1563 pieces (105.9 kg) of fcr (Table 4.5). All but ten of these fragments were quartzite. Other lithic materials represented include granite, diatomaceous earth and sandstone. Almost 90% of these fragments were less than 2.5 cm in diameter; only 2.5% were over 5 cm in diameter. However, these latter pieces make up 61% of the assemblage by weight.

Table 4.5: Fire-Cracked Rock from the Kill Area (Weight in Grams)

	Diat.Earth		Granite		Quartzite		Total	
	Count	Weight	Count	Weight	Count	Weight	Count	Weigh
2-6 mm	0	0	0	0	170	344.8	170	344.8
6-12 mm	0	0	0	0	924	884.3	924	897.9
12-25 mm	1	12.6	0	0	307	17.5	308	17.5
25-50 mm	3	56.9	3	120.7	115	2730	121	2907
50 + mm	2	263.7	1	447	37	5717	40	6427
Total	6	333.2	4	567.7	1553	9694	1563	10594

There were 322 fcr fragments weighing 4.29 kg recovered from the burned bone portion of the kill area (Table 4.6). If the burned bone area represented a boiling pit dump, it would be expected that there would be considerably more fcr than recovered in the main kill area. An examination of excavation unit volume densities reveals that this was not the case. Discounting the disturbed portion (2 m^2) and the upper southwest portion of the kill where there was little bone or fcr recovered (4 m^2), there were on average 53 pieces of fcr recovered per unit from the burned bone areas and 41 pieces of fcr recovered per unit from the rest of the kill. These differences are too small to be considered significant.

Table 4.6: Fire-Cracked Rock from the Burned Area (Weight in Grams)

	Diat.Earth		Granite		Total	
	Count	Weight	Count	Weight	Count	Weight
6-12 mm	0	0	0	200	200	84.7
12-25 mm	0	0	0	72	72	189.6
25-50 mm	1	5.9	42	34	36	811.9
50 + mm	1	147	447	12	14	3202
Total	2	152.9	489	318	322	4289

Recovered in the processing area were 4675 pieces of fcr weighing 20.17 kg (Tables 4.7). All the fcr from the processing area is composed of quartzite. Again, most of these fragments are under 2.5 cm wide (93%). However, there are 173 fcr fragments per m^2, almost three and a half times more than in the kill. So, while there were no hearth or boiling pit features located in the main excavation block, it is evident that they were in the vicinity. Indeed, a single boiling pit feature was located during the testing program approximately 50 meters southwest of this excavation block.

Table 4.7: Fire-Cracked Rock from the Processing Area (Weight in Grams)

	Quartzite		Total	
	Count	Weight	Count	Weight
6-12 mm	3864	1617	3864	1617
12-25 mm	476	1624	476	1624
25-50 mm	215	4090	215	4090
50 + mm	120	12840	120	12840
Total	4675	20171	4675	20171

4.7 Lithic Materials

Lithic materials were identified by visual inspection; geochemical and petrographic sourcing methods were not attempted. Many archaeologists have been critical of classifying recovered lithic materials to particular quarry sources without proper quantitative analyses. However, almost all the lithics seem to be of a single well documented variety, Knife River Flint, so difficulties normally associated with lithic material identification were for the most part avoided.

Knife River Flint "is a fairly uniform, non-porous, dark brown flint" (Clayton et al. 1970: 287) that is often mottled. As the material is quite vitreous, it makes an "excellent material for tools" (Clayton et al. 1970: 287). It is found in 29 different quarries along the Knife River in Dunn and Mercer counties in North Dakota (Clayton et al. 1970: 282). Smaller secondary deposits have also been found to the north and south in the Missouri River Trench (Gregg 1987: 369).

There were 113 projectile points, 5 formed tools, 37 utilized flakes and 798 pieces of debitage and shatter recovered from the main excavation block. Approximately 97% of the projectile points, 66% of the formed tools, 92% of the utilized flakes and 90% of the debitage and shatter are composed of Knife River Flint. In the processing area, all of the (N=7) of the projectile points, 94% (N=15) of the formed tools, 96% (N=54) of the utilized flakes, and 88% (N=956) of the debitage and shatter are Knife River Flint.

Approximately 10% of the material from the Fitzgerald site is not Knife River Flint. There were ten different materials found in the kill area (Tables 4.8 and 4.9). They include the following exotic materials: fused shale (7), Tongue River Silicified Sediment (2) and obsidian (2). Possible locally available materials include quartzite (40), Swan River Chert (12), chert (9), chalcedony (6), siltstone (2), jasper (1), silicified peat (1) and andesite (1). In the processing area there were the following exotic materials: fused shale (77), obsidian (7) and Tongue River Silicified Sediment (1). Possible locally available materials include quartzite (22), chert (21), chalcedony (3), Swan River Chert (1) and petrified wood (1) (Tables 4.10 an 4.11).

Materials that can be identified to source include fused shale, Tongue River Silicified Sediment and obsidian. Fused shale is defined by the American Geological

Tables 4.8: Exotic Lithics from the Kill Area

	Knife River		Fused Shale		Tongue River		Obsidian		Grand total	
SIZE	Count	Weigh	Count	Weigh	Count	Weigh	Count	Weigh	Count	Weigh
2-6 mm	352	35.4	2	0.2	0	0	0	0	354	35.6
6-12 mm	265	31.5	3	0.3	0	0	2	0.2	270	32
12-25 mm	79	42.7	2	0.3	2	1	0	0	83	44
25-50 mm	19	34.8	0	0	0	0	0	0	19	34.8
50+ mm	0	0	0	0	0	0	0	0	0	0
Grand tota	715	144.4	7	0.8	2	1	2	0.2	726	146.4
% of Kill	89.6	65.67	0.877	0.364	0.251	0.455	0.251	0.091	90.98	66.58

Tables 4.9: Possible Local Lithics from the Kill Area

	Andesite		Chalcedony		Chert		Diat.Earth		Jasper	
SIZE	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight
2-6 mm	0	0	1	0.1	1	0.1	0	0	0	0
6-12 mm	0	0	5	0.8	1	0.5	1	0.1	1	0.1
12-25 mm	0	0	0	0	4	4.9	0	0	0	0
25-50 mm	1	6.9	0	0	3	13.1	0	0	0	0
50+ mm	0	0	0	0	0	0	0	0	0	0
Grand total	1	6.9	6	0.9	9	18.6	1	0.1	1	0.1
% of Kill	0.125	3.138	0.752	0.409	1.128	8.458	0.125	0.045	0.125	0.045
SIZE	Quartzite		Siltstone		Swan River		Grand total			
2-6 mm	Count	Weight	Count	Weight	Count	Weight	Count	Weight		
6-12 mm	1	0.1	0	0	2	0.5	5	0.8		
12-25 mm	22	4.1	1	0.1	7	1.9	38	7.6		
25-50 mm	14	14.5	1	0.6	2	1.7	21	21.7		
50+ mm	3	16	0	0	1	7.8	8	43.8		
Grand total	0	0	0	0	0	0	0	0		
% of Kill	40	34.7	2	0.7	12	11.9	72	73.9		
	5.013	15.78	0.251	0.318	1.504	5.412	9.023	33.61		

	Knife River		Fused Shale		Tongue River		Obsidian		Grand total	
SIZE	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight
2-6 mm	493	49.3	17	2.1	0	0	2	0.2	512	51.6
6-12 mm	304	31	43	5.1	0	0	4	0.4	351	36.5
12-25 mm	176	48.4	17	3	1	0.2	1	0.3	195	51.9
25-50 mm	36	48.7	0	0	0	0	0	0	36	48.7
50+ mm	1	0	0	0	0	0	0	0	1	0
Grand total	1010	177.4	77	10.2	1	0.2	7	0.9	1095	188.7
% of Pro.	88.4	81.413	6.74	4.681	0.09	0.0918	0.61	0.413	95.8	86.599

Table 4.10: Processing Area Exotic Lithic Materials

	Chalcedony		Chert		Petrl.Wood		Quartzite		Swan River		Grand total	
SIZE	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight
2-6 mm	1	0.1	1	0.1	0	0	0	0	0	0	2	0.2
6-12 mm	1	0.1	12	1.2	0	0	10	1.2	0	0	23	2.5
12-25 mm	1	0.4	8	1.8	1	0.8	9	6	1	0.5	21	9.7
25-50 mm	0	0	0	0	0	0	3	17	0	0	3	17
50+ mm	0	0	0	0	0	0	0	0	0	0	0	0
Grand total	3	0.6	21	3.1	1	0.8	22	24.2	1	0.5	49	29.4
% of Pro.	0.26	0.2754	1.84	1.4227	0.09	0.3671	1.92	11.106	0.09	0.2295	4.29	13.492

Table 4.11: Processing Area Possible Locally Available Lithic Materials

Institute as a "hard, dense, siliceous rock having the texture, dull luster, hardness, fracture, or general appearance of unglazed porcelain; it is less hard, dense and vitreous than chert" (in Fredlund 1976: 208). It comes in a variety of colors including black, red, green, yellow and grey (Fredlund 1976: 208); the materials collected from the Fitzgerald site are grey. The closest available sources are in southeastern Saskatchewan near present day Estevan and in south-central Saskatchewan along the Big Muddy (Johnson 1993: 75; Meyer and Beaulieu 1987: 201). Other sources are found in eastern Montana and western North Dakota (Meyer and Beaulieu 1987: 201).

Tongue River Silicified Sediment is located in the Fort Union Formation of southwest North Dakota, northwest South Dakota, eastern Montana, western Iowa and northeast Wyoming, in stream deposits of the Missouri River (Anderson 1978: 149). The material is made up of "angular quartz grains cemented by opal and chalcedony" (Porter 1962: 268). It can be divided into two types "based on color, texture and flaking quality differences" (Ahler 1977: 139). The first type is an opaque, dull, mottled grey of good flaking quality with few fossil inclusions (Ahler 1977: 139). The second type is coarser grained and has plant fossil inclusions and varies in color from yellow-brown to red (Ahler 1977: 139). Anderson hypothesizes that this latter color might be the result of "thermal pretreatment" (Anderson 1978: 150). Without this treatment, the material is extremely difficult to knap (Anderson 1978: 150). The Fitzgerald site materials most closely resemble this latter type.

Obsidian is found in a number of different quarry sources in the Yellowstone Formations of Montana, Wyoming and Idaho. Quarry sources are also known in the Columbia Plateau in Oregon and along the coastal range in British Columbia. While trace element analyses can be completed to identify the exact source of obsidian, these methods were not undertaken in this analysis.

Immediately apparent in the Fitzgerald site collection is the dearth of locally available materials. Accepting that all the materials have been correctly identified to source, it becomes clear that almost all the Fitzgerald site lithic resources could only be collected to the southeast, specifically south-central and south-eastern Saskatchewan and western North Dakota. In the kill area, 99% (N = 112) of the projectile points, 83% (N = 5) of the formed tools, all the utilized flakes and 92% (N = 705) of the debitage and shatter are made from materials that could only be collected from this portion of the Northern Plains. In the processing area, all the projectile points, formed tools, and utilized flakes, and 1063 of the 1087 (97%) pieces of debitage and shatter are also from sources south-east of the site.

4.8 Ceramic Assemblage

Three ceramic shards were recovered in excavation at the Fitzgerald site. These shards were located in both the kill area (SW of unit 89S 82E and SE of unit 91S 85E) and processing area (NW of unit 111S 130E). They are small (6-12 mm) and are made from a gray clay tempered with small amounts of quartzite grit. The surface area has exfoliated so no surface texturing is apparent. The paucity of ceramic shards in the kill area would indicate that it is unlikely that a complete pot was broken at the site. It is more likely that these shards are from a vessel(s) that was only partially broken.

One ceramic piece (artifact number 17202) collected from the processing area (NW of unit 109S 129E) is not from a vessel. The piece is a circular ball of gray clay with a small amount of grit temper. It was likely manufactured by rolling a small piece of clay between the palms of the hand. The surface is smoothed and is undecorated. Its function is unknown; though it is probably nothing more than daub (Corbeil 1990). The presence of daub may indicate that pottery manufacture was undertaken at the Fitzgerald site. Other explanations of its function would include a gaming piece; a decorative piece; a test piece for firing; and a piece for smoothing or decorating a vessel (Corbeil 1990: 44).

4.9 Bone Tools

Because of the generally poor condition of the cortical surface of the faunal elements, it was exceedingly difficult to differentiate between utilized elements and spirally-fractured bone. As a result, only two positively identified bone tools were recognized, a bone needle and a scraper. There were also five faunal decorative items.

Artifact number 1061 is a scraping tool (Figure 4.11). The piece was manufactured from a left metatarsal that had been split longitudinally along the length of the shaft. The distal epiphyseal end was been broken and smoothed into a convex edge. Use wear is not evident because of the poor condition of the bone. The artifact is 176 mm long, 47 mm wide at the base and 25 mm wide at the distal end.

From the SE 1/4 of unit 91S 89E a bone tool of unknown function was recovered (Figure 4.11). The piece is roughly shaped like a tear drop, and is some 110.5 mm long, 37 mm wide and 9 mm thick. The inside edge is concave and polished. The proximal end has been broken near the base. It is possible that the tool might have been used as a spoon.

Artifact number 10549 is the base of a bone "needle" (Figure 4.12) was recovered from NW 1/4 of unit 91S 83E in the kill area. The proximal end of the needle is oval, 12 mm in diameter and 3.8 mm thick; the tool is 36 mm long but the tip has been broken. No evidence of polish, grinding or other forms of use wear are found.

An incised cervid first phalanx (artifact number 10836) was found in the NW 1/4 of unit 91S 85E (Figure 4.12). The piece has been decorated with two quite deeply incised cut marks that form an upside down 'V' on the lateral edge of the body. The phalanx seems to have been hollowed out and likely was a decorative pendant of some sort.

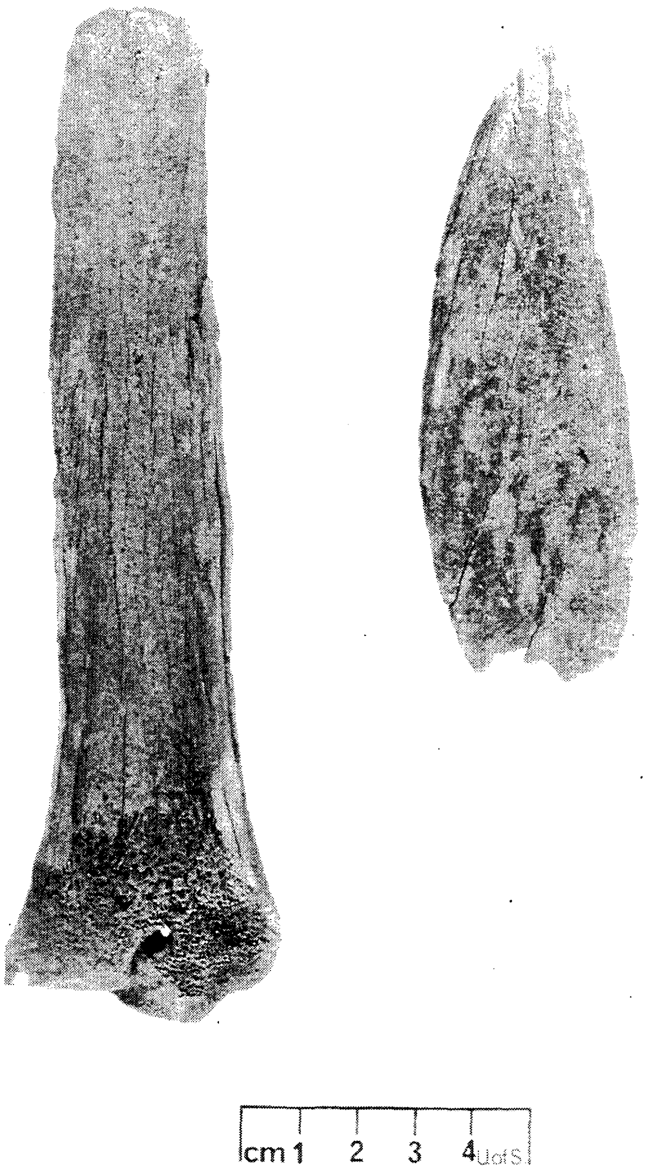


Figure 4.11: Bone Scraper (#1061) and Spoon (?) (#10837) from the Fitzgerald Site

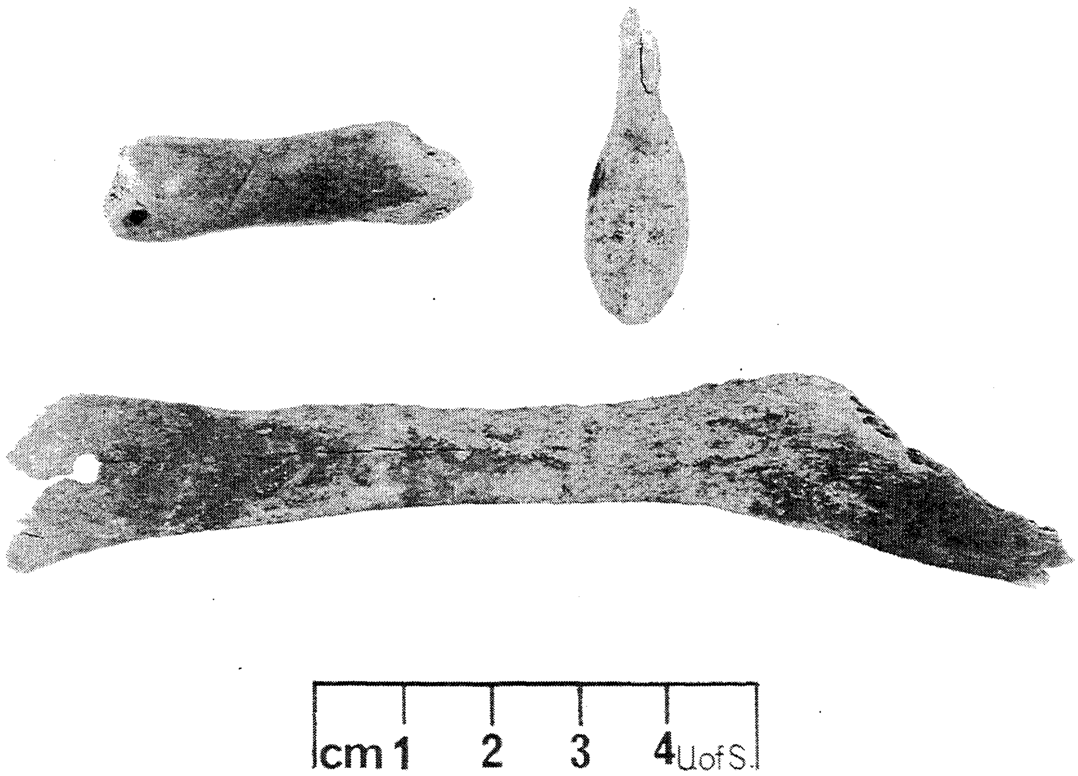


Figure 4.12: Bone Needle (#10549), Modified Hyoid (#9680) and Modified Cervid 1st Phalanx (#10836)

An anterior portion of a right bison hyoid was recovered in the NW 1/4 of 90S 88E (Artifact number 9680) (Figure 4.12). The piece is weathered and has been gnawed by a rodent. A small hole some 3.5 mm in diameter was drilled near the anterior end of the body.

Artifact number 17197 is likely a small broken pendant or gorget. The piece is rectangular with rounded corners. It is 4.3 cm long (broken), 1.2 cm wide and 0.4 cm thick. A .2 cm diameter hole was drilled 0.5 cm from the end of the piece. Polish and striations are visible along the edges of the hole. It was found in the SW 1/4 of unit 106S 129E in the processing area.

Located in the SE 1/4 of unit 106S 129E in the processing area, artifact number 17197 is a ground cylindrical bone element. It is 4.6 cm long and 0.8 cm in diameter. There are two distinct incisions running in a series of circles around one of the ends. The other end has been broken. The piece may have functioned as a gambling piece or some type of decorative or ceremonial item. It is also reminiscent of animal motifs found in the Canadian Arctic.

4.10 Features

Considering the extent of the excavations at the Fitzgerald site, there were relatively few features observed (N = 16). All but two of these features are from the kill area. Identified features fall into three categories: 1) basin-shaped pits, 2) ash stains and 3) post holes and bone uprights (Figure 4.13).

4.10.1 Pit Feature (Feature #2)

A basin-shaped pit filled with bone and fire-cracked rock was first identified during the 1992 testing program (Figure 4.14). It was found on the edge of a small terrace overlooking the main kill area 40 meters to the north. Three square meters of excavation

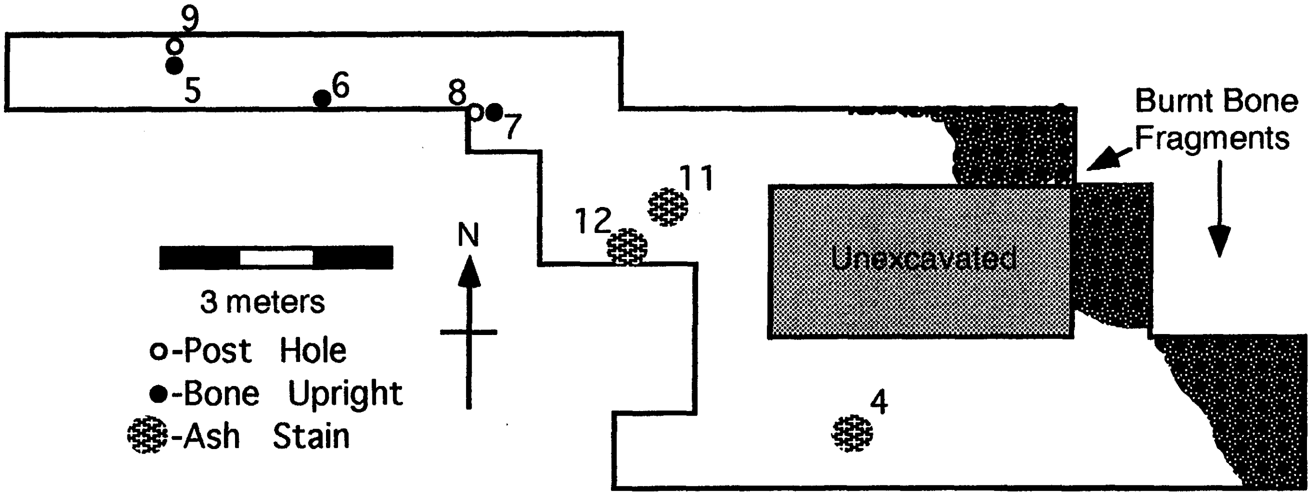


Figure 4.13: Features in Main Kill Area (Numbers Correspond to Feature Numbers)

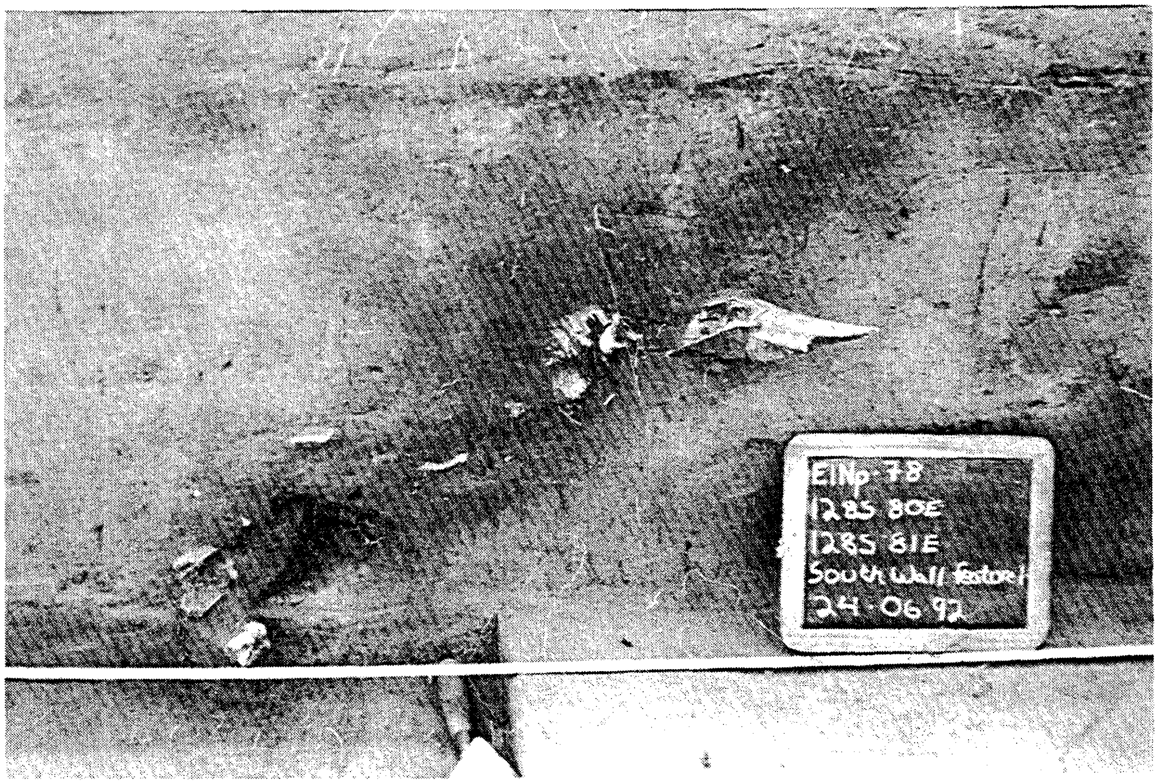


Figure 4.14: Feature 1, The Bone Boiling Pit (South Wall)

were eventually completed centering on this feature (128S 80E, 128S 81E and 129S 80E). Because the paleosol has been disturbed during cultivation, almost no artifacts were located outside the feature itself.

The pit is located approximately 25 cm below the modern ground surface in a disturbed gray-brown paleosol. It is approximately 40 cm deep, 65 x 65 cm across at the surface and 50 x 45 cm wide at the base. By volume, the pit is approximately 7067 cm^3. The north-south profile shows a clear basin-shaped pit (Figure 4.15). The east-west profile (Figure 4.16) is more ambiguous bulging out some 10 to 15 cm. Evidently part of the east wall has collapsed, likely soon after it was originally abandoned.

The lower 20 cm of the pit was filled with a small quantity of unburned bone and fire-cracked rock. Unburned bone included 52 identifiable bison specimens (2.3 kg). The only complete elements were an axis vertebra, an ulnar carpal and three phalanges. Axial

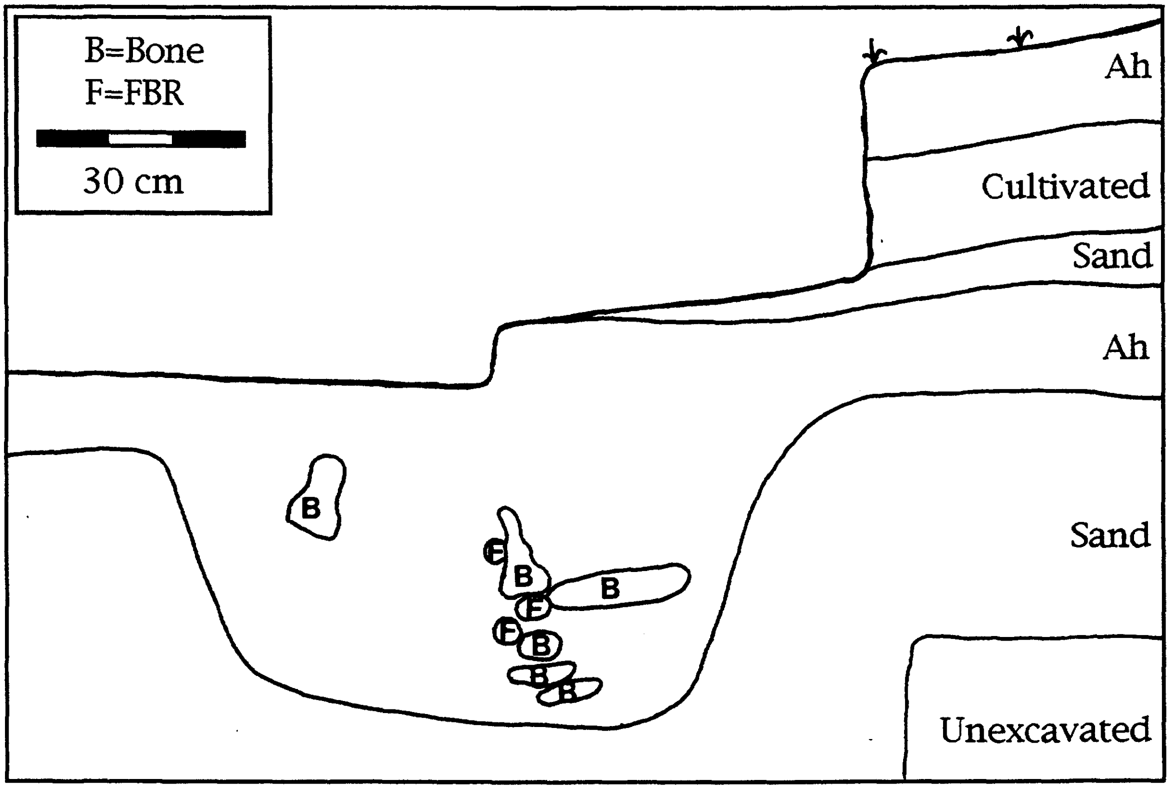


Figure 4.15: Profile of East Wall of Feature 1, The Bone Boiling Pit

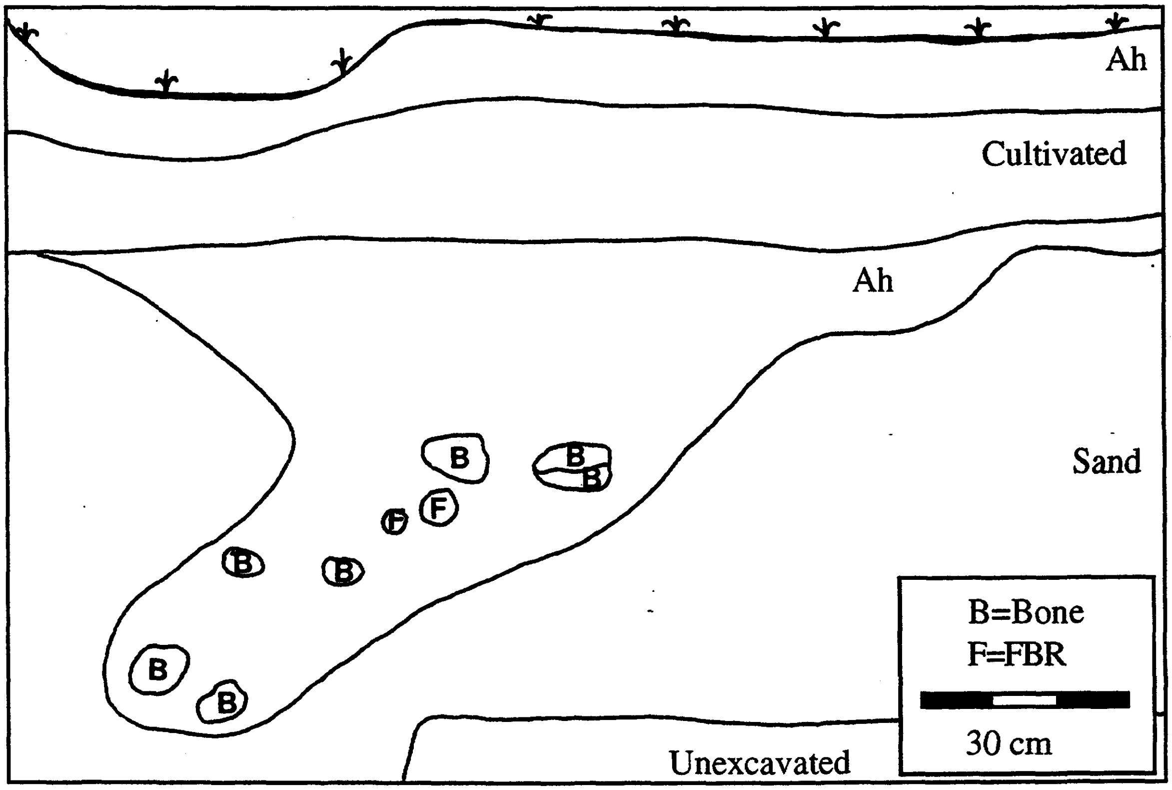


Figure 4.16: Profile of South Wall of Feature 1, The Bone Boiling Pit

elements (NISP = 29) are dominated by rib bodies (N = 5), mandible corpus (N = 3) and thoracic vertebrae spinous processes (N = 3) and vertebral arches (N = 2).

Appendicular elements (NISP = 23) include proximal radius fragments (N=3), scapula blade fragments (N=3) and proximal metatarsals (N=2). Interestingly, little grease is associated with any of these elements (Emerson 1990). If the feature was a boiling pit, it would seem that the cooks were quite indiscriminate in what bone they chose for grease extraction.

There were 50 pieces of quartzite fcr weighing 1662.7 grams. In contrast to the kill and processing area, the fcr is quite large, almost 40% being over 2.5 cm in diameter. No other lithic artifacts were recovered within the pit feature.

4.10.2 Ash and Burn Stains (Feature 4, 11 and 12)

Three small ash and burned soil features were identified in excavation. They include Feature 4 located in the NW 1/4 of unit 91S 84E. An amorphous 3 cm wide band of burned soil was found that is some 51 x 44 cm in area. Burned and calcined bone found within this feature include a left first phalanx, an unidentifiable cranial fragment, an unidentifiable long bone fragment, and six other unidentifiable fragments. Three pieces of quartzite fcr and ten Knife River Flint retouch/resharpening flakes were also recovered within the feature.

Feature 11 is a circle of burned soil some 17 x 9 cm in diameter and 1.5 cm thick. It is located in the NE 1/4 of unit 88S 80E. No cultural materials were associated with this stain.

Feature 12 is found in the SW 1/4 of unit 88S 80E. It is a small ash lens some 7 cm in diameter and 5 cm thick. Identifiable burned materials include the medial portion of a third phalanx, a cervical vertebral arch, a thoracic transverse process and a lumbar post-zygapophysis. Four other burned unidentifiable fragments and a single piece of quartzite fcr were also identified.

These features could have served a number of different functions. They may have served as a smudge pit if the weather was sufficiently warm that the insect population had not yet died off. If the weather was cool, fires may have been lit for warmth. However, it is more likely that they were used to cook portions of the butchered bison for immediate consumption.

4.10.3 Bone Uprights and Post Molds (Features 2, 5, 6, 7, 8, 9 and 16)

There are two main types of post remains, the post mold and the bone upright. Following Munson (1984), the latter feature type can be further divided into three categories: 1) single bone uprights, 2) multi-bone uprights and 3) multi-bone uprights with packed bone. There were two post molds, three single bone uprights, one multi-bone upright, and one multi-bone upright with packed bone identified in excavation. All but one of these features was found in the kill area. Three other possible single bone uprights (features 3, 14 and 15) were eliminated from this analysis because of difficulties in distinguishing between cultural features and rodent disturbance.

Feature 2 is an upright found at 64.25S 59.48E (Figures 4.17 and 4.18). A right metatarsal was found some 5 cm beneath the main bone bed. An unidentifiable cranial fragment, an unidentifiable bone fragment and a white quartzite flake were also recovered near the bottom of the feature. The metatarsal was found in the northwest portion of a 16 cm in diameter gray-stained post hole. The post hole extended to a depth of 27 cm below the bone bed.

Feature 7 is a bone upright comprised of an articulation of an immature right distal femur and a proximal tibia (Figure 4.19). An upright rib is located within the same post hole 2 cm east of the articulation. These elements are centered at 87.12S 79.45E.

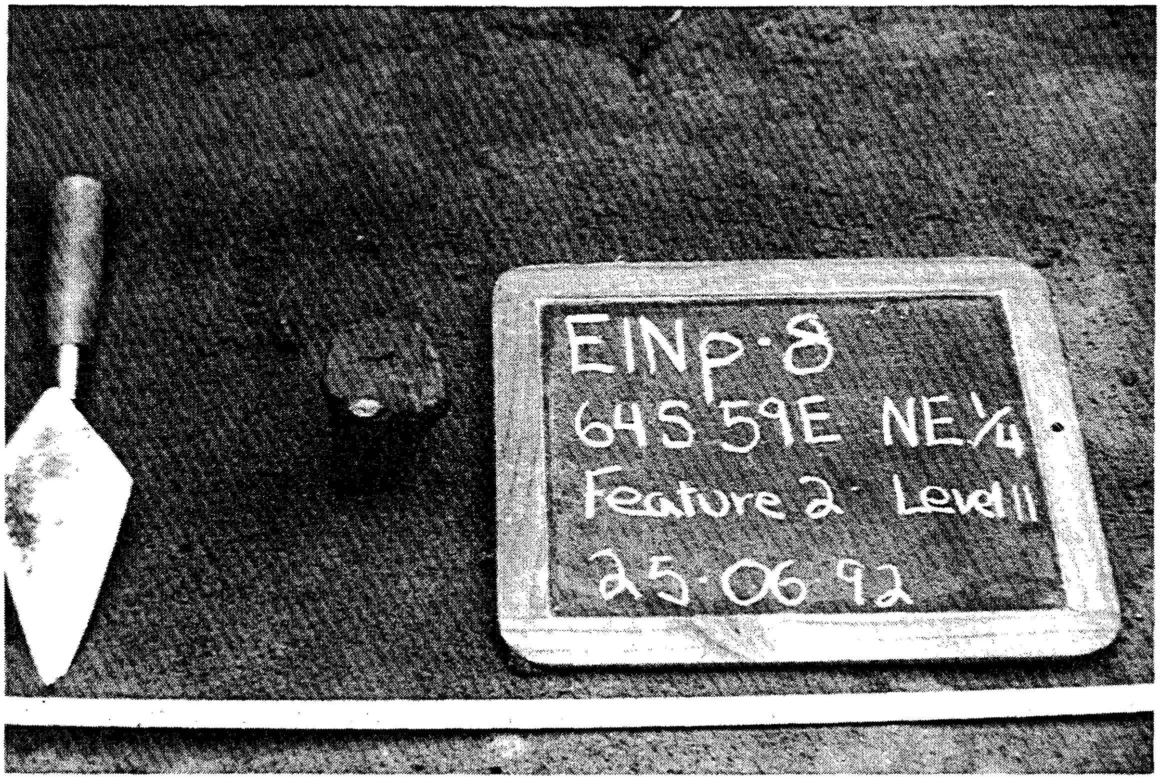


Figure 4.17: Feature 2, Bone Upright

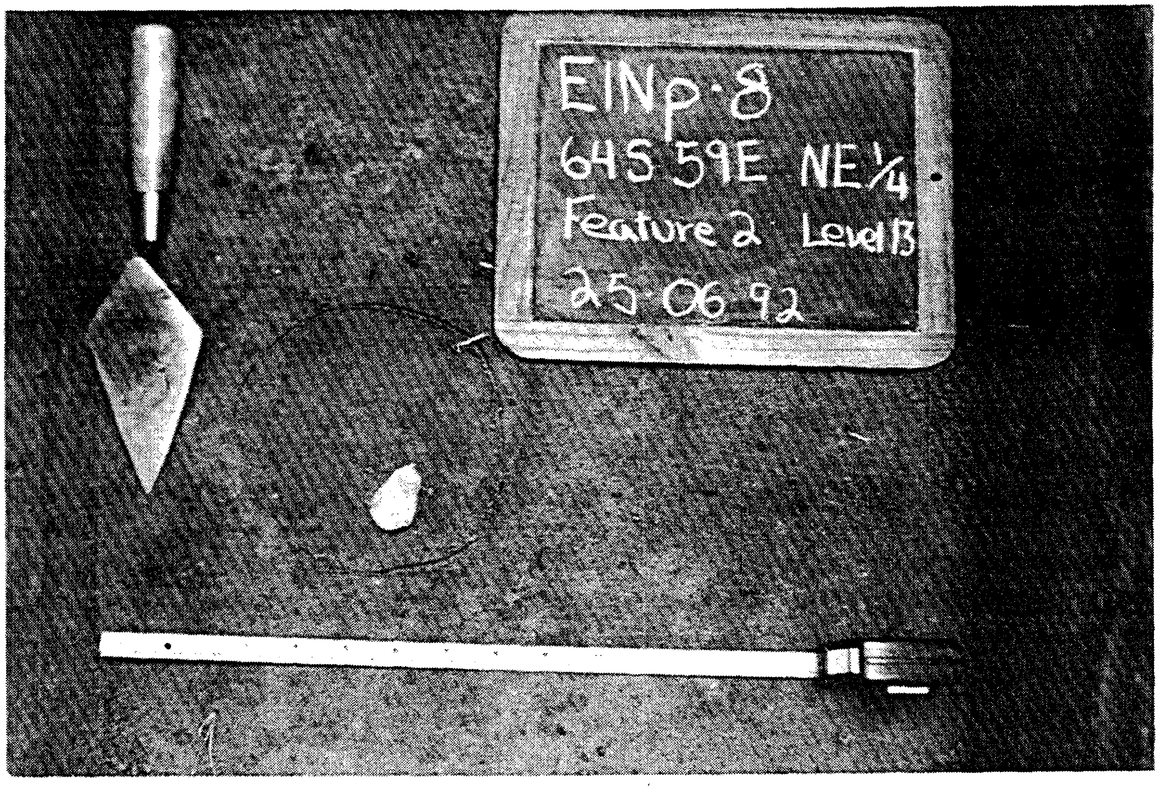


Figure 4.18: Feature 2, The Post Hole After the Removal of the Bone Upright

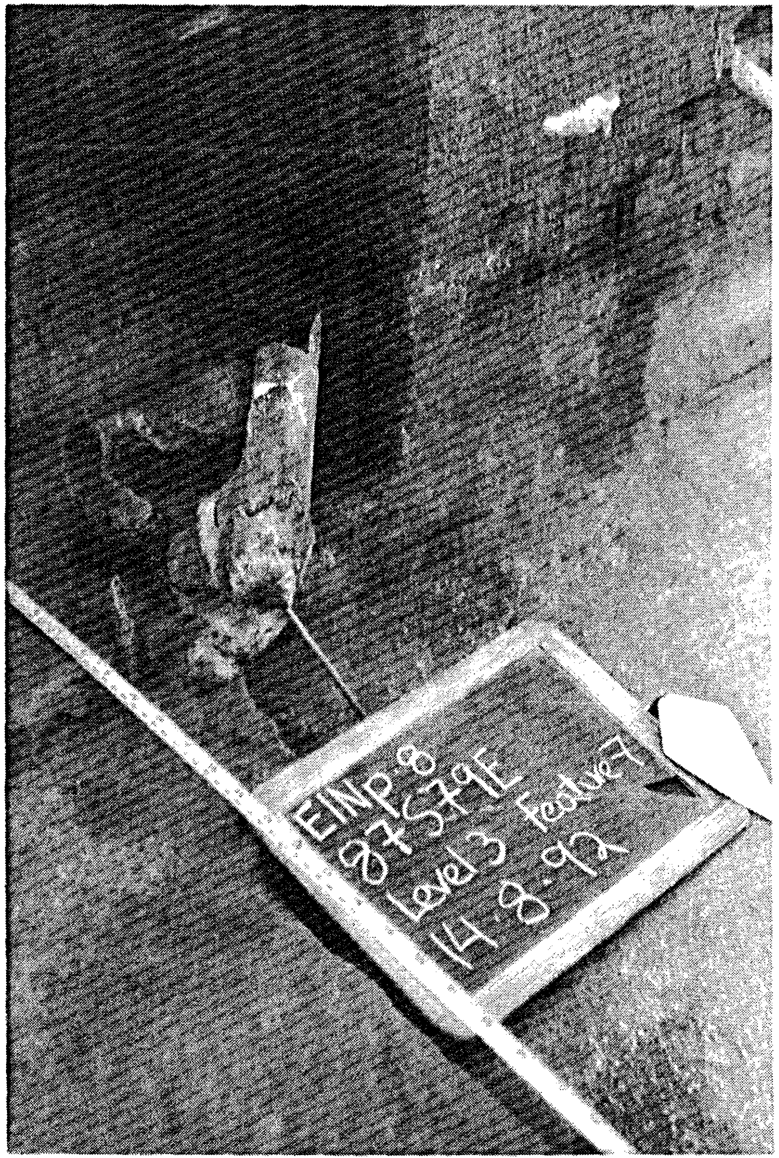


Figure 4.19: Feature 7 and 8, Bone Upright and Post Hole

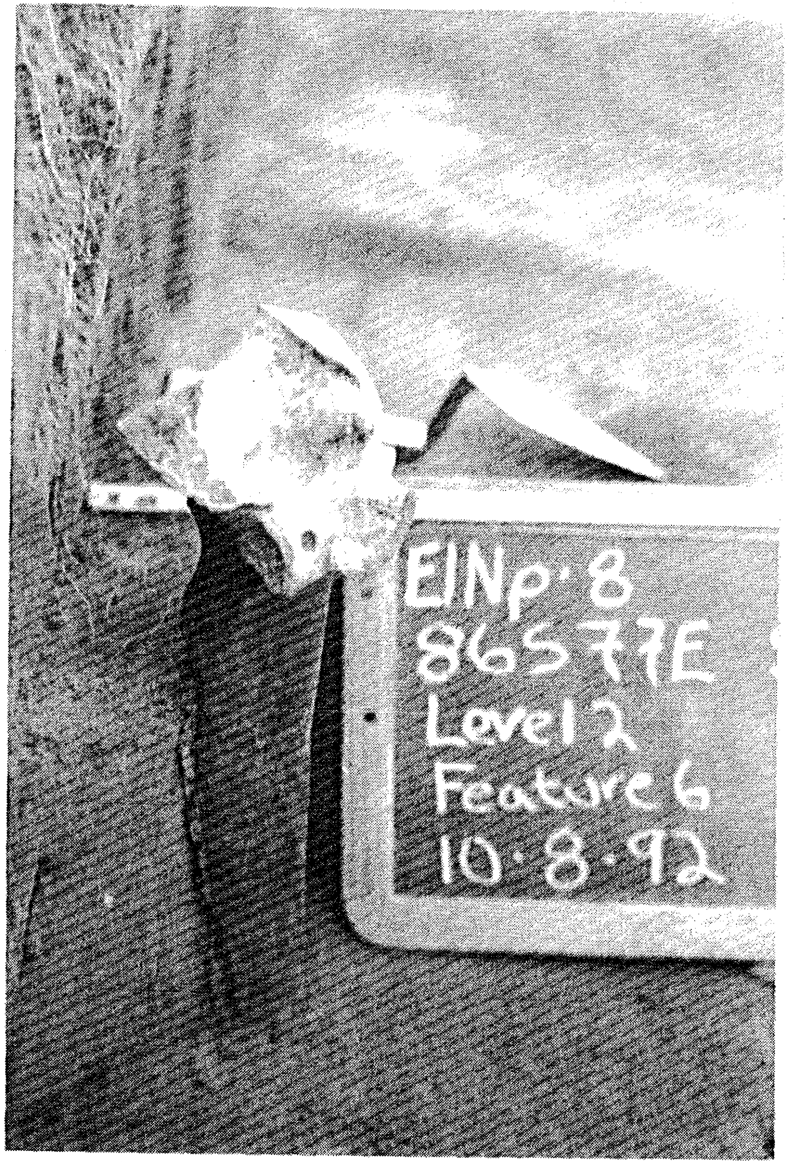


Figure 4.20: Feature 6, Bone Upright

The post hole is 21 cm in diameter at the top, and 6 cm in diameter at the base, 13 cm below the paleosol.

A second post hole (feature 8) was located 8 cm west of feature 7 (Figure 4.19). This post hole is 18 cm wide at the top; 7 cm below the base of the paleosol it is 12.5 cm in diameter. No artifacts are associated with this feature.

Feature 6 is located at 86.99S 78.01E (Figure 4.20). It is a complete thoracic vertebra with the spinous process inserted into a 23 cm deep post hole. The post hole is 10.5 cm in diameter at the top, 7 cm in diameter at the base. It extends 14 cm below the paleosol surface.

Feature 5 is a right distal humerus upright found at 86.37S 76.60E (Figure 4.21). The shaft of the humerus is inserted into a 11 cm in diameter post hole. The post hole is funnel-shaped, the base is 4 cm in diameter at a depth of 11 cm below the paleosol.

Eighteen centimeters north of feature 5 is feature 9, a gray stained-post mold (Figure 4.21). The top of the post mold is 10 cm in diameter and 7 cm in diameter at the base. It extends 11 cm below the paleosol surface. No artifacts were found in the feature.

Feature 16, a multi-bone upright, is found in the processing area in unit 129S 109E (Figure 4.22). This upright is significantly different from those recovered in the kill area. Feature 16 consists of the following faunal elements: a left proximal radius, a right tibia, a right first tarsal, a right immature metatarsal, two complete thoracic vertebrae and a thoracic posterior epiphysis. This bone is tightly packed into the post hole leaving little or no room for any other elements, such as a wooden post, to be inserted inside.

Figure 4.21: Feature 5 and 9, Bone Upright and Post Hole

Figure 4.22: Feature 16, Multiple-Bone Upright

4.11 Discussion

Numerous artifacts and features were identified at the Fitzgerald site. There is an especially large number of Knife River Flint Outlook Side-notched projectile points and pieces of lithic debitage; other formed tools are relatively rare. However, the artifacts and features recovered from the kill and processing areas are exceedingly different. The kill assemblage is dominated by utilized Besant projectile points and small thinning and retouch/resharpening flakes. Features include post molds, bone uprights and ash and burned soil stains. These artifacts and features are consistent with the hypothesis that this portion of the site represents a pound area where the bison underwent primary and secondary processing.

In contrast, the processing site has numerous end and side scrapers, utilized secondary flakes and thinning and retouch/resharpening flakes. Projectile points are rare. Features include a basin-shaped pit and a multi-bone upright with packed bone. These cultural materials would indicate that grease and hide processing were the primary activities undertaken in this portion of the site. Clearly, very different activities were completed in these two areas.

Direct comparisons to other Besant kill and processing areas are possible. The large number of Besant points, utilized flakes and micro-debitage recovered at the Fitzgerald site is typical of Besant kill sites. At the Melhagen (Ramsay 1991), Muhlbach (Gruhn 1971) and Ruby sites (Frison 1971) similarly high numbers of Besant points and tool maintenance flakes were recovered. Only 2% of the 3008 flakes from the Ruby site were tool manufacturing flakes (Frison 1971). Only at the Richards (Hlady 1967; Paulson 1980) and Happy Valley kill sites (Shortt 1993) are there small amounts of debitage. There were only 19 flakes and 24 flakes respectively recovered at these sites.

The corresponding absence of other formed tools, like bifaces, cannot be explained by sampling methods; too large a sample of the site was excavated and too many utilized points were recovered. Their absence is not an anomaly. At the Muhlbach site there were only three bifaces, two end scrapers, a perforator and two cobble hammers (Gruhn 1971). The Richards site had three side scrapers, and a small number of awls, blades, spokeshaves, pecking stones, atlatl weights and a grooved maul (Paulson 1980). The Melhagen site tool kit included a ground stone pestle, a hammerstone and 15 end scrapers (Ramsay 1991). At the Ruby site, two scrapers, seven bifaces, two manos and two hammerstones were recovered (Frison 1971). At the Happy Valley site there were three bifaces, two cobble choppers, four ovate cortical flake choppers, five cobble spalls and one hammerstone (Shortt 1993).

Even though the Wardell site is from a later culture than Besant, because it contained separate kill and processing areas it offers a convenient comparison to the Fitzgerald site. In the Wardell kill area 436 arrow points were recovered. The only other tools were two side-notched bifaces, 29 choppers, 15 hammerstones and large numbers of utilized flakes, each with "a fine, pressure flaked edge" (Frison 1973: 15). In contrast, the processing artifacts included 62 end scrapers, 14 bifaces, 3 choppers and a small number of gravers and drills or borers. Utilized flakes were used as either "cutting, scraping, graving or grooving, and boring, ...combing (possibly vegetable fibers or sinew) and polishing or smoothing" tools (Frison 1973: 57). These cutting tools are thin with one or two sharp edges that are often resharpened. Only 23 points were recovered from this portion of the site. The Fitzgerald site assemblage mirrors that found at the Wardell site.

Following Dyck and Morlan's (1995) typology, all but four of the projectile points are consistent with the Outlook Side-notched variety within the Besant Series. Four points are identified as Bratton Side-notched points. There was no horizontal or vertical separation of the two points at the Fitzgerald site.

Photographs and artifact drawings of projectile points from site reports on other Besant kill sites were examined to determine if these results were consistent with the Fitzgerald site. This form of study is far inferior to actual hands-on analysis and can be criticized for relying on non-quantitative data. As well, often only a representative sample of the projectile point collection is represented in published site reports. However, it was felt that a general picture of point use over time and space could be ascertained from these records. Projectile points were examined from the following kill sites: Melhagen (Ramsay 1991: 332-357), Newo Asiniak (Kelly 1986), Muhlbach (Gruhn 1969: 151-155), Richards (Paulson 1980: 12-16), Happy Valley (Shortt 1993: 48-49), Wahkpa Chu'gn (Davis and Stallcop 1966: 41), Antonsen (Davis and Zeier 1978: 228), Agency (Johnson 1970: 57), Stellings (Shumate 1976: 23-24), Dago Hill (Shumate 1976: 17-18), Ruby (Frison 1971: 82) and Muddy Creek (Frison 1978: 219).

Outlook points would seem to dominate all these assemblages; Bratton points are extremely rare. Possible Bratton points were identified at Melhagen (Ramsay 1991: 332-357, artifacts 674, 876, 10887 and 10890); Newo Asiniak (Kelly 1986); Richards (Paulson 1980: 12-16, specimens 12, 52, 69, 83, 88 and 109 and plate 4, no.4); Happy Valley (Shortt 1993: 48-49, artifact EgPn-290/2); Agency (Johnson 1970: 57, artifact d); Dago Hill (Shumate 1976: 17; artifact h and t); Stellings (Shumate 1976: 24; artifact k); and the Ruby Site (Frison 1971: 82, artifact h). In not one of these sites do Bratton points dominate the assemblage. If one includes the Fitzgerald sample, only 22 Bratton points have been recognized in kill sites on the Northern Plains.

There are no patterns in the use of the Outlook and Bratton projectile points over space and time. The two point styles were both identified in sites from Wyoming (Ruby) to Manitoba (Richards), in contexts ranging in age from 2500 BP (Happy Valley) to 1200 BP (Antonsen), and in assemblages dominated by both Knife River Flint (Fitzgerald) and by local materials (Happy Valley). Coupled with the results from the Sjovold site excavations (Dyck and Morlan 1995), it would seem that these Bratton and Outlook points overlap both temporally and spatially for a period of at least 1300 years.

As a result of this analysis, it is concluded that the separation of the Besant Series points into four distinct projectile point styles (Sandy Creek, Bratton Side-notched, Outlook Side-notched and Samantha Side-notched) was premature. Thus, for the purpose of this thesis the Outlook and Bratton points will be considered as one style called Besant Side-notched. The term Besant Series will continue to be employed as the relationship between Besant Side-notched and other projectile points from this Series like Sandy Creek and Samantha is still under debate.

Thomas (1978: 471) has derived discriminant function analyses to "classify unknown projectile points as either arrow heads or dart tips". This formula is derived from measurements of length, width, thickness and neck width. Only 26 projectile points from the Fitzgerald site were complete enough to conduct these analyses. The results would indicate that 19 of these points are arrowheads, only seven were dart tips (Table 4.12). If the results include only those points where the difference in values is over 0.9, only 12 points can be considered arrowheads and six dart tips.

Similar results were achieved by Dyck and Morlan at the Sjovold site. Of the five Besant points, three were found to be arrowheads and two could not be classified (Dyck and Morlan 1995: 436). Applying these calculations to the Melhagen collection, 11 can be classified as arrowheads, 10 as dart points and 10 could not be classified. Unfortunately, other Besant site projectile point data remain incomplete or unpublished.

Dyck and Morlan (1995: 436-437) have suggested that the age of the bow and arrow "must be greater than previously believed". The results from the Fitzgerald and Melhagen sites would conform to this hypothesis. It would seem that the people were using both atlatl and bow technology to slaughter the bison at these sites. However, the generally large size of the Fitzgerald and Melhagen points makes it difficult to believe that many of them were used as arrowheads. Further evidence comes from the Richards site where an atlatl weight was recovered (Paulson 1980). Thomas (1978) based his analyses on an admittedly small sample of nine atlatl points. It may be best to reserve judgment on this form of analysis until a larger sample of known atlatl points can be tested.

Table 4.12: Discriminant Equation Values and Classificatory Decisions on Measurable Projectile Points From the Fitzgerald Site

CatNo	C-Dart	C-Arrow	Class
674	14.406	15.057	No Decision
876	14.518	15.765	Arrow
1460	14.513	15.091	No Decision
2973	21.901	19.361	Dart
3544	13.97	13.945	No Decision
3588	8.5011	10.386	Arrow
10857	10.14	11.809	Arrow
10858	15.612	14.672	Dart
10860	19.799	17.757	Dart
10861	16.736	17.072	No Decision
10862	10.984	12.838	Arrow
10863	8.8457	11.453	Arrow
10866	16.826	15.47	Dart
10868	23.246	18.878	Dart
10870	21.924	18.913	Dart
10871	13.343	13.981	No Decision
10873	7.9252	10.724	Arrow
10875	15.532	15.436	No Decision
10877	20.109	19.957	No Decision
10881	27.225	21.608	Dart
10885	17.186	17.535	No Decision
10886	11.915	13.551	Arrow
10887	19.396	18.379	Dart
10888	17.675	16.664	Dart
10890	13.606	14.319	No Decision
10892	16.431	15.42	Dart
10893	13.897	13.983	No Decision
10895	11.561	12.994	Arrow
10896	13.759	14.846	Arrow
10897	11.495	12.782	Arrow
10898	11.274	13.148	Arrow

It has been argued that projectile points would not have been used as knives as they are too small and that hafting was designed for penetration not cutting (Frison et al. 1976: 49). Frison (1991: 318) believes that "points are particularly poor for cutting hide, because... they are difficult to sharpen." However, he does acknowledge that larger projectile points "on a foreshaft have potential as skinning and flesh-cutting tools" (Frison 1991: 318).

Use wear would indicate that the Besant points from the Fitzgerald site were used to assist in the butchering process at the Fitzgerald Site. It is likely then that these tools were mounted on foreshafts; after the kill the points could be removed from the atlatl or spear shaft for easier manipulation as knives. The reason the points were also used as knives may be in the lithic materials used by these hunters to make their tools. As Frison (1967: 45) demonstrated at the Piney Creek site, tools made from costly and scarce materials will tend to be used much longer than those from local and easily available resources. Indeed, Christenson (1986: 112) has postulated that "an inverse relationship between population mobility and the frequency of use of multi-function tools might be expected." Where hunters are a long distance from their traditional lithic sources, as those who utilized the Fitzgerald site seemed to have been, the more likely that they will use their tools in non-traditional ways. This would be especially true if they were unfamiliar with local quarry sources. This may explain why all but two of the Fitzgerald site 144 points are made from Knife River Flint.

The Fitzgerald site lithic materials are very similar to those recovered from the Melhagen (Ramsay 1991), Muhlbach (Gruhn 1971) and Richards (Hlady 1967) kill sites, collections that are all dominated by Knife River Flint. Approximately 99% of the Fitzgerald points, 96% of the Richards points (Hlady 1967; Paulson 1980), 87% of the Muhlbach points (Gruhn 1971), and about 70% of the Melhagen points (Ramsay 1991) are made from Knife River Flint. Obviously, there must be some sort of association between these sites located on the Canadian plains and the Middle Missouri River region to the southeast. In addressing the relationship between these two regions, it must be asked how these materials from the Missouri River region moved northwards.

There are at least three explanations for how Knife River Flint entered Canadian Plains sites. First, it could have been moved into the region through a trade network linking groups neighboring the quarries to those living further north and west. Hayden (1982: 119) has concluded that projectile points uniformity may be the result of a need to maintain long-distance interaction networks. This may explain why the Besant projectile point remained similar over such a large geographical area.

A second explanation is that Knife River Flint was carried on to the Canadian Plains by groups visiting the quarries directly and then returning north. As a result, the "amount or degree of reuse of Knife River flint tools may be a reflection of the group's physical proximity to the quarries" (Ramsay 1991: 90-91). The longer the group stayed away from the quarries, the more they would have to rely on locally available materials. It would be expected that groups that had just returned from this region would have unusually high amounts of Knife River Flint. This latter situation is analogous to the Fitzgerald site and other kill sites like Richards, Melhagen and Muhlbach. Sites like Walter Felt and Kenney with moderate amounts of Knife River Flint would be the result of a considerable time being spent away from the quarry sites.

A third explanation may be that sites like Fitzgerald are the result of people from the quarry region moving onto the Canadian Plains to hunt (Duke 1991: 94; Vickers 1994). This hypothesis would suggest a stronger relationship between the western Knife River flint dominated sites and the Missouri River mound builders than even Syms (1977) suggests.

Knife River Flint has been documented in Northern Plains sites as far as back as 10,000 years ago. Almost all pre-contact cultural groups who occupied the Northern Plains made some use of this material (Fawcett 1987: 415-419). That Knife River Flint is found in what Syms (1977) would term Besant Complex sites like Old Women's, Long Creek and Mortlach in low frequencies should not then be surprising. These sites with small percentages of Knife River Flint likely represent people who had little direct contact with the Knife River quarries. Like previous cultures on the Northern Plains, they probably received this material through trade. This pattern demonstrates a use similar to many other camp and kill sites from earlier and later complexes. Knife River Flint is an excellent stone for tool manufacture and as a result would be coveted by knappers from any era.

In contrast, the complete domination of some lithic assemblages by Knife River Flint is unique to the Besant Period. Few other sites on the Canadian Plains outside of the area surrounding the quarries approach the levels of this material found at the Fitzgerald, Melhagen, Muhlbach and Richards sites. Almost all lithic artifacts from the Fitzgerald site (nearly 94% in the kill and 99% in the processing area) are from the south and southeast, including fused shale (south-central and southeast Saskatchewan), Knife River Flint (North Dakota) and Tongue River Silicified Sediment (South Dakota).

The situation may be analogous to that seen in the relationship between Besant sites on the Middle Missouri and cultures to the east like Laurel, Howard Lake and Hopewell. Clark's (1984) analysis of the frequency of Knife River Flint in these sites has found that the greater the distance these cultures are from the quarries, the less likely they are to have this material. As the distance from the quarries increased, there would be a corresponding decrease in the amount of waste debitage. So while, 80% of the lithic assemblage in Middle Missouri sites would be made from Knife River Flint, only between 12.8 and 18% of the nearby Laurel assemblages and 2.3% of the further east

Howard Lake Focus sites are composed of this material. In Hopewell sites this lithic is usually only found in burial mounds in the form of large non-utilitarian bifaces; there is little or no Knife River Flint debitage or ordinary tools. The rarity of Knife River Flint in the Hopewell sites is probably the result "of small transactions over a long period of time" with the result that this material attained great prestige (Clark 1984: 185).

The complete domination of a lithic assemblage by Knife River Flint is likely the result of what Clark (1984: 185) has called "internal trade". Sites like Fitzgerald, Melhagen, Richards and Muhlbach which contain similar frequencies of Knife River Flint to the Middle Missouri Besant sites are likely receiving this stone through this form of trade. These are people from the North Dakota region.

Knife River Flint use during Besant was probably not purely functional; it is likely that it held some sort of ideological significance to the people. Almost all the Besant sites with large amounts of this material are communal bison kills, activities known from the historic period to have strong spiritual aspects. Knife River Flint might somehow have acted to bond dispersed bands of people; a situation analogous to lithic use among Australian Aborigines who associate particular lithics with particular regions. (Duke 1991: 168). The domination of Knife River Flint might indicate that these people had strong ties to the Middle Missouri River region.

In conclusion, it seems improbable that these were people who had just visited these quarries from a home base in the vicinity of the Fitzgerald site. Rather, it is argued that the reverse is true, this was a group from present day North Dakota hunting on the northern edge of the Plains. It is believed that sites like Fitzgerald, Melhagen, Muhlbach and Richards represent people from the Middle Missouri River moving onto the Northern Plains to hunt bison communally. The reasons for venturing north will be discussed in the following chapters.

Considerable debate still exists about the use of the post holes that have been so far identified at archaeological sites on the Plains. Reeves (1983a) has called the presence of post holes and bone uprights one of the defining characteristics of Besant. Besant sites with post holes and/or bone uprights include the kill, processing and camp site types. Included in the former are the Fitzgerald, Melhagen (Ramsay 1990), Muhlbach (Gruhn 1972), Wahkpa Chu'gn (Davis and Zeier 1966), Ruby (Frison 1971), Muddy Creek (Frison 1991), Leavitt and Malta Kills (Reeves 1983a). Processing sites with these features include the Fitzgerald, Steltzer (Neuman 1975) and Naze (Gregg 1985) sites. Finally, there are the Avery, Kenney, Burns Ranch (Reeves 1983b), Steltzer and Porcupine Creek camp sites (Neuman 1975) and the Mortlach (Wettlauffer 1955), Ruby (Frison 1971) and LaRoche (Hoffman 1968) sites which have post holes which are presumably associated with some sort of structure.

Interpretations of the function of postholes and bone uprights are numerous. Initial research by Neuman (1975) at the Steltzer site in North Dakota concluded that the numerous bone uprights at this site were anvils. This theory was supported by Gruhn (1972) from her work at the Muhlbach site. However, evidence supporting this hypothesis is tenuous at best. For instance, there is no evidence of the pounding on the proximal or distal ends of any of the bones recovered from the Steltzer, Muhlbach or Fitzgerald site uprights. Neither is there any lithic debitage surrounding these features. Neuman (1975) suggests that hides wrapped around the end and base of the bone might have protected the feature from fracture while removing any evidence of lithic reduction from the area.

Post holes from the LaRoche, Ruby and Mortlach sites have been interpreted as the archaeological remains of post-in-ground dwellings. There can be no doubt that the well-preserved post molds from the LaRoche site represent a house structure (Hoffman 1968). Frison's (1971) interpretation of the small structure at the Ruby site as a building associated with shamanic activity is also reasonable. Applying this interpretation to the Mortlach site materials is more tenuous. First, the small sample of the feature makes is difficult to extrapolate the original diameter of the structure. However, it seems clear that the arc is significantly wider than one would expect for a house structure. The "many fragments of split bone" that Wettlauffer (1955) reports are also inconsistent with a house structure. It may be possible that this feature represents a pound structure.

Another hypothesis of the function of bone uprights is that they were used as tie down stakes. Munson (1984) first hypothesized that the features served as tipi anchors or pegs. Brink and Dawe (1985) conclude that the bone uprights located at Head-Smashed-In Buffalo Jump were tie down stakes for tipi lines. This hypothesis was reached after consideration of the fact that they were located some distance from the jump itself and were never found in any linear relationship. They later hypothesize that they may have been used as tie down stakes for hides, boiling pit covers or horses (Brink and Dawe 1988). A reasonable extension of the latter idea would be a tie down stake for dogs. Indeed, Wissler notes that they were usually "tied up" and muzzled to prevent them from barking during the hunt (Verbicky-Todd 1984: 60).

Numerous interpretations of bone uprights have focused on their use as supports for corral fence posts. The relationship of post holes at the Ruby (Frison 1971), Jots (Dale Russell, personal communication 1994) and Tschetter kill sites (Linnamae 1988) are consistent with the historic and ethnographic accounts of corral structure. As the bone uprights and post holes from the kill area at the Fitzgerald site are almost identical in size and positioning to these sites and to the historic and ethnographic accounts, it seems reasonable to conclude that they represent the archaeological remains of a corral structure.

The archaeological record indicates that corrals were made a number of different ways. However, the great size of these features makes it very difficult to test empirically the information provided by the historic explorers and ethnographers. As the Ruby site in Wyoming is the only fully excavated pound structure that has so far been published, little research has focused on the actual construction of these features. This has resulted in quite a bit of supposition by archaeologists about their use. The following will attempt to reconcile the differences between the archaeological, historical and ethnographic literature regarding pound structure.

Pounds could be built on four types of terrain; 1) on or at the base of a slope; 2) on level ground; 3) beneath a precipice high enough to keep the bison from leaping back out of the corral or 4) between two hills where the valley would act as a natural funnel (Verbicky-Todd 1984: 37). There is evidence that some tribes would only use one of these types. For instance, Wissler and Grinnell state that the Blackfoot usually used the third method (Verbicky-Todd 1984: 59).

Ethnographic and historic accounts of pound structure are fairly consistent. It would seem from both these sources that pounds were for the most part circular (Verbicky-Todd 1984), though instances of square or rectangular enclosures are known (Jenness 1938: 16). Pounds varied in width from 10 to 50m in diameter (Verbicky-Todd 1984). The size of the band and the number of bison the hunters believed they could kill would determine the size of the corral (Verbicky-Todd 1984: 75 and 84). While this is never mentioned in accounts, width would likely be limited also by the availability of suitable construction materials and the local topography.

While the overall structure of the pound seems somewhat consistent, construction practices seems to have varied greatly. Saying that, all accounts agree that the most important construction habit was to build a pound that looked strong and sturdy. As Grinnell states, it "could be only an enclosure made of a fence of bush, but even here the bison did not push against it" unless they could see through it (Verbicky-Todd 1984: 40).

As was stated earlier in this chapter, archaeology has added little to our understanding of corral structure and construction methods. Using the ethnographic and historic evidence, corral construction techniques can be reconstructed. The only firm evidence of the width and size of these structures comes from Wyoming where Frison (1971, 1991) has fully excavated two Besant phase pounds, the Muddy Creek and Ruby Sites. He estimates both to be around 13m in circumference. This is comparatively small when compared to historical and ethnographic accounts. However, there is not yet enough evidence to determine if pounds were smaller in the prehistoric period or if the historical and ethnographic observations are exaggerated.

Two types of corral structures can be identified in the archaeological record. The first employs a single line of post holes. This most likely represents a post in ground fence structure. Either long poles could be tied to, or willows woven between, these fence posts. For instance, Blackfoot corrals were constructed from "cottonwood posts set upright into the ground to a height of about 7 feet, and connected by cross poles of cottonwood and birch tied to the posts with rawhide ropes (Ewers 1968: 166).

The second variety consists of a line of twinned post molds. Sites like Fitzgerald and Ruby have post molds located in pairs only 5 to 10 centimeters apart. Frison (1991: 214) has suggested a corral structure based on overlapping poles. This would result in an extremely strong structure similar to those used by modern ranchers. However, no historic or ethnographic accounts exist of this type of construction technique. Most witnesses specifically comment on the fact that the corrals they saw were quite fragile.

Most excavated pounds have a larger number of post molds than is reasonable in a fence structure. This can be interpreted in one of three ways. First, these extra post holes might be the result of repair events. It is known historically and ethnographically that pounds once constructed would be used repeatedly. It is inevitable with the large numbers of people and bison involved that the pound structure would have to be repaired after every successful hunt or a season of disuse. Another explanation for these extra post molds comes from Ewers' (1968: 166). account of the use of impaling stakes. A third explanation might be that these extra molds were used to hold flags and even hides to keep the bison from escaping the confines of the enclosure. Rollans (1987) has argued that the small cairns that make up the drive lanes at Head-Smashed-In Buffalo Jump were used to hold a pole with a flag attached to the end. It is hypothesized that these "dead men" would help distract the bison and keep them from wandering off course. Neech-a-moose's (Verbicky-Todd 1984: 39) account would argue that this technique was also applied in corrals. It is easy to see how these different accessories could change the archaeological remains of corral structures. They offer a plausible explanation as to why certain post holes do not seem to "fit" the fence lines that have been reconstructed.

Interestingly, there seem to be no superfluous post molds at the Fitzgerald site. This would argue against the use of secondary posts. It is also unlikely that the corral underwent many major repairs during its lifetime. This would argue for the hypothesis that the pound was used over a relatively short time.

4.12 Conclusion

In conclusion, the Fitzgerald site is a Besant Series site dominated by Besant Side-notched projectile points and the lithic material Knife River Flint. Analysis of the collected artifacts and features would indicate that kill and processing activities were undertaken in different portions of the site. The kill area is dominated by utilized projectile points, the processing area by scrapers and utilized flakes. The lithic material collection argues that the Fitzgerald hunters are from the Knife River region in North Dakota. To assist in their hunt, they constructed what was likely quite a large pound using twinned post holes to create a cross-post pattern.

It is possible that pound structure could be used as a diagnostic in the future. For example, the only description we have of a Sarsi pound indicates that it was square instead of round. Realizing the difficulties inherent in excavating such large features, it is still recommended that more work in the future be concentrated on identifying the pound structures themselves.

Chapter 5

Quantitative Methods

5.1 Introduction

Since the 1950's, archaeologists have used a series of different counting methods to interpret their faunal data. These calculations are used to formulate how many animals are represented at a site. As archaeologists sought to understand how people once utilized the bison, these methods became increasingly sophisticated. Techniques were developed that not only asked how many bison were being killed and butchered, but what portions of the animals were being used. Explanations could then be formulated to answer questions about why particular elements were found in substantial numbers while others were not. This chapter presents the results of a series of analyses to determine how the hunters at the Fitzgerald site used and manipulated the herds that they captured 1300 years ago.

5.2 Faunal Counts

5.2.1) Numbers of Identified Specimens (NISP)

One of the most basic and frequently encountered quantifying units in archaeology is the number of identified specimens (NISP). From this simple count almost all other equations that determine the size and structure of a faunal assemblage are derived. For instance, it is used to identify minimum numbers of elements (MNE), minimum number of individuals (MNI) and minimum animal units (MAU). In turn these counts are compared to utility indices that analyze hunting, butchering and taphonomic patterns in the assemblage.

NISP is the sum total of identified faunal specimens per taxon from an archaeological assemblage. A specimen is defined as a "bone or tooth, or fragment thereof" (Grayson 1984: 16). NISP accounts for the relative abundance of one taxon or element over another. It is useful in that it inventories the size of the assemblage and produces a general count of the number of specimens that exist for each taxon and faunal element. Implied in this count is that taxon and element abundance and utilization can be accounted for.

Numerous difficulties have been encountered in the application of NISP derived counts. These problems have been well documented by other researchers (Grayson 1984), but are still worth examining here briefly. As the Fitzgerald assemblage is completely dominated by a single species, it is only affected by a small, but relevant, number of these issues.

The largest concern with relying on NISP is the effect that differential butchering and taphonomic patterns will have on the count. These problems have mainly to do with interdependence. Does the NISP count contain 100 bones from a single individual or one bone from each of 100 individuals. NISP counts do not reveal the number of animals or elements that might be represented at the site. Certain cultural practices like pemmican production result in particular elements being highly fragmented, resulting in very large NISP counts. In cases where the element becomes so fragmented as to be unidentifiable, this can produce low NISP counts.

Another potential form of cultural bias is known as the Schlepp effect. Particular taxa might be butchered on site, while other animals may be removed entirely from the kill area. The result is that those animals left behind will dominate the assemblage and resulting NISP count. This phenomenon might explain why there is an almost complete absence of new born calves in bison kill sites (Driver 1983).

Similar to this problem is the effect that element size will have on NISP counts. Larger elements are more likely to be broken into a greater number of recognizable fragments than smaller elements.

5.2.2) Minimum Number of Individuals (MNI)

One of the most frequently cited counts in archaeology is the minimum number of individuals (MNI). To formulate the MNI, "separate the most abundant element of the species found... into right and left components and use the greater number as the unit of calculation" (White 1953: 397). Information on the age and sex of the faunal elements can be used to increase this number. Suggestions that size can also be employed to increase MNI counts has been found to be problematic and for the most part judgmental (Klein and Cruz-Uribe 1984: 27).

MNI is superior to NISP in that the difficulty associated with interdependence is accounted for. However, there are other problems that are specific to MNI counts, the most critical being aggregation. Archaeologists commonly divide the assemblage into separate analytical units based on vertical and horizontal distribution, excavation block or identified activity areas. When an assemblage is sub-divided the MNI will likely increase, especially if the element is well distributed throughout the site.

This is a problem very relevant to the treatment of the Fitzgerald assemblage. Five separate excavation blocks are under study. Separating these blocks into contiguous units results in a larger MNI on certain elements than treating the assemblage as a whole.

MNI has also been demonstrated to be partly the function of sample size (Grayson 1984). Other processes that will unavoidably affect the assemblage include excavation strategy (e.g. screen size) and identification expertise.

MNI is often extrapolated to account for all the animals that are in the complete site. Theoretically, if ten percent of the site has been excavated, an MNI count of 50 could mean that the overall MNI of the site is about 500 (10% of 500 = 50). This argument assumes that the size of the site is known and that elements are equally distributed across its breadth.

5.2.3) Minimum Number of Elements (MNE)

Similar to MNI is the count of minimum number of elements (MNE). MNE is the sum of the number of individual elements per taxon irrespective of body side. An element is defined as a complete bone or tooth (Grayson 1984: 38). Proximal and distal long bone ends are traditionally recorded as separate elements if they are over 75% complete.

MNE counts are affected by the same biases as MNI counts (e.g. aggregation). It will also mask differences in use by side. For these reasons, it is most useful when distinguishing between right and left elements becomes difficult.

5.2.4) Minimum Number of Animal Units (MAU)

The minimum number of animal units (MAU) is arrived at by "dividing the observed bone count for a given identification unit by the number of bones in the anatomy of a complete animal for that unit" (Binford 1984: 51). Where there are 50 left and 25 right radii, the MNI would be 50 (50 left radii) while the MAU would be 37.5 {(50 + 25) / 2}. To standardize this count (%MAU), Binford divides each element by the largest derived MAU count and then multiplies by 100.

Unlike MNI counts, Binford's MAU count examines faunal elements without regard to side. MAU counts emphasize the number of faunal elements discarded at a site, something traditional MNI counts would tend to mask. However, if there is variance in use by side, MAU would mask these differences (Klein and Cruz-Uribe 1984: 57). Binford developed this formula to reflect the number of consumption units that might be introduced into, or removed from a particular activity area.

5.2.5) Analysis

Each of these four counts (NISP, MNI, MNE, MAU) was applied to the Fitzgerald site materials. In total, 11,287 identifiable specimens were recovered from the Fitzgerald site. By weight, there was 492,818 grams of identifiable bone. The MNI for the complete assemblage is 49 and is based on the left anterior fused central and fourth tarsal.

The exact size of the site is unknown as testing could not be completed in the north-east section of the Fitzgerald site. As well, excavations were concentrated on the periphery of the kill. Not knowing the extent of the faunal resources makes it difficult to produce with certainty an accurate MNI for the complete site area. But assuming 5% of the kill site was excavated, an MNI of about 800 animals for the complete site seems reasonable.

As stated in chapter 3, three separate activity areas are hypothesized to exist at the Fitzgerald site. They include the kill area, the processing area and the burned bone area. It is believed that a thorough analysis of the above noted counts can be used to test the validity of these distinctions. To this end, each of these three activity areas is treated as a separate unit; independent NISP, MNI, MNE and MAU values are provided for each area. The results are summarized in Table 5.1.

The danger in separating the assemblage into three separate activity areas is that this will inflate the MNI and MAU counts. As an example, the MNI on proximal radius is 22. By subdividing the catalogue, this same element has an MNI of 21 in kill area, five in processing area and two in burned bone area. Sub-dividing the site into just three areas has resulted in a nearly 30% increase in MNI.

While sub-dividing the catalogue does bias MNI and MAU counts, these actions were deemed critical for analysis. The justification for these actions is two fold. First, the hypothesis that separate activities were undertaken in these different locales could only be tested by sub-dividing the catalogue. Second, it is possible that each of these activity areas represents different cultural events, or even different occupations. By distinguishing

	UNBURNT KILL							ALL PROCESSING							KILL BURNT						
	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP
Skull	640	71	37	35.5	90.24	98.61	24271	46	8	6	4	37.5	57.14	794.3	92	7	4	3.5	50	43.75	448.9
U PM2	46	46	25	23	60.98	56.1	463	39	6	5	3	62.5	42.86	125	6	6	3	3	37.5	42.86	54
U PM3/4	90	92	23	23	56.1	56.1	884	0	0	0	0	0	0	0	11	9	5	2.3	62.5	32.14	189
U M1/2	69	63	16	15.8	39.02	38.41	2188	7	7	4	1.75	50	25	225.9	6	5	3	1.3	37.5	17.86	211
U M3	3	3	2	1.5	4.878	3.659	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mandible	23	23	13	11.5	31.71	31.94	14274	1	1	1	0.5	12.5	7.143	279.3	0	0	0	0	0	0	0
A Mandible	95	31	16	15.5	39.02	43.06	3220.3	24	10	7	5	87.5	71.43	884.4	40	10	8	5	100	62.5	392.7
P Mandible	85	19	11	9.5	26.83	26.39	8613.8	57	6	5	3	62.5	42.86	4567	29	4	4	2	50	25	294.1
Incisor	234	216	27	27	65.85	65.85	363	39	28	4	3.5	50	50	58.1	50	40	5	5	62.5	71.43	56
L PM2	51	48	24	24	58.54	58.54	105	5	5	5	2.5	62.5	35.71	3.3	0	0	0	0	0	0	0
L P3/4	38	38	12	9.5	29.27	23.17	183	5	5	3	1.25	37.5	17.86	6.7	13	13	7	3.3	87.5	46.43	60
L M1/2	19	19	6	4.75	14.63	11.59	352	2	2	1	0.5	12.5	7.143	41.7	6	6	3	1.5	37.5	21.43	135
L M3	7	7	6	3.5	14.63	8.537	340	1	1	1	0.5	12.5	7.143	51	1	1	1	0.5	12.5	7.143	65
Hyoid	54	17	9	8.5	21.95	23.61	244.8	2	2	1	1	12.5	14.29	4.6	3	1	1	0.5	12.5	6.25	6.3
Atlas	31	20	20	20	48.78	55.56	4883.9	3	2	3	2	37.5	28.57	471.8	16	8	8	8	100	100	199
Axis	31	22	22	22	53.66	61.11	5785.7	2	2	2	2	12.5	28.57	414.4	4	3	3	3	37.5	37.5	77.9
Cervical	229	96	22	19.2	53.66	53.33	21930	13	7	2	1.4	25	20	1258	147	34	7	6.8	87.5	85	1387
Thoracic	420	289	21	20.6	51.22	57.34	36930	33	14	2	1	25	14.29	1458	72	9	1	0.6	12.5	8.036	1124
Thor Spine	128	69	5	4.93	12.2	13.69	3243.2	23	6	1	0.43	12.5	6.122	557.4	37	25	2	1.8	25	22.32	264.7
Lumbar	190	91	19	18.2	46.34	50.56	12683	11	3	1	0.6	12.5	8.571	226.8	69	7	2	1.4	25	17.5	588.1
Wings	17	7	1	0.7	2.439	1.944	217.2	10	5	1	0.5	12.5	7.143	62.8	1	1	1	0.1	12.5	1.25	4.2
Sacrum	22	16	18	16	43.9	44.44	5617.2	1	1	1	1	12.5	14.29	173.2	4	4	4	4	50	50	73.9
Caudal	43	29	2	1.45	4.878	4.028	365.7	4	4	1	0.2	12.5	2.857	28.2	6	2	1	0.1	12.5	1.25	23.5
Rib	52	52	2	1.86	4.878	5.159	48981	18	1	1	0.04	12.5	0.51	92.5	0	0	0	0	0	0	0
P Rib	504	342	13	12.2	31.71	33.93	12749	37	17	2	0.61	25	8.673	408.8	58	10	1	0.4	12.5	4.464	310.6
D Rib	2012	173	7	6.18	17.07	17.16	39269	182	6	2	0.21	25	3.061	31.3.8	146	10	1	0.4	12.5	4.464	1099
Sternum	9	9	9	9	21.95	25	219.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scapulae	173	39	27	19.5	65.85	54.17	20137	42	14	8	7	100	100	3359	25	4	2	2	25	25	591.9
Humerus	11	11	6	5.5	14.63	15.28	6663	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P Humerus	39	7	9	3.5	21.95	9.722	3265.4	9	2	1	1	12.5	14.29	403.6	0	0	0	0	0	0	0
D Humerus	23	23	12	11.5	29.27	31.94	6812.4	7	7	4	3.5	50	50	1902	26	3	2	1.5	25	18.75	579.8
Hum Shaft	48	3	2	1.5	4.878	4.167	3292.3	8	8	6	4	75	57.14	438.3	8	8	4	4	50	50	151.8
Radius	16	16	10	8	24.39	22.22	7724.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P Radius	33	21	15	10.5	36.59	29.17	4611	12	8	5	4	62.5	57.14	1411	11	3	2	1.5	25	18.75	158.8
D Radius	28	18	9	9	21.95	25	2524.5	6	2	4	1	50	14.29	604.7	19	6	4	3	50	37.5	266.2
R Shaft	20	7	5	3.5	12.2	9.722	85.1	10	2	2	1	25	14.29	317.6	2	1	1	0.5	12.5	6.25	60.5
Ulna	46	40	21	20	51.22	55.56	6083.2	18	8	6	4	75	57.14	1059	21	3	2	1.5	25	18.75	305.9

Table 5.1: NISP/MNE/MAU/WISP Charts for the Kill, Processing and Burned Areas

	UNBURNT KILL							ALL PROCESSING							KILL BURNT						
	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP	NISP	MNE	MNI	MAU	%MNI	%MAU	WISP
5th MTC	35	11	5	5.5	12.2	15.28	79.8	2	1	1	0.5	12.5	7.143	4.5	1	1	1	0.5	12.5	6.25	2.4
Radial	58	54	27	27	65.85	75	2723.9	5	5	3	2.5	37.5	35.71	101.7	7	9	5	4.5	62.5	56.25	337.6
Internal	68	68	35	34	85.37	94.44	1401.4	7	7	5	3.5	62.5	50	125.1	6	6	4	3	50	37.5	86.6
Ulnar	45	42	23	21	56.1	58.33	834.9	3	3	2	1.5	25	21.43	39.9	12	12	8	6	100	75	165.7
Accessory	45	44	25	22	60.98	61.11	431	2	2	1	1	12.5	14.29	26.5	5	4	2	2	25	25	37.5
Unciform	53	52	31	26	75.61	72.22	2459.2	4	4	3	2	37.5	28.57	184.8	10	10	5	5	62.5	62.5	727.1
2nd/3rd	57	56	28	28	68.29	77.78	1500.3	7	7	7	3.5	87.5	50	144.6	9	10	5	5	62.5	62.5	155.1
Metacarpal	25	29	17	14.5	41.46	40.28	2611	3	3	2	1.5	25	21.43	827.4	0	0	0	0	0	0	0
P MTC	16	15	8	7.5	19.51	20.83	1632.6	6	5	3	2.5	37.5	35.71	376.4	5	2	2	1	25	12.5	83.1
D MTC	9	9	5	4.5	12.2	12.5	1251	2	2	1	1	12.5	14.29	427.5	1	1	1	0.5	12.5	6.25	182.2
MTC Shaft	8	2	1	1	2.439	2.778	704.4	2	1	1	0.5	12.5	7.143	43.9	1	0	0	0	0	0	25.4
1st Phalanx	242	224	29	28	70.73	77.78	9435	27	27	4	3.38	50	48.21	885.8	59	21	3	2.6	37.5	32.81	660.1
2nd Phalanx	254	246	36	30.8	87.8	85.42	6728.8	14	14	2	1.75	25	25	299.4	37	17	3	2.1	37.5	26.56	493.9
3rd Phalanx	227	197	25	24.6	60.98	68.4	4884.1	13	13	2	1.63	25	23.21	287.2	22	15	3	1.9	37.5	23.44	188.4
SM Sesamoid	107	107	14	13.4	34.15	37.15	371.3	45	45	6	5.63	75	80.36	13	13	13	2	1.6	25	20.31	43.6
SL Sesamoid	136	136	17	17	41.46	47.22	439.1	31	31	4	3.88	50	55.36	8	22	22	3	2.8	37.5	34.38	82.2
I Sesamoid	74	75	10	9.38	24.39	26.04	151.8	21	21	3	2.63	37.5	37.5	11	7	6	1	0.8	12.5	9.375	15.4
Pelvis	81	41	26	20.5	63.41	56.94	16296	13	6	3	3	37.5	42.86	995.9	79	1	1	0.5	12.5	6.25	1218
Femur	7	7	5	3.5	12.2	9.722	2250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P Femur	36	15	11	7.5	26.83	20.83	5356.7	4	3	2	1.5	25	21.43	171.1	13	5	3	2.5	37.5	31.25	263.9
D Femur	18	10	5	5	12.2	13.89	3809.8	2	1	1	0.5	12.5	7.143	222.6	3	2	1	1	12.5	12.5	53.8
F Shaft	31	8	4	4	9.756	11.11	2068.2	20	5	5	2.5	62.5	35.71	698.5	1	1	1	0.5	12.5	6.25	12.9
Patella	33	28	14	14	34.15	38.89	1411	2	2	1	1	12.5	14.29	67.1	4	2	2	1	25	12.5	108.7
Tibia	7	7	4	3.5	9.756	9.722	4313.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P Tibia	17	13	5	6.5	12.2	18.06	2097.7	2	1	1	0.5	12.5	7.143	59.2	1	5	3	2.5	37.5	31.25	175.6
D Tibia	32	35	22	17.5	53.66	48.61	4697.3	6	6	4	3	50	42.86	665.3	12	1	1	0.5	12.5	6.25	95.5
T Shaft	108	19	10	9.5	24.39	26.39	5164.1	53	8	8	4	100	57.14	1974	7	0	0	0	0	0	0
1st Tarsal	9	9	4	4.5	9.756	12.5	17.3	1	1	1	0.5	12.5	7.143	0.6	3	3	2	1.5	25	18.75	5.8
Astragalus	68	65	32	32.5	78.05	90.28	6010.4	6	6	4	3	50	42.86	373.6	20	6	4	3	50	37.5	494.1
Calcaneus	66	50	30	25	73.17	69.44	7520.6	7	7	4	3.5	50	50	577.8	19	8	5	4	62.5	50	552.9
Cen/4th	72	72	41	36	100	100	4461.6	8	8	4	4	50	57.14	392.7	16	8	4	4	50	50	410.9
2nd/3rd	68	66	35	33	85.37	91.67	705.2	8	8	5	4	62.5	57.14	57.7	9	8	5	4	62.5	50	80.4
L Malleolus	42	42	22	21	53.66	58.33	313.6	2	2	2	1	25	14.29	15.9	7	7	6	3.5	75	43.75	85.6
Metatarsal	30	30	16	15	39.02	41.67	9080.6	1	1	1	0.5	12.5	7.143	124.4	0	0	0	0	0	0	0
P MTT	25	24	12	12	29.27	33.33	1894.8	8	8	5	4	62.5	57.14	617.7	10	5	4	2.5	50	31.25	311.5
D MTT	14	15	8	7.5	19.51	20.83	1468.4	3	3	3	1.5	37.5	21.43	355.7	1	1	1	0.5	12.5	6.25	158.1
MTT Shaft	11	1	1	0.5	2.439	1.389	956	5	2	2	1	25	14.29	124.4	3	1	1	0.5	12.5	6.25	260.5
Indt Shaft	675	0	0	0	0	0	10812	147	0	0	0	0	0	1733	276	270	0	0	0	0	3283
TOTAL	8488		41	36			438061	1169		8	7			34721	1630		8	8			20036

Table 5.1 (cont'd): NISP/MNE/MAU/WISP Charts for the Kill, Processing and Burned Areas

between these three activity areas, biases that are to some extent inherent in amalgamating different cultural events are reduced.

In sum, there were 8488 specimens in the kill area, 1169 in the processing area and 1630 in the burned bone area. MNI in the kill is based on the fused central and fourth tarsal and is 41. The processing (glenoid) and the burned bone (atlas) area MNI are both 8. These results are tabulated in Table 5.1. Figures 5.1, 5.2 and 5.3 outline in graphic format the %MAU for each of the three areas.

5.3 Unidentified Bone

There were approximately 251,373 pieces of unidentifiable bone weighing 133.03 kg at the Fitzgerald site. These fragments were separated into five separate size categories: 0-6 mm, 6-12 mm, 12-25mm, 25-50 mm and over 50 mm. Almost 90% of these fragments are under 2.5cm in diameter. While not systematically recorded, many of the larger fragments were either rib bodies, spinous processes or transverse processes. In future analyses it would be advisable to create a separate count of this form of unidentified bone.

All unidentifiable bone was classified as unburned, burned and calcined. A fragment was considered burned if any visible part of the surface was burned black. Calcined fragments were burned white. In total, there were 100,415 (49.23 kg) unburned, 141,467 (71.06 kg) burned and 9503 (5.2 kg) calcined fragments.

For analysis, the sample was divided between the three activity areas under review - the kill area, the processing area, and the burned bone area. In the kill area, 106,061 (58.09 kg) unidentifiable pieces of bone were recovered (Table 5.2). On average, there were 2946 fragments per m^2. Most of the fragments were not burned (87%) and few were larger then 2.5cm (85%).

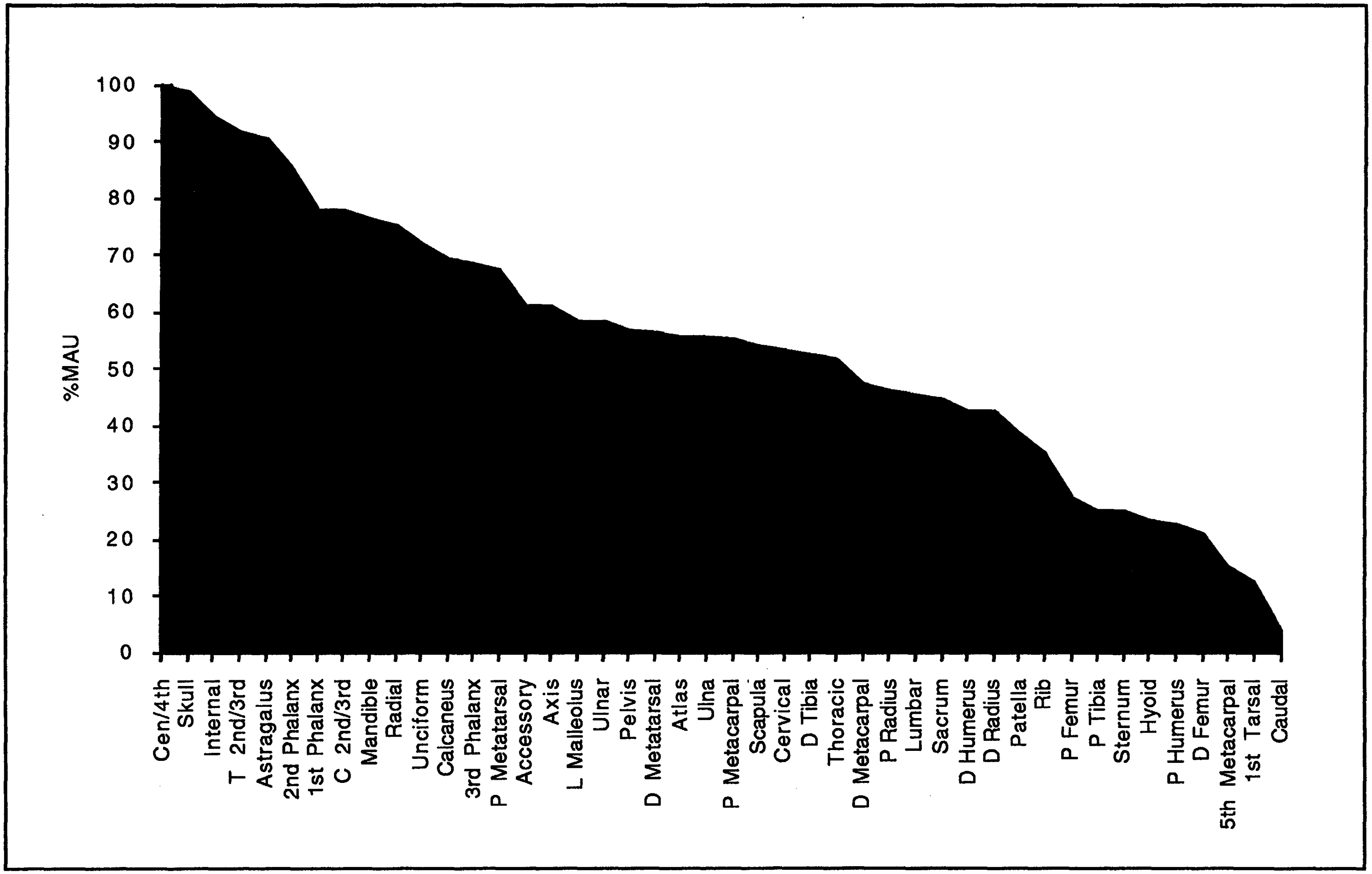


Figure 5.1: Kill Area %MAU

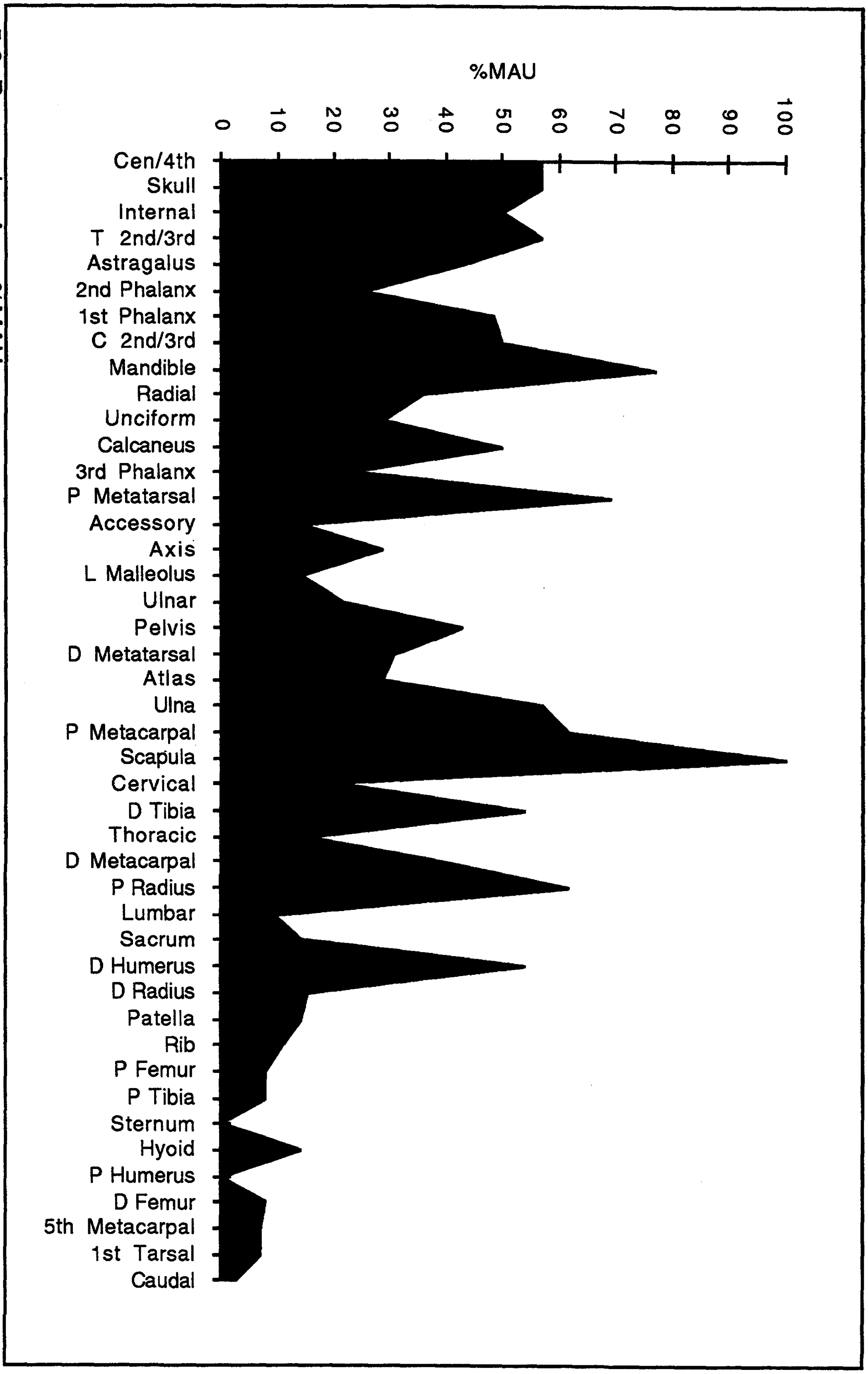


Figure 5.2: Processing Area %MAU

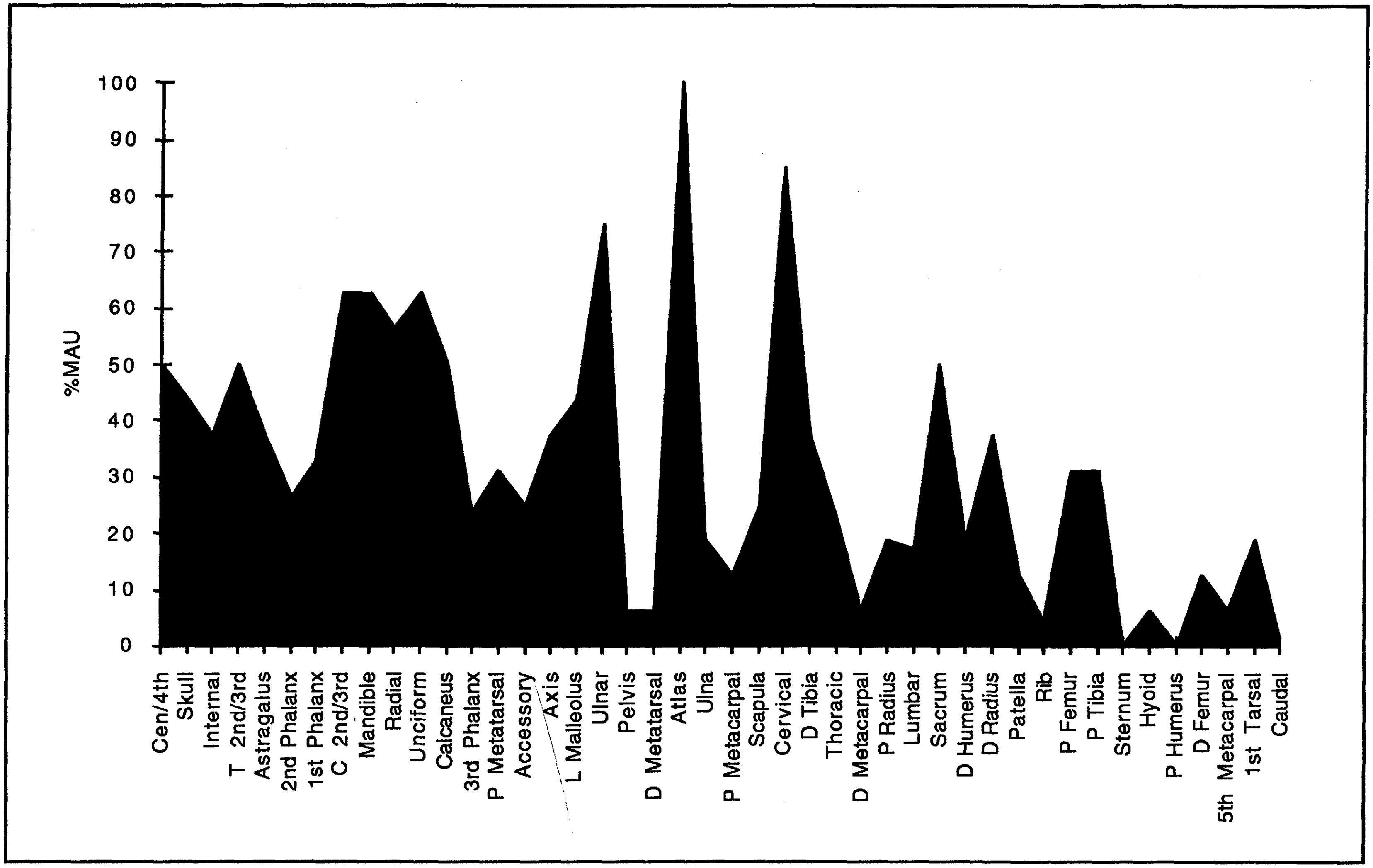


Figure 5.3: Burned Bone Area %MAU

Table 5.2: Unidentifiable Bone from the Kill Area (Weight in Grams)

	Unburned		Burned		Calcine		Total	
	Count	Weight	Count	Weight	Count	Weight	Count	Weight
2-6 mm	13399	509.1	1977	140.1	197	24	15573	673.2
6-12 mm	33452	5102	11398	1648	1381	247	46231	6997
12-25 mm	24209	10703	5755	3558	647	427	30611	14687
25-50 mm	10506	16439	1056	2408	80	211	11642	19058
50 + mm	1972	16476	30	182.8	2	14.5	2004	16673
Total	83538	49229	20216	7937	2307	923	106061	58088

In contrast, there was no unburned bone in the burned area (Table 5.3). However, the burned deposits were extremely dense. There were nearly 122,000 pieces (58.09 kg) of unidentifiable burned and calcined bone recovered in only about 6 m^2 of excavation, an average 20,318 fragments per m^2. Most of these fragments (92%) were under 2.5cm in diameter.

Table 5.3: Unidentifiable Bone from the Burned Area (Weight in Grams)

	Burned		Calcine		Total	
	Count	Weight	Count	Weight	Count	Weight
2-6 mm	9851	442.2	98	3.8	9949	446
6-12 mm	45622	9185	1458	307	47080	9492.3
12-25 mm	52892	29608	2588	1504	55480	31112
25-50 mm	8719	22062	583	1843	9302	23905
50 + mm	94	657.8	7	42	101	699.8
Total	117178	61956	4734	3700	121912	65656

In the processing area there were about 23,400 (9.29 kg) unidentifiable pieces of bone (Table 5.4). Density was about 387 fragments per m^2. These fragments were usually quite small (under 2.5cm in diameter), and about three-quarters were unburned. The paucity of unidentifiable fragments over 5cm in diameter (N=163) was partially the result of there being few rib bodies, spinous processes or transverse processes in this area.

Each of the three areas seems to be different from the other in terms of the amount and type of unidentifiable bone recovered. In the kill there were considerable frequencies of unburned bone. In the processing area, the deposits were considerably less dense and

Table 5.4: Unidentifiable Bone from the Processing Area (Weight in Grams)

	Unburnt		Burned		Calcine		Total	
	Count	Weight	Count	Weight	Count	Weight	Count	Weight
6-12mm	7017	871	2600	361	1673	254	11290	1486
12-25mm	7134	2493	1389	640	767	290	9290	3424
25-50mm	2563	3414	84	167	15	34.2	2662	3615
50+mm	163	763	0	0	0	0	163	762.5
Total	16877	7540	4073	1169	2455	579	23405	9288

there was proportionally more unburned pieces. However, it is likely that the unidentifiable bone from both the kill and processing areas was the result of breaking the bone during the butchering process. This would be completed to remove the meat and marrow and prepare the elements for grease production.

In the burned area, the density of the unidentifiable burned and calcined deposits indicates that different activities are in evidence. It is possible that this area represents a kill that was burned-off to make way for a second hunting event. However, excavation located few identifiable elements in this area and in all cases the fragments were completely burned through. It is expected that if a kill was burned, there would be many elements that would still be identifiable and/or would not have been burned. It is much more plausible that the burned bone area represents a dump. This bone was burned in a separate location and then deposited along the edge of the kill area. Activities that could produce this sample would include bone grease production; breaking bone into small fragments is consistent with this activity. Later analysis of the identifiable elements from this area in Chapters 8 and 9 will test this hypothesis.

5.4 Conclusions

A minimum of 49 bison are represented at the Fitzgerald site. If correlated against the estimated size of the complete kill area, there may have been upwards of 800 animals slaughtered in what was almost certainly a series of communal hunting operations. By area, there are a minimum of 41 animals in the kill and 8 in the processing area. These animals were heavily butchered; there were over 11,000 identifiable specimens and a quarter million unidentifiable fragments.

Chapter 6

Taphonomy

6.1 Objectives

Archaeologists study areas of past human activity to better depict how these cultures once lived. Meaningful interpretations are based on a proper analysis of the materials left behind by past cultures. However, every assemblage is subjected to a number of changes after being abandoned by the people who created it. Only by understanding the natural processes that have come to affect an archaeological assemblage can archaeologists hope to understand the human processes that first created it.

Taphonomy is "the study of the transition, in all details, of organics from the biosphere into the lithosphere" (Lyman 1994b: 1). The mechanisms of change include cultural (e.g. hunting and butchering) and natural transformation processes (e.g. weathering and carnivore chewing). Archaeologists study taphonomy to filter out the natural transformation processes that mask the cultural processes that they wish to analyze and interpret. Without removing the biases that these natural transformations can produce, any interpretations of past life ways will necessarily be suspect.

Recent work has focused on three forms of analysis whose results may be affected by transformation processes (Lyman 1994b: 6-7). These include faunal identification, spatial analysis and paleoevironmental studies. With the advent of the New Archaeology and the reliance on deductive reasoning, increasing emphasis has been placed on the quantification of the archaeological assemblage. This would be due in part to the substantial faunal resources found in such sites as the Fitzgerald kill and the general accessibility of the personal computer to process this raw data. Clearly, an understanding of "how taphonomic processes affect quantitative measures of faunal remains" is necessary (Lyman 1994b: 6).

Cultural materials are not randomly abandoned across the site. An understanding of how materials are distributed can be employed to make inferences about what types of cultural activities were undertaken. However, other transformation processes, like fluvial action, can profoundly alter the distribution of these materials. A second goal of taphonomy would then be "ascertaining the meaning of the distributions of faunal remains" (Lyman 1994b: 7).

Finally, taphonomy can be used to help develop an understanding of the ecosystem to which past cultures had adapted. With the increasingly sophisticated use of paleodemography, archaeologists can start to ask "how and why the recovered faunal remains differ from the biotic community in which they originated" (Lyman 1994b: 7). It can be used to identify the cultural and natural processes that have affected the character of the slaughtered population.

All these processes can be produced by cultural or natural means. In a kill site, cultural activities might affect the assemblage by removing particular taxa or elements from the occupation for further processing. Natural activities that affect the assemblage would include carnivore action, since canids are capable of removing entire elements from the original site.

The rest of this chapter will examine in more detail these different transformation processes. Analysis will focus on those mechanisms that have been identified at the Fitzgerald site. Principal among these are: disarticulation, carnivore chewing, rodent gnawing, slope wash, root etching, weathering and loading. More specifically, attempts will be made to filter out those transformation processes that have altered the occupation remains so as to construct a more accurate picture of the cultural activities that produced the assemblage in the first place.

6.2 Methods and Analysis

6.2.1) Carnivore Chewing

The fact that various carnivore species scavenge at abandoned kill sites is well known. For instance, Lowie reports that in the Assiniboine pounds "(s)mall openings were left to allow dogs to feed upon the abandoned carcasses of the bulls" (Verbicky-Todd 1984: 69). The Blackfoot ethnographer, George Bird Grinnell, also remarks that "(w)olves, foxes, badgers, and other small carnivorous animals visited the pis'kun, and soon made away with the entrails" (Verbicky-Todd 1984: 58). Other sources report that some hunters would often remain behind after the main party had abandoned the kill to pursue carnivores like foxes for their pelts.

Binford (1981: 217-225) suggests that differences between proximal and distal humeri %MAU can be used to identify assemblages that have been carnivore modified. Where there are few proximal humeri in relation to distal humeri, carnivore damage was likely extensive. The differences between the proximal (9.72) and distal (31.94) humeri at the Fitzgerald site is substantial and falls into Binford's "zone of destruction".

Lyman (1994b: 210) has identified seven hallmarks of carnivore damage. They include striations and gouge marks, punctures, shallow pitting, ragged-edged chewing, acid etching, splintering and cracking, and crenulated edges. Because the cortical surfaces and edges of the bone were in relatively poor condition, recognizing evidence of carnivore chewing was quite difficult in the Fitzgerald site assemblage. Only punctures, striations and gouge marks were found. Puncture marks were recognized on 14 elements; they were identified by small oval depressions where the bone had collapsed. Striations and gouge marks are "usually short parallel, and linear or straight marks that are roughly perpendicular or transverse to the long axis of the bone" (Lyman 1994b: 210). Striations and gouge marks were found on only six elements. However, there was great difficulty separating these marks from what could be root etching.

Studies of hyena-ravaged long bones have found that these animals destroy the distal and proximal ends and not the shaft (Lyman 1994b: 271). As a result, carnivore-modified sites should have two to five times as many shaft elements as ends. However, this is not the case at the Fitzgerald site. Figure 6.1 shows that the number of shaft elements never exceeds that of the distal or proximal ends. Assemblages that have been carnivore damaged should have more shaft elements. However, it is important to remember that carnivore chewing has a cumulative effect on bone. It is only after a considerable period of time that a long bone becomes so fragmented that it is unrecognizable and thus invisible quantifiably (Lyman 1994b: 277). Garvin (1987) found that even after two weeks of gnawing, carnivore damage could not be counted on to change the sample enough to alter long bone element counts.

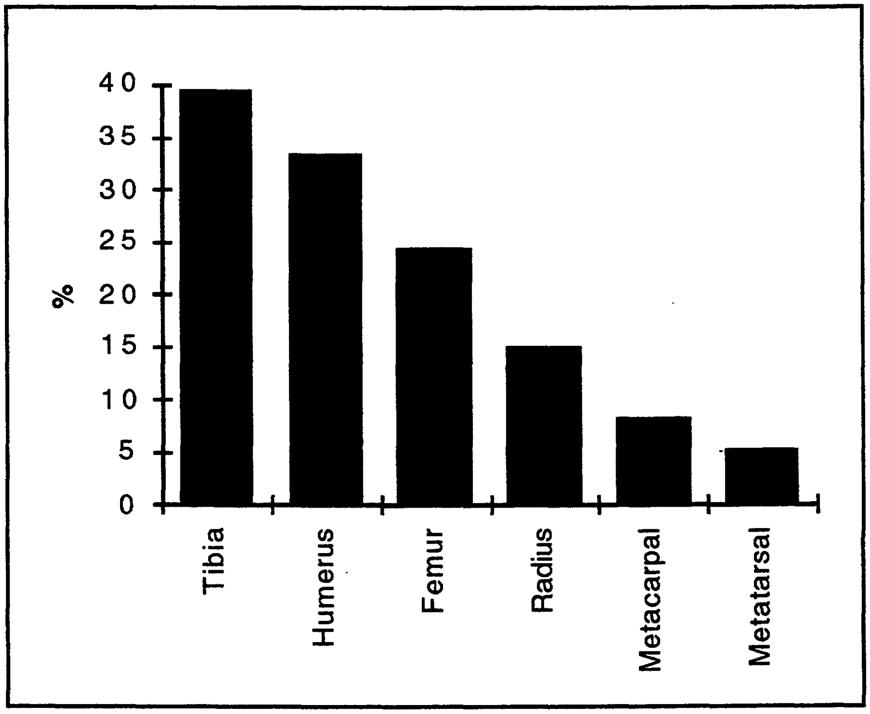


Figure 6.1: Ratio (as a percentage) of Shaft to Proximal And Distal Long Bone Elements

Other faunal elements would be more susceptible to carnivore action. For instance, Payne and Munson (1985) found that domestic dogs usually would chew off the ramus and often the diastema of mandibles. Munson (1991: 149) also found that when domestic dogs were given an option (as in a kill site) of what bone to gnaw, they would usually choose the most cancellous and least dense bone. He hypothesizes that this may be one reason why there are so few neonate faunal elements found in kill sites.

As indicated by the relatively few proximal humeri and the occasional tooth marks, carnivore action has affected the Fitzgerald site faunal assemblage. However, it is likely that carnivore damage has had little affect on the frequency of particular elements at the Fitzgerald site. Cultural processes would account for the breakage and destruction of most faunal elements.

6.2.2) Bioturbation and Rodent Gnawing

Many rodent burrows were discovered running throughout the bone bed. Rodent holes were easily identifiable because of the strong contrast in color between the dark paleosol that forms the cultural horizon and the upper and the lower yellow sand matrix. That the rodents were responsible for moving faunal elements can not be discounted. However, the fact that almost all identifiable bone was located within a single level, would argue that disturbance was in fact minimal. This argument is supported by evidence that rodents do not usually move bone more than 1.1cm thick, 29.5cm long, and weighing more than 54.5 grams (Hockett in Lyman 1994b: 194).

Many of the faunal elements recovered from the Fitzgerald site show evidence of rodent gnawing. Tooth marks are usually found along the edges of elements like the ribs and scapulae. Larger, rounder and more dense elements like the long bones and vertebral centra remain unmodified by rodent gnawing. Gnawing was in all cases quite minimal; no bone was found that had more than a single edge chewed to a depth of more than three or four millimeters.

6.2.3) Slope Wash

As has been previously demonstrated, much of the Fitzgerald assemblage rests on the side of a long slope. Quantitative evidence indicates that the upper portion of the slope has considerably smaller amounts of bone than the bottom of the basin. "Small scale slumping on dune slopes" can displace artifacts (Waters 1992: 196). However, the dune likely remained stable for some period after the site was abandoned. The black paleosol located above the occupation would indicate that the site was protected from slumping by a vegetation cover.

It is also possible that faunal elements were transported down slope by a series of aeolian and colluvial processes. It is hypothesized that transported bone would act much the same way as if affected by fluvial processes. The pieces would orient themselves in particular directions dependent upon their general shape and weight (Lyman 1994b: 177). Orientation measurements of the faunal elements were not completed at the Fitzgerald site. However, examination of photographs and maps of the site reveal no easily identifiable trends in the orientation of the bones.

It would also be expected that slope movement would have a lesser affect on larger faunal elements than on the smaller unidentifiable fragments and micro-debitage. These latter artifacts are also found in low frequencies in the upper part of the site. However, considering that the corral structure, the likely edge of the kill, was also found at the bottom of the basin, the small quantities of artifacts found in the upper slope is likely a result of cultural, rather than natural, processes. Butchering activities were centered around the location of the kill at the bottom of the basin.

6.2.4) Disarticulation

Considering the size of the faunal assemblage at the Fitzgerald site, there are relatively few articulations of bison elements (N = 60) (Figure 6.2). Articulated elements

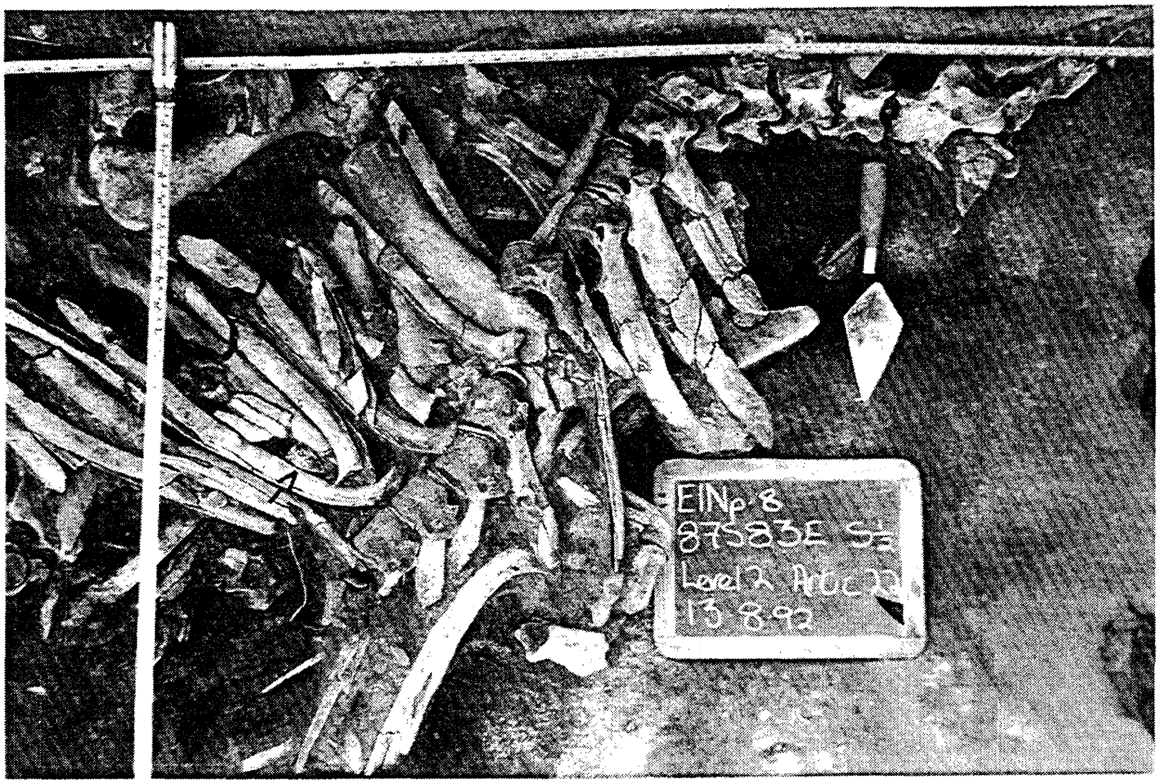


Figure 6.2: Articulated Axial Column and Ribs. Note the Projectile Point Located Between the Third and Fourth Ribs from the Bottom

can be disjointed by cultural and natural processes. Differentiating between these processes proved to be very difficult.

Transformation processes can widely disperse faunal elements across a site. The degree of scattering has been utilized to determine how long the bone was exposed before deposition (Lyman 1994b: 162). Scattering can be measured by examining the number and type of direct articulations against those that were disjointed after the site had been abandoned.

The density of the deposits precluded the possibility of refitting disjointed articulations even within the same excavation unit. There were too many instances where two or more examples of the same element were found within the same excavation unit to properly refit disjointed units. Articulations at the Fitzgerald site were only recorded if the elements were either still in direct articulation or were in correct anatomical position and separated by only a few centimeters.

Another means for determining the scale of scattering is through an examination of the number and types of articulations recovered. The first attempt to measure this quantitatively was by Hill (1979). Hill (1979: 740) developed the Corrected Joint Frequency, a formula that measures the frequency of different types of articulations in an assemblage. However, the Corrected Joint Frequency does not take into account the number of elements that are not articulated (Lyman 1994b: 151).

Lyman proposes that the best means of determining the scale of disarticulation is by comparing the number of articulations in the assemblage to the number of possible joints in the assemblage (Lyman 1994b: 151). Measuring what he terms "the percentage of potential articulations" would give a more reasonable indication of the degree to which the assemblage has been altered by cultural and natural processes (Lyman 1994b: 151). Lyman does not present a specific formula for measuring this occurrence, so a measure of the percentage of potential articulations (PPA) was formulated using MNE counts for this thesis. MNE was used instead of MNI and MAU counts as missing elements might have been removed from the site in articulation. PPA was formulated as follows:

$$\frac{\text{N x 100}}{\text{MNE x J}} = \text{PPA}$$

Where N = Number of intact joints recovered; MNE = Minimum Number of Elements; J = Number of joints for that particular element in a skeleton; and PPA = Percentage of Potential Articulations.

A joint is defined as the maximum number of elements with which a bone is in direct articulation. As an example, there were 194 cervical vertebrae within the Fitzgerald kill area. Since each cervical vertebrae only articulates with two other vertebrae or the skull, there are a maximum of 388 possible joints in the kill area. In contrast, a thoracic vertebrae has four joints, two with other vertebrae and two with the ribs. As the joints of the 5th metacarpal, 1st tarsal, lateral malleolus, sesamoids and the fibrous joints in the skull were not recorded as articulations in excavation, they are not included in the analysis.

At the Fitzgerald site sixty articulations were recovered, all from within the kill area. These articulations account for 468 joints. The 2682 elements recovered from the kill account for a maximum of 6966 possible joints. As a result, only 6.7% of the possible joints in the Fitzgerald kill were still in articulation {(468 x 100) / 6966= 6.7}

The animal skeleton is articulated in three different ways. Fibrous joints are those in which there is little or no movement (e.g. skull and radius-ulna); cartilaginous joints are slightly mobile (e.g. rib/sternum; vertebrae and pubic symphysis) and synovial joints are highly dynamic (e.g. long bones, atlas/axis, phalanges) (Lyman 1994b: 143). Disarticulation tends to occur first in mobile joints and last in immobile joints (Lyman 1994b: 144). Thus, a large number of disarticulated synovial joints is to be expected, even in a site that was not culturally modified.

The rate of disarticulation can be affected by other mechanisms. For instance, Todd (in Lyman 1994b: 146) has noted that bones would be more likely to disarticulate in the warmer months than in the fall and winter. He also notes that carnivore action is more likely to affect the elements on the periphery of the bone bed (in Lyman 1994b).

It is difficult to ascertain from the above evidence whether disarticulation at the Fitzgerald site is the result of cultural or natural taphonomic processes. As there are relatively few articulations of the long bone (N = 19), the most susceptible bone to natural disarticulation, it is tempting to attribute these low numbers to such processes as carnivore ravaging and slope wash. However, in all but five cases, long bone elements that are in articulation are complete and unmodified.

To test if there was a correlation between unmodified elements and articulation, the number of complete long bones was divided by the number of articulations with complete elements (Table 6.1). Nearly a quarter (22%) of the 111 complete long bone elements were found in articulation. While many of these articulations were of the radius and ulna, the especially large proportion of complete tibiae in articulation (28.6%) indicate that even the synovial joints could remain intact.

Table 6.1: The Percent of Complete Long Bones in Articulation from the Kill Area

	Articulated	Complete	
Element	Completes	MNE	% Articulated
Humerus	3	11	27.3
Radius	6	16	37.5
Ulna	7	18	38.9
Metacarpal	3	29	10.3
Femur	1	7	14.3
Tibia	2	7	28.6
Metatarsal	4	30	13.3
Total	26	118	22

That almost none of the proximal and distal elements are in articulation is not surprising. It is logical that those elements that would have been split for marrow removal and grease manufacture would have first been disjointed. Elements not processed for these food items, would be more likely to be left in articulation. That this pattern is found at the Fitzgerald site, argues strongly that disarticulation occurred as a result of cultural processes.

6.2.5) Weathering

Weathering is "the process by which the original microscopic organic and inorganic components of a bone are separated from each other and destroyed by physical and chemical agents operating on the bone in situ" (Behrensmeyer 1978: 153). Faunal elements can be adversely affected by weathering in a relatively short time (Behrensmeyer 1978: 156-158). Gordon and Buikstra (1982: 568-569) have developed a series of categories for determining the extent of this damage to bone. The first of these categories is Strong Complete Bone where "elements are whole and undamaged." Fragile Bone has "superficial destruction" like minor etching and fragmentation. Fragmented Bone is "heavily etched and cracked." Often the articular surface of the long bones and vertebrae remain unidentifiable. Extremely Fragmented Bone are fragmented to the point of being almost unrecognizable. The final category is Bone Meal/Ghost where faunal elements "are reduced to a powdery substance which will not hold shape" and as a result are usually unidentifiable.

While not recorded quantitatively, a re-examination of a sample of the Fitzgerald materials would indicate that almost all identifiable elements can be classified as fragile bone. There are a few elements that are in pristine condition and some that are reduced to the bone meal/ghost category (especially horn cores). The exception is the south-western corner of the kill site. The bone from excavation units 90S 82E to 83 E and 91S 81E to 83E can be classified variously from fragmented to extremely fragmented. Of these units, bones in 90S 82E and 83E and 91S 81E are in the poorest condition. The cortical surface is in all cases completely missing. The outer surface is instead bleached almost entirely white and is pitted. The outer surface and edges are extremely worn. Root mat also covers much of the surface. These units happen to be the closest to the present day ground surface. As no trace of the original paleosol was located in these units, it seems likely that after the upper black paleosol was originally buried by sand, the overlying sediments eroded away further exposing the soil and cultural materials to weathering. There is no evidence to indicate that this occurred during recent cultivation.

Faunal materials from Unit 91S 82E are in an equally poor state. While there is slightly more bone in this area, most is highly fragmented and in a condition similar to that reported in Unit 91S 81E. The exception is a single thoracic vertebral centrum found in the north-east quadrant of this unit. This bone is for the most part in similar condition to the other fragments found in this unit. However, the cortical surface of the bone is still in place on the anterior epiphysis. This same surface was found laying face down.

The soil profile is intact in Unit 91S 83E. As a result the faunal elements, though still fragmented, are in comparatively good condition. The cortical surface is intact and there is little evidence of bleaching or heavy weathering.

Saskatchewan's environment is one of extremes; summers are hot and dry, winters are exceedingly cold. The likely cause of the condition of the upper portion of the bone bed can be found in the exposure to these elements. Climate strongly affects faunal remains, especially if bone is frozen or alternately wet and dry (Behrensmeyer 1978: 154). The upper level of the bone bed was very likely exposed to these conditions. Whether this exposure occurred soon after the bone was originally deposited, or later during cultivation, is difficult to ascertain.

Except for the aforementioned upper south-west corner of the kill, all weathering would have occurred after only a few years of exposure (Behrensmeyer 1978: 158). This evidence is supported by the fact that the dark black paleosol that formed over the cultural horizon remains unbroken across the breadth of the site. After this soil was formed, the lower cultural horizon would not have been exposed to further weathering.

Further proof of this hypothesis is found with a mandible (catalogue number 5963) recovered from unit 88S 80E. The lingual surface of this element, which faced upwards, is quite weathered with the cortical surface worn off and the bone beginning to crack. In contrast, the labial side is remarkably free of weathering. The cortical surface is still in place, and the bone remains in relatively pristine condition. This suggests that the bone was exposed to the elements for only a short period of time, almost certainly for no more than a few years. The exposed upper face began to erode, but the bone was buried before the lower surface could begin to weather.

Other forms of weathering occurred after the assemblage was buried. There can be no doubt that the Fitzgerald assemblage has been considerably affected by the surrounding sand matrix. Nearly all faunal elements have evidence of abrasion, the wearing away of the outer portion of bone. Abrasion affects the bone in numerous ways. On most specimens, portions of the outer cortical edge of the bone have been removed. Muscle attachments, especially, have been worn smooth. Also affected are the edges of broken bone which have become rounded and thinner. At its most extreme, abrasion can eventually lead to the bone becoming unidentifiable (Lyman 1994b: 186). However, few elements are so worn that identification is difficult.

Much of the bone has evidence of root etching. The formation of the dark black paleosol immediately above the cultural horizon would likely have been the result of the growth of various grass species. The roots may have caused considerable damage to the faunal assemblage in the period immediately after the site was abandoned. Considering that most of the roots identified in excavation are alfalfa (*Medicago sativa*), a portion of this damage may also be recent. Alfalfa was introduced to North America during the historic period from the Near East and its roots can grow up to three meters long.

6.2.6) Bone Density and Survivorship

Much of the Fitzgerald site is buried under up to 1.25 meters of sand. There is a strong relationship between depth of burial and soil weight. This occurs when the "underlying sediments become more compact and of greater bulk density because there are smaller and fewer pore spaces between sedimentary particles" (Lyman 1994b: 423). The faster these sediments are deposited, the more susceptible the bone becomes to breakage.

There are very few complete elements found at the Fitzgerald site. Differentiating between breakage caused by soil weight and cultural processes then becomes the next challenge. Klein and Cruz-Uribe (1984: 75) hypothesize that high NISP/MNI ratios are the result of post-depositional factors. However, this fails to recognize that most elements are "influenced by mammalian agents such as humans and carnivores" (Marean 1991: 678). It has already been determined that there was little carnivore damage to the site assemblage.

Marean (1991: 680) argues that to measure properly post-depositional destruction, archaeologists should only use bones that "are rarely or never broken by people or carnivores" and that are independent "from bone transport behavior." Carpals and tarsals match this description. Independent of Marean, it is argued that the phalanges would also fall within these same parameters. All these elements are rarely processed for grease or marrow, are extremely dense and are rarely broken in disarticulation (Marean 1991: 681). Culturally and canid-modified elements are easily recognized and can be removed from the sample. Thus, phalanges, carpals and tarsals are the practical choice for measuring post-depositional destruction.

Marean has formulated the Completeness Index which "is derived by estimating for each specimen the fraction of the original compact bone that is present, summing the values, and dividing that by the total number of specimens ascribed to that bone and taxon" (Marean 1991: 685). It excludes culturally-modified and carnivore-chewed specimens. If there were one complete calcaneus (value = 1), half a calcaneus (0.5), and a third of calcaneus (0.33), the completeness index would be 63% {(1 + 0.5 + 0.33) * 100/3}.

The completeness index for the Fitzgerald site phalanges, carpals and tarsals can be found in Table 6.2. The results demonstrate that these elements remain remarkably complete, usually well over 90%. Post-depositional destruction was therefore quite minimal.

Table 6.2: The Completeness Index

NISP	100%	90%	50%	25%	Index
5MC	29	0	6	0	91.4
Radial	53	5	0	0	99.1
Internal	61	1	5	1	95.1
Ulnar	42	2	1	0	98.4
Acessory	42	3	0	0	99.3
C2/3	55	2	0	0	99.6
Unciform	51	1	1	0	98.9
1Tarsal	9	0	0	0	100
Astralagus	53	4	4	7	88.8
Calcaneous	45	8	11	2	88.2
C/4	65	6	1	0	98.5
T2/3	67	1	0	0	99.9
Lat Malleolus	42	0	0	0	100
1st Phalanx	210	9	16	7	94.2
2nd Phalanx	231	8	9	6	96.1
3rd Phalanx	164	19	36	8	88.6

Most other faunal elements from the Fitzgerald site have been broken. Archaeologists have identified two types of fracturing, static and dynamic loading, that can be used to differentiate between natural processes like carnivore chewing and human activities like marrow and grease extraction. Static loading, whereby constant pressure is put on a bone until it breaks, is usually associated with carnivore chewing (Lyman 1994b: 270). Dynamic loading describes a sudden impact to the bone (Lyman 1994b: 270). It tends to produce "rounded fracture ends" and fracture fronts that tend to end at the base of the epiphyses (Lyman 1994b: 317). Dynamic loading can be produced culturally or through animal trampling. Differentiating between these can be problematical. Lyman argues that humans break bones using a chopping tool and an anvil. These tools tend to produce true spiral fractures and an impact point, usually a "circular or oval depressed area marked by incipient ring cracks or crushed bone" sometimes with flakes still attached within the medullary cavity (Lyman 1994b: 324).

At the Fitzgerald site, almost all fractured long bones have evidence of spiral fracturing suggests that the bone was broken green (Lyman 1994b: 320). However, little evidence of the impact point could be identified. That numerous elements are broken in the same location suggesting a cultural rather then a randomly generated breaking pattern. For instance, the mandible diastema is almost always broken at the base of the second premolar, though the density of these elements would indicate that breakage would be more likely to occur at the mid-shaft of the diastema.

Another method of determining the significance of non-cultural destruction comes through an examination of bone density. Certain bones and certain parts of the bone are more susceptible to fragmentation than others. For instance, cancellous bone is much less likely to survive carnivore chewing and post-depositional processes than the denser cortical bone. As a result, differentiating between grease manufacture and post-depositional destruction is problematical. Culturally, there are two major biases. First, humans tend to select dense bone for tools (Lyman 1994b: 252). More importantly, though, is the "weak but significant correlation between the volume density of bone parts" and economic utility (Lyman 1992: 13). It has been demonstrated that "bones of high utility should consistently, if not always, have low volume densities whereas bones of low utility should consistently, if not always, have high volume densities" (Lyman 1992: 13).

Using single-beam photo-densitometry, Kreutzer (1992) has determined the bone density of most major elements in the bison skeleton. Scan sites were usually taken in a number of different locations corresponding to areas where bone is likely to be broken by natural and/or cultural processes. Using these figures, a means of testing whether breakage patterns are correlated with volume density or butchering processes has been developed (Lyman 1994b: 246-248).

This method is based first upon selecting a scan site for each bison element that best represents the area where the bone was consistently being broken. If most of the elements are complete, the scan site is chosen that seems to best characterize that particular element, usually the site closest to the mean. These sites are then compared to the generated bone mineral densities of bison (Kreutzer 1992). The scan site locations and corresponding density readings used at the Fitzgerald Site are found in Table 6.3.

Table 6.3: Scan Sites and Density Plots Utilized at the Fitzgerald Site (from Kreutzer 1992)

	Location	Density
Atlas	AT1	0.52
Axis	AX1	0.65
Cervical	CE2	0.62
Thoracic	TH1	0.42
Lumbar	LU1	0.31
Innominate	AC1	0.53
Rib	RI2	0.27
Scapula	SP1	0.5
P Humerus	HU2	0.25
D Humerus	HU4	0.48
P Radius	RA3	0.62
D Radius	RA4	0.42
D Metacarpal	MC2	0.63
P Metacarpal	MC2	0.63
Phalanx	P12	0.46
P Femur	FE2	0.34
D Femur	FE5	0.36
P Tibia	TI2	0.58
D Tibia	TI4	0.44
Tarsal	AS2	0.62
D Metatarsal	MR1	0.52
P Metatarsal	MR1	0.52

Bone density, bison utility indices and the Fitzgerald site %MAU were first plotted on bilateral scattergrams (Figures 6.3, 6.4 and 6.5). Using rank order correlation, the degree of correspondence between two sets of rankings was then measured. Where correspondence was close to zero, there is little relationship between the two sets. If the rank order correlation is high, whether positive or negative (close to +1 or -1), "variation in one set of ranks is predicted by variation in another" (Mueller et al. 1977: 263).

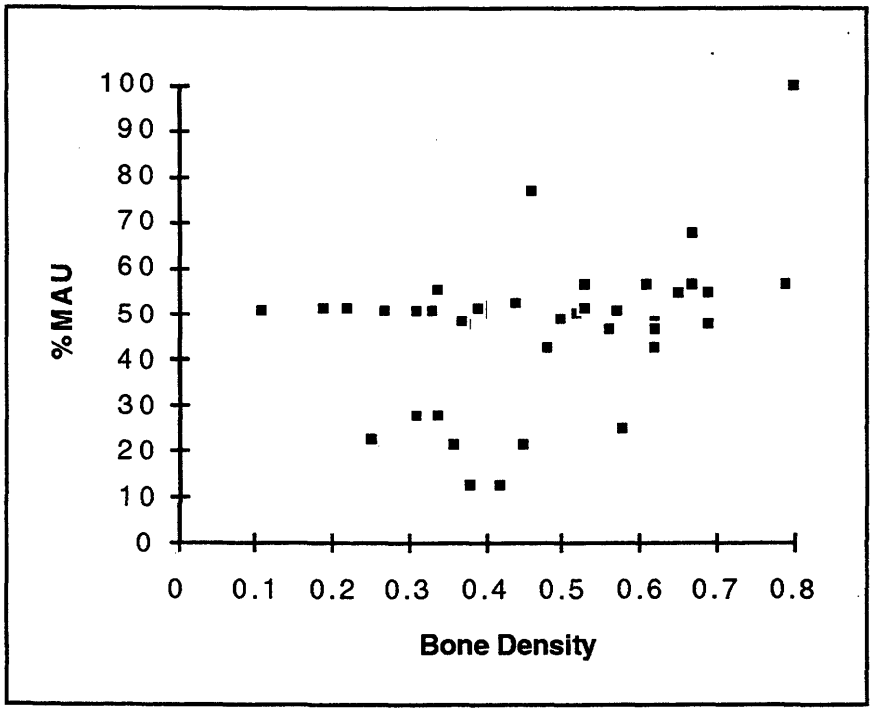


Figure 6.3: Relationship between % MAU and Bone Density

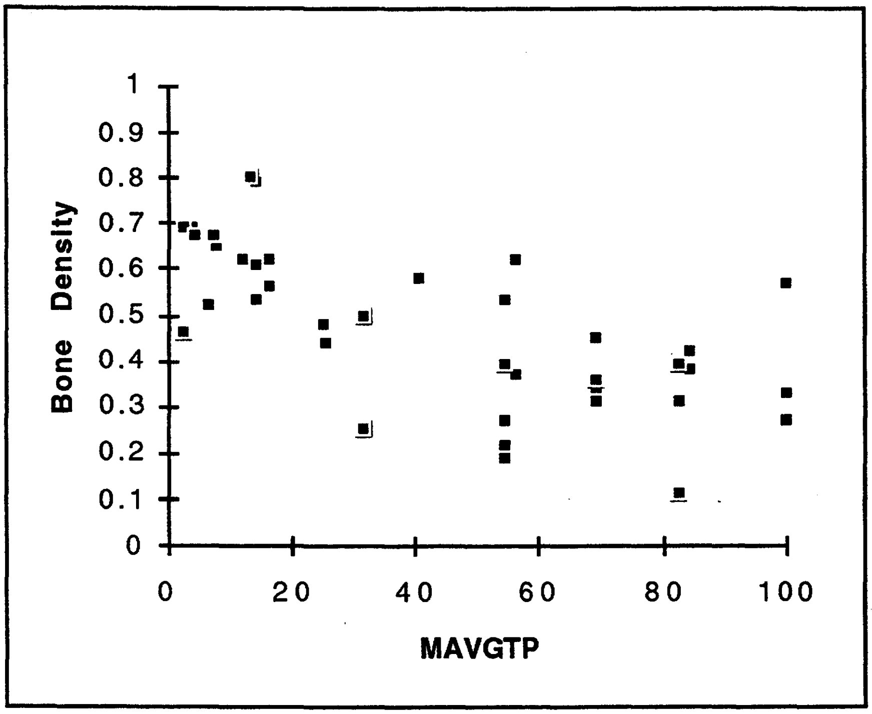


Figure 6.4: Relationship between Bone Density and the Modified Average Total Products Index

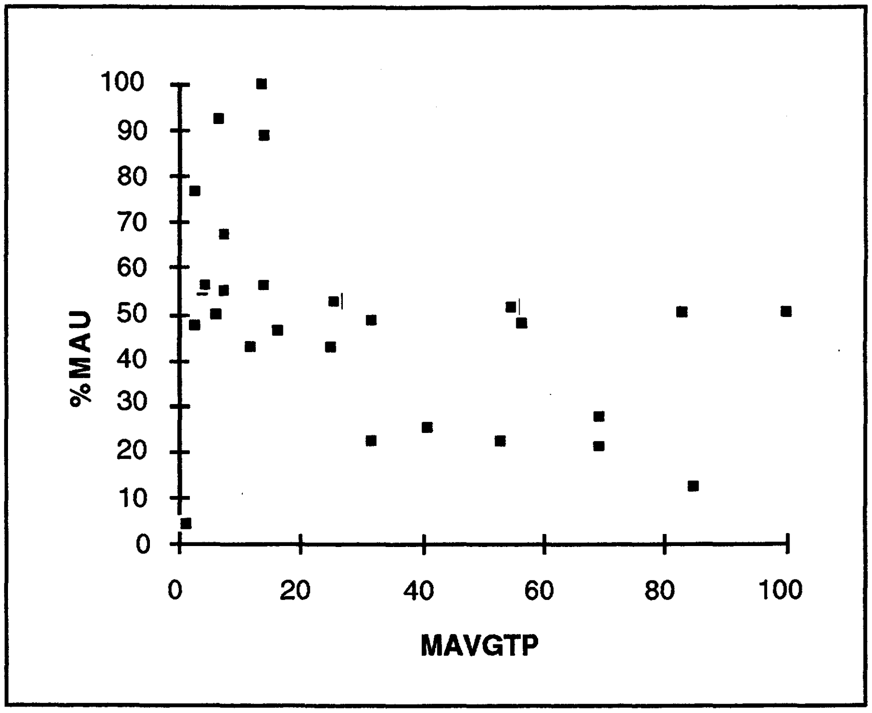


Figure 6.5: Relationship between % MAU and the Modified Average Total Products Index

There is a correlation of +0.48 between %MAU and bone density rankings. Between the Modified Average Total Products Index and bone density there is a moderate negative correlation of -0.546. However, there is a very strong negative correlation of -0.66 between Emerson's (1991) utility index and %MAU.

These numbers would indicate that bone density mediated destruction had only a small effect on quantitative counts. Some elements were likely destroyed by natural taphonomic processes. However, the very strong correlation between %MAU and utility indices would indicate that elements were more likely not to be found in the kill because of their high economic utility. The high correlation between %MAU and density is likely the result of these elements being the same as those that would have been selected for grease processing. So while density mediated destruction is indicated, it is hypothesized that the bone elements that were not recovered were missing for cultural reasons.

6.3 Discussion and Conclusions

The Fitzgerald site has been influenced by natural transformation processes. Sand abrasion and root etching seem to have had the most serious affect on the assemblage. Other post-depositional processes have modified the assemblage only slightly. For instance, weathering has had little affect on the bone; this almost certainly indicates that the bone was exposed for only a few years at most. As the cultural horizon was protected from erosion by a paleosol rather then later dune deposits, soil formation must have occurred quite rapidly. Root etching would indicate that this period of stability lasted for some years after the occupation. While some elements may have been moved from where they were originally deposited by processes like slope wash and carnivore activity, the effect of these different processes on the assemblage would likely have been quite minimal. This would explain why so many of the complete long bone elements remain in articulation; disarticulation was likely a cultural rather then a natural process.

Because so much of the cortical surface of the bone is damaged, it is difficult to identify evidence of modifications such as cut marks, carnivore chewing and rodent gnawing that occurred prior to burial. Damage from these processes may then have been more extensive than determined in this analysis. However, there is no indication that element counts have been severely altered by anything but cultural activities.

The uniformity of the natural taphonomic processes that effected the faunal assemblage indicates that the site was used for a relatively short time. It is expected that such weathering could only have occurred over a period of no more than 15 years (Behrensmeyer 1978: 162). If the site had been used for a longer period of time, considerably more variety in weathering would have been noted.

Chapter 7

Age and Gender Analysis

7.1 Introduction

As a result of Speth's (1983) pioneering work in the early 1980's, archaeologists have become very conscious of the role that animal age and gender may play in hunting and butchering decisions. Work by Emerson (1990) and Brink (1994) has demonstrated that there is variation in the meat, marrow and grease content in individual sections of the carcass among mature male, mature female and juvenile bison. In addition, variation has been demonstrated to exist within these categories during different times of the year. As nursery and bull herds tend to remain separate for most of the year, hunters might choose between one of these two types of herds depending on which was likely to be the most productive in terms of available fat, marrow and grease. These decisions might also affect the butchering process. Certain anatomical portions might be selected, depending on the sex of the bison.

7.2 Age Analysis

7.2.1 Objectives

The accurate inference of age at the time of death depends upon many different forms of study. First, because of the limited time frame in which the bison rut occurs, accurate aging of the herd can help estimate the season in which the kill might have taken place. Age estimates can also present a demographic profile of the herd population at the time of the kill. These profiles can be used to delineate both the general health of the herd and the kinds of herds hunters once selected.

7.2.2 Methods and Analysis

Analysis of the age structure of the bison population was based upon 54 of the 65 mandibles with teeth recovered from the kill and processing areas. Eleven mandibles were not analyzed because the first molar was either broken or missing. Tooth eruption schedules and the degree of molar wear provide a reasonably reliable means of inferring age at death in ungulates. Other methods such as epiphyseal fusion and cementum analysis are either imprecise or are still in the early stages of research.

Analysis proceeded in two stages. All 54 mandibles were first separated into fully mature and immature animals. Immature mandibles were then individually examined to determine the state of eruption of each molar and premolar. Cusp wear was next recorded following guidelines outlined by Frison and Reher (1970). The results of this analysis were then compared to bison tooth eruption schedules adapted from Frison (1970a; 1982), Reher and Frison (1980), Todd and Hoffman (1987), Todd et al. (1990) and Wilson (1980). An estimated age was then assigned to each mandible in the Fitzgerald site population, each year being divided into tenths. An assigned age of 1.5 means that the bison died at an estimated age of one and a half years or 18 months, not 1 year and 5 months. All bison mandibles and maxilla were assigned to a particular seasonality category; x.5 means that the bison died in October assuming a peak calving period in early May.

The second portion of this analysis was concerned with creating a demographic profile of the Fitzgerald herd. To this end, the metaconid height of each first molar in the fully mature bison mandibles was measured. Measurements were also taken on immature specimens where it could be completed without damage to the ramus. They were not completed on second and third molars because of similar concerns about damage to the ramus. Maxillary first molars were also measured using these same techniques. Measurement location was based on diagrams provided by Brumley (1990: 67) and by consultations with Dr. Ernest Walker. All measurements were taken to the nearest tenth of a millimeter using sliding calipers. Results are summarized in appendices 5 and 6.

a) Seasonality Indices

Seasonality indices were based on a limited sample of 16 immature bison mandibles and 18 immature maxillary elements. The results of the analysis were initially discouraging (Figure 7.1 and 7.2). All mandibular and maxillary dentitions fall into one of five age categories from x.3 to x.7. Assuming a May 1 calving period (Roe 1970; McHugh 1972), these results would mean that the kill took place between late July and early January. Indeed, it is known historically and ethnographically that pounds could be used for long periods of time.

Closer analysis would show that 75% (N=12) of the mandible sample are in either the x.5 and x.6 age categories; 87% (N=14) are found between the x.5 and x.7 age categories. Two-thirds (N = 12) of the maxillary elements are from the x.6 age category, all fall between x.5 and x.7. This argues for a more restricted season of site utilization. The kill probably occurred sometime between late October and early December.

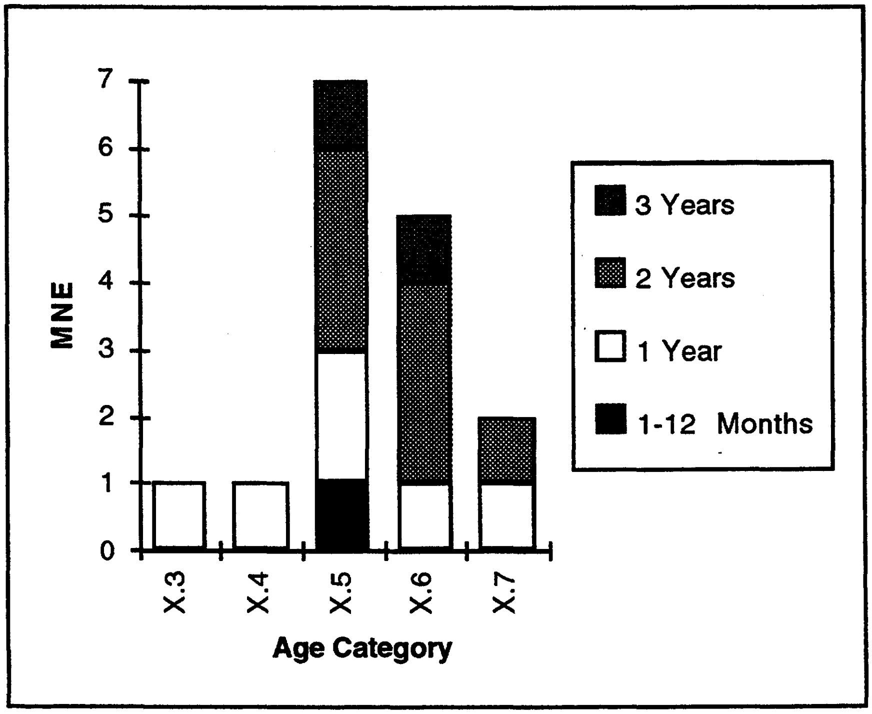


Figure 7.1: Number and Age of Juvenile Mandibles in Each Seasonality Category

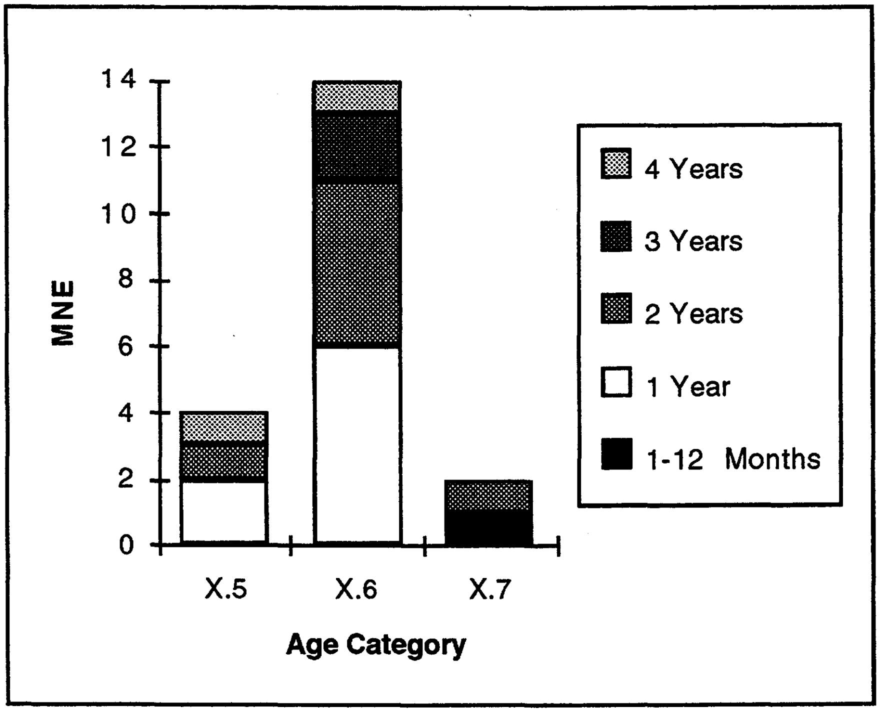


Figure 7.2: Number and Age of Juvenile Maxilla in Each Seasonality Category

These results are quite consistent with what is currently known about bison reproductive behavior (Roe 1970; McHugh 1972). The bison rut is generally agreed to have occurred over a nearly three month period beginning in early July. While not common, the rut could begin slightly earlier or later. The gestation period for bison is approximately nine and a half months long. So, while the peak calving period would be in early May, calves could be born any time from early April through late June. Because of the variations in the rutting season, some calves could be born before or after this period. This could explain why two of the juveniles seem unusually young.

Only one foetal element was identified in the Fitzgerald assemblage. This element was an unidentifiable long bone shaft recovered from the processing area. Unfortunately, this item was to small and fragmentary to identify its stage of development. The presence of foetal bone would indicate that the kill took place some time from the late fall to early spring. This result conforms to seasonality data derived from the mandible sample.

b) Herd Demography

An early study initiated by Reher (1970) attempted to provide the profile of the bison population recovered at the Glenrock bison jump. Population dynamics refers to the "balance between births and deaths and to the age distribution within a natural population" (Reher 1970: 51). In catastrophic events like a bison kill, a representative sample of the complete bison herd is left for the archaeologist to analyze. Providing that the age of each bison has been correctly inferred, the general age and health of the bison herd may be determined.

The determination of age of death is based on juvenile tooth eruption sequences and adult degree of wear, especially on the first molar metaconid. It is assumed that bison molars wear at a uniform rate. The older the animal, the more wear the molar will exhibit. In a catastrophic kill event, as suspected at the Fitzgerald site, it is likely that a representative sample of all animal ages will be present. If a kill event or events took place in a limited period of time (e.g. a single season), it is expected that there will be clusters that reflect yearly age groupings. However, if the kill site was used constantly over the course of a year, there should be no separation in enamel height reflecting the fact that all age groups are present. This model depends on the assumption that there is a peak calving period in the late spring.

Analysis of the Fitzgerald sample argues strongly for a seasonally restricted bison kill. The mandible results are graphed in Figure 7.3. There are 13 distinct clusters based on mandibular M1 enamel height. A large gap between the fourth and fifth cluster likely is an unrepresented fourteenth cluster. These clusters are labeled as Cohorts I - XIII. Using the juvenile eruption sequences as a check, Cohorts I and II would represent a mix of animals from the 6 month and 1.5 year range. As the 6 month old's molar has not come into wear, it should not be surprising that it falls into the same cluster as the 1.5 year olds. Using enamel height, the 2.5 and 3.5 year old mandibles fall into two distinct clusters,

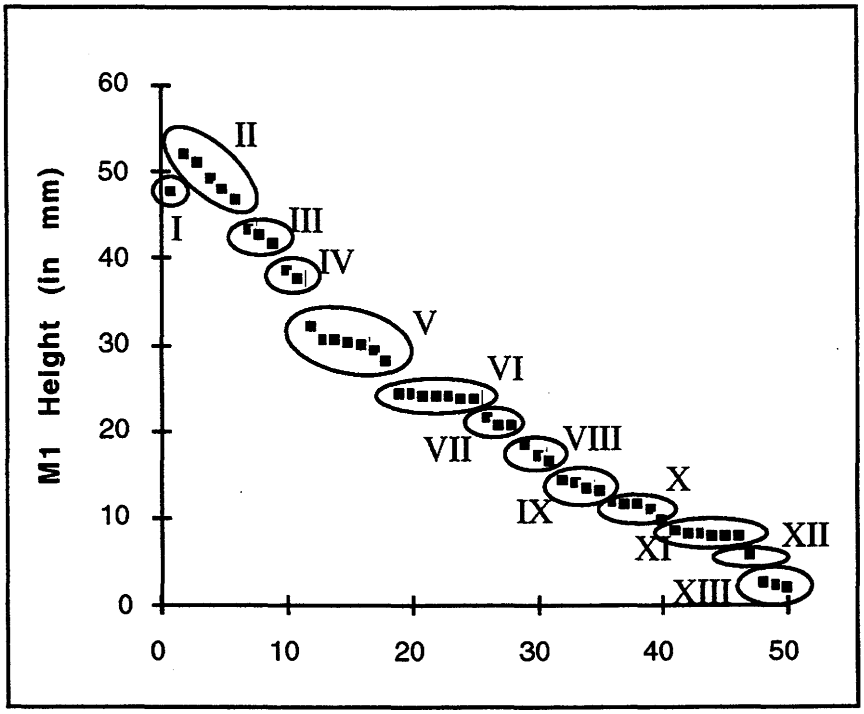


Figure 7.3: Molar 1 Metaconid Height and Mandible Element Frequency (Roman Numerals Correspond to Age Categories)

cohorts III and IV. No 4.5 year old mandibles were identified. A distinct gap exists between cohorts IV and V. It is clear then that metaconid height is a valid indicator of age in juvenile mandibles.

A further method for checking the validity of using M1 enamel height to age the population, is to examine mean wear patterns between the different cohorts. An examination of Table 7.1 shows the mean M1 height in each mandible cluster and the amount of wear that occurs between each group. It is expected that wear patterns should remain relatively stable between these groups. In the Fitzgerald sample, wear patterns are quite constant. No mean wear is presented for the age groups .5 and 1.5 because, as mentioned before, the first molar has not come into wear. No samples exist in cohort V so mean wear was extrapolated for cohorts V and VI but not included in the overall mean wear rate.

Table 7.1: Wear Rates for Mandible Molar 1 (in mm)

Cohort	Age	No.	Mean M1	Mean Wear
I	0.5	1	47.7	N/A
II	1.5	6	49.3	N/A
III	2.5	7	42.5	6.8
IV	3.5	2	38.2	4.3
	4.5	0	N/A	N/A
V	5.5	7	30.06	N/A
VI	6.5	7	23.99	6.07
VII	7.5	3	20.8	3.19
VIII	8.5	3	17.4	3.4
IX	9.5	4	13.7	3.7
X	10.5	5	11.1	2.6
XI	11.5	6	8	3.1
XII	12.5	1	5.6	2.4
XIII	13.5	3	2.2	3.4
	Total	**55**		**3.5**

The greatest wear occurs in the juvenile mandible sample. Between the ages of 1.5 and 2.5, the molar wears some 6.8 mm opposed to 3.2 mm per year for the rest of the sample. Similar results are found at the Glenrock Bison kill (Reher 1970). It is likely that the juvenile molars are more susceptible to wear due to the high crown height. More mature specimens would wear at a slower but still steady rate. This is likely why clustering is not as distinct in the older animals as it is in the juveniles.

It must be asked whether there are one or two missing clusters between mandible cohorts IV and V. The mean molar height for these two cohorts are 38.2 mm and 30 mm, respectively. If there were two age groups between these clusters the mean wear rate would be about 2.7 mm per year. Since this missing cluster would represent a fairly young animal and the overall mean wear rate is 3.5 mm per year, it is more reasonable to argue that only a single group exists between these two cohorts. The mean M1 height would then be about 34.1 mm for this new group; an averaged wear rate of 4.1 mm per year for cohorts V and VI can be surmised.

Following Reher, it is hypothesized that each of these 13 cohorts represents a distinct age group. Assuming that the juveniles have been correctly aged, 14 distinct age groups are present in the sample ranging in age from 6 months to 13.5 years. No mandibles representing the age of 4.5 are present.

Similar results were obtained from measurements of M1 enamel height in the maxillary dentition (Figure 7.4). There are 11 distinct cohorts, with a missing twelfth cohort located between cohort X and XI. Each of these twelve cohorts likely represents a distinct age category. Mean wear rate is 2.8 mm per year for animals over the age of 1.5 (Table 7.2). Wear rates correspond to those found at the Glenrock (3.9-4.2 mm per year), Wardell (3.5 mm per year) and Vore sites (3.5-3.8 mm per year).They are significantly higher than the 1.7 mm per year reported for historic samples recovered in Wood Buffalo National Park (Haynes 1984: 488). The latter rates are relatively low because "of significant dietary differences between plains and northern bison", the amount of soil grit and possibly "dietary deficiencies " (Haynes 1984: 488-490).

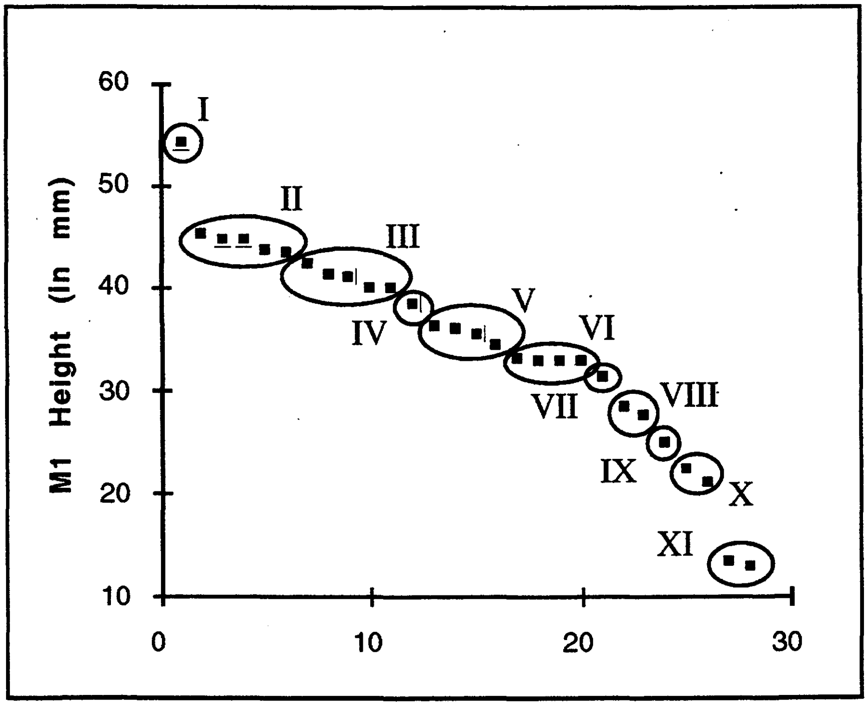


Figure 7.4: Molar 1 Paracone Height and Maxillary Element Frequency (Roman Numerals Correspond to Age Categories)

Table 7.2: Wear Rates for Maxillary Molar 1 (in mm)

Cohort	Age	No.	Mean M1	Mean Wear
I	0.5	1	54.2	N/A
II	1.5	5	44.3	9.9
III	2.5	5	41	3.3
IV	3.5	1	38.4	2.6
V	4.5	4	35.6	2.8
VI	5.5	4	32.9	2.7
VII	6.5	2	31.2	1.7
VIII	7.5	2	28	3.2
IX	8.5	1	25.1	2.9
X	9.5	2	21.6	3.5
XI	10.5	0	N/A	N/A
XII	11.5	2	13.2	N/A
	Total	**29**		**3.62**

An examination of the frequency of mandibles and maxilla in each age category would suggest that there is a preponderance of older bison (Figure 7.5). Indeed, the older the bison, the more likely it will be represented in the mandibular dentitions. While there are a large number of juveniles in the sample (MNI = 15), this number is actually quite small when compared to what is expected for the number of mature animals present. This is especially true for the 6 month age group.

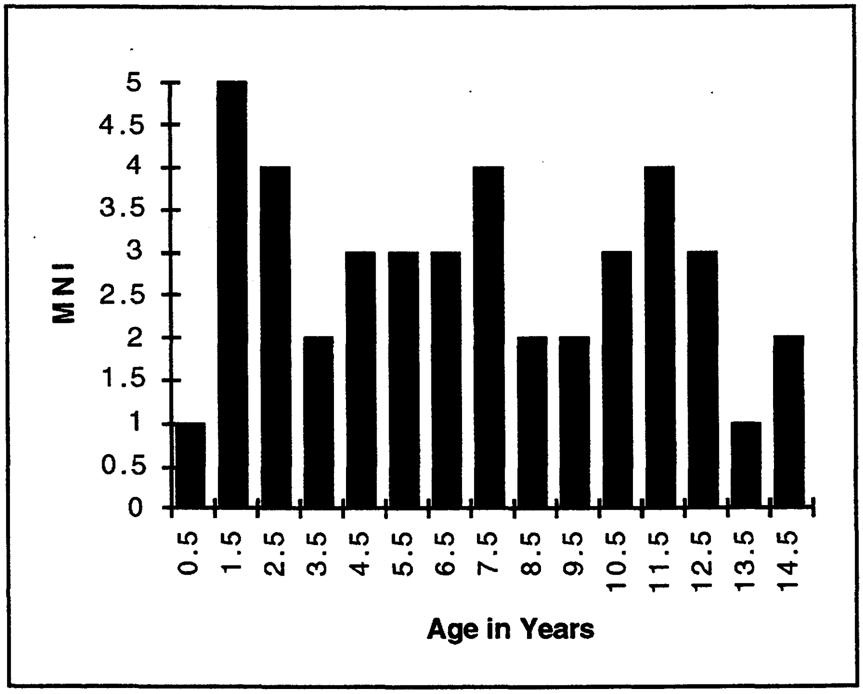


Figure 7.5: MNI on Mandibles and Maxilla in Each Age Category

Reher (1970) has demonstrated that many bison kills represent catastrophic mortality. A communal kill especially should provide a snap-shot of the bison herd composition at the time of death. Implied from this argument is that any variations from what constitutes a normal herd must be because of environmental, cultural or transformation processes. What constitutes a "normal" generalized age group distribution is never explicitly defined by Reher. His figures (Reher 1970: 53) would suggest that there would be a large number of immature bison, with declining numbers of adult cows and only a small number of mature bulls. The small number of immature bison found at the Glenrock and Wardell site was likely the result of this age group being removed for further processing.

The Fitzgerald sample does not conform to this theoretical norm (Figure 7.6). This is probably because Reher's population does not take into account the possibility of a mixed assemblage. A bull herd might have been driven into the pound in a separate event from the nursery herd. As immature males do not join a bull herd until the age of three or four, such a bull herd would represent a large influx of mature animals into the archaeological sample.

No systematic study of epiphyseal closure rates for *Bison bison* has been published. Duffield (1973) and Dyck and Morlan (1995) present rates of epiphyseal closure that Koch and Empel and Roskosz derived from the European bison, *Bison bonasus.*. Where there are discrepancies, values reported by Empel and Roskosz (Dyck and Morlan 1995) are assigned. In general terms, most faunal elements fuse somewhere between the third and end of the sixth year of age in this species.

There is an obvious concern with using data derived from a species even as closely related as *Bison bonasus*. Even if these rates were derived from *Bison bison* species, uncertainties remain about using epiphyseal fusion to age animals bones. For

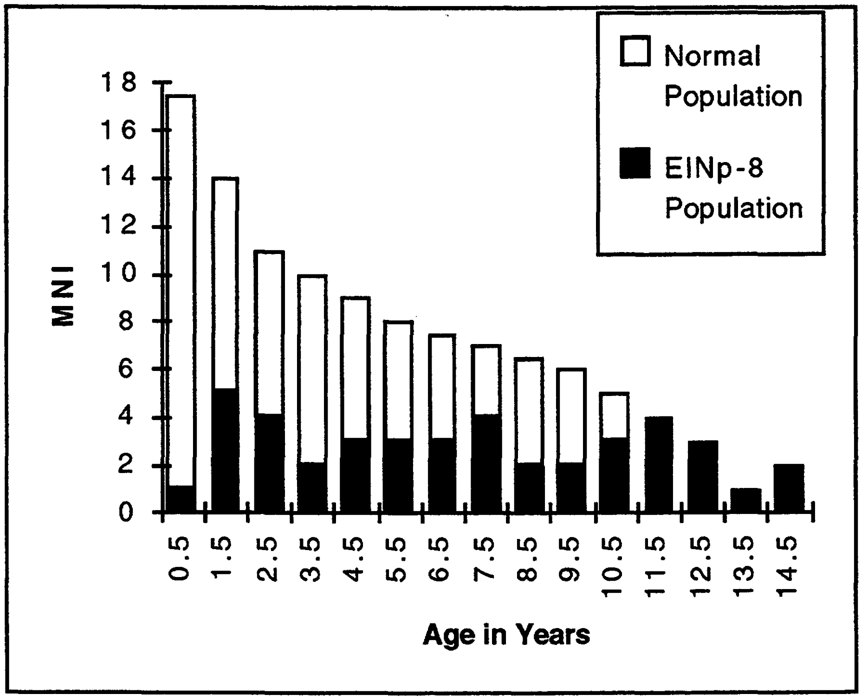


Figure 7.6: MNI on Mandibles and Maxillaries in Each Age Category Compared to a Normal Population

instance, health and nutrition play an important role in determining rates of fusion (Sadek-Kooros 1972: 369). Extreme ecological pressure like a drought, can delay epiphyseal fusion for an undetermined time.

These warnings aside, epiphyseal fusion still remains the only method of separating mature from juvenile long bone elements. There are 305 long bone elements in the kill area and 48 in the processing area. Unfused elements form 17% of the kill and 21% of the processing assemblage (Figures 7.7 and 7.8). Remembering that one third of the mandible population is below the age of three and a half, these numbers are somewhat smaller than expected.

However, the long bone does not fully represent the overall MNI for the site. Calcaneus elements are found in considerably more abundance then any of these other

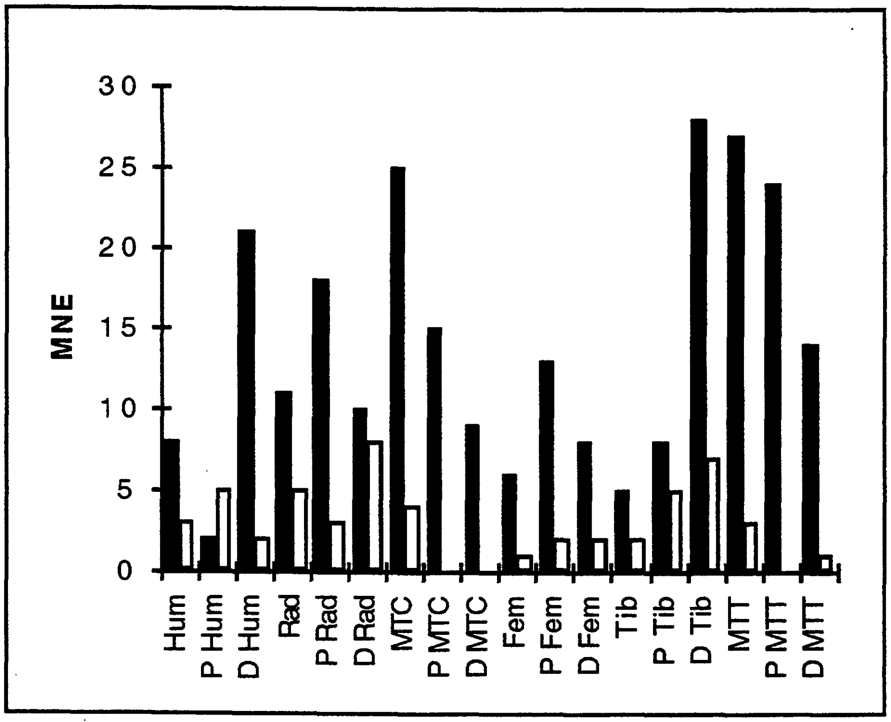


Figure 7.7: Number of Fused (Black) and Unfused (White) Long Bone Elements in the Kill Area

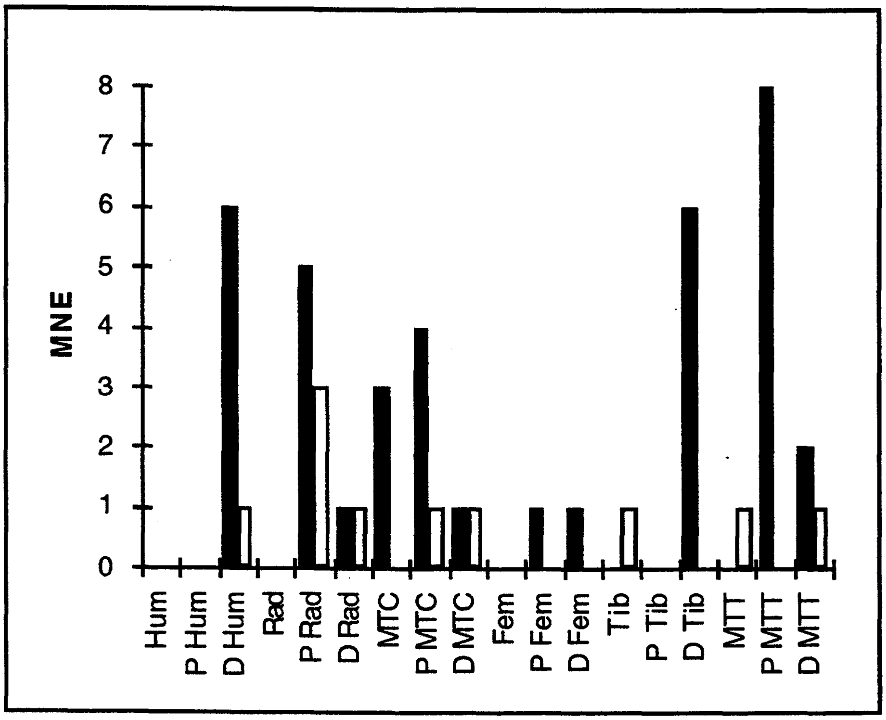


Figure 7.8: Number of Fused (Black) and Unfused (White) Long Bone Elements in the Processing Area

elements (MNE = 70). Over 38% of these elements were unfused. Fusion occurs in the fifth year in males and the sixth year in females. The calcaneus likely provides a more accurate reflection of the age structure of the bison sample than the long bones. The herd was made up of a substantial number of immatures (MNI = 15).

Other unfused elements are found in greater or lesser abundance than would be expected in a randomly derived sample. There are relatively large numbers of unfused proximal humeri (N = 5 of 10), distal radii (N = 7 of 17) and ulnae (N = 19 of 40) in the kill site. In the processing area, all of the proximal humeri (N = 2), distal radii (N = 1), proximal femora (N = 2), tibiae (N = 1) and metatarsals (N =1) are unfused. Juveniles make up less than their expected numbers for the following elements in the kill area: distal humeri (5%), proximal radii (13%), metacarpals (14%), proximal femora (15%) and metatarsals (10%). Especially curious is that only a single unfused distal metapodial was recovered in the kill. In the processing area, there are no unfused distal tibiae and few unfused distal humeri (17%).

7.3 Gender

7.3.1 Objectives

Realizing the potential influence of bison gender on hunting decisions, inferring the sex of faunal elements has become standard practice in Plains archaeology. Early attempts at sexing bison concentrated on complete elements such as mandibles and metapodials. However, it soon became clear that because of the butchering practices used by Plains peoples, few unmodified examples of these elements are recovered from kill and processing sites. Later efforts have concentrated on proximal and distal long bones, and dense bones like the phalanges, carpals and tarsals.

7.3.2 Methods and Analysis

Using mandibles collected from the Glenrock bison jump, Reher (1970) developed a series of measurements to determine their gender. Reher was attempting to create life tables and survivorship curves by determining the sex and age of mandibular elements. His method of aging bison was discussed earlier in this chapter. Determining gender was based on measuring the width of a mature adult mandible below the fourth premolar and the third molar. These measurements were then plotted on a bilateral scattergram. The resulting bimodal distribution was interpreted as being related to gender; larger specimens would be male, smaller being female. Using this method, Reher suggested that 9-14% of the Glenrock herd was male.

This method was later modified to include only a single measurement of mandibular height. Mandibular height is measured lingually from the alveolus to the base of the corpus at the third molar of mature animals. Results are plotted on an histogram, bimodality is interpreted as gender specific. Bulls being more robust will be larger then the more gracile cows. However, when Reher and Frison (1980: 74) used this test to sex the Vore Site population, the results did not correspond to that derived from metapodials by Bedord.

Reher's measurements were completed to determine if there was any correspondence between the age and sex of the mandibles. Wilson (1980) has criticized Reher's methods of determining age by using enamel height for not taking into account the sex of the bison involved. Implied is that molar height maybe partially the result of differences in the size between males and females. Unfortunately, the sample of mandibles that could be both aged and sexed from the Fitzgerald site (MNE = 15) is far too small to test accurately Wilson's conclusions.

Because of the poor condition of the corpus, only 22 (13 left and 9 right) of a sample of 65 mature mandibles from the Fitzgerald site could be measured. The results of this analysis were disappointing. Plotted on an histogram, mandible heights form three distinct clusters (Figure 7.9). Group 1 includes 6 left and 2 right mandibles between 68 and 70 mm in height. Group 2 mandibles (3 left and 5 right) are between 72 and 78 mm in height. Group 3 mandibles (4 left and 2 right) are between 78 and 82 mm in height.

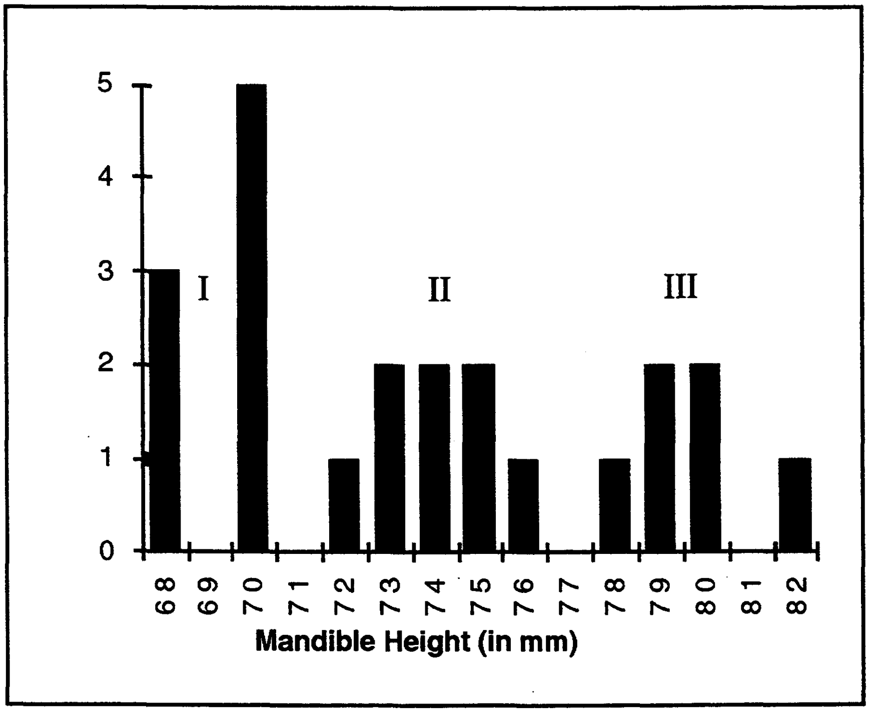


Figure 7.9: Mandible Corpus Height at M3 and Mandible Frequency

Group 1 mandibles are interpreted as representing females, Group 3 as males. It was impossible to discern whether Group 2 mandibles were male, female or a combination of the two. As a result, mandible height was dismissed from the Fitzgerald site analysis.

Walde (1995) has used discriminant function analysis on bison of known sex to produce 29 equations to determine the sex of proximal and distal ends of the humerus, radius, metacarpal, femur, tibia, and metatarsal. These equations are intended for analysis of mature bison as determined by complete epiphyseal fusion. Walde's equations are superior to other techniques for two principal reasons. First, these equations can be applied to fragmentary elements. As long bone elements are seldom left unmodified when processed, this is an important consideration. Second, they rely on simple equations to determine gender. Where the assemblage is small or potentially mixed, this technique would be much less prone to inaccuracy than cross-tabulations based on only two cohorts. In short, this technique would tend to limit biases in interpretation.

Walde's discriminant-function analyses are based on measurements derived from Speth (1983). A sample of approximately 33 bison of known sex was used to produce the measurements needed for the sample. Using a computer statistical program, equations were derived from these measurements "which can be used to classify unknown cases into defined groups" (Walde 1995: 10). Most equations have proved to be 100% accurate using known sex bison. None is less then 94% accurate. For the Fitzgerald assemblage this margin of error was considered acceptable even with the relatively small samples involved for the site.

Walde (1995: 38) has noted two consistent patterns of error in the application of his equations. First, immature proximal metacarpals and metatarsals cannot be distinguished from matures as there is no epiphyseal fusion. As a result immature males are often identified as mature females. Walde's equations also rely on a 1.6 equation difference to differentiate between males and females. Where the difference is less then 1.6, the element is defined as unidentifiable to gender. Walde (1995: 38) has noted "that more correctly assigned males are eliminated from the analysis than are correctly assigned females." Other factors that could affect the gender equation are cultural and taphonomic. Walde has noted that certain female elements are more susceptible to transformation processes than others. For example, the female proximal humerus is more prone to splitting then the male. Certain elements might also have been selected to be used as tools or fed to dogs.

Results from the use of Walde's discriminant function analyses were quite successful. Of the 290 fully fused complete, proximal and distal limb elements, some 63% (N = 183) were identified to sex. Almost all the complete elements (86%) and the greater majority (59%) of the proximal and distal elements were identified to sex. In the kill area, the MNE on fully fused limb elements is 252, of which 166 were identifiable to gender. Of the 38 fully fused limb elements in the processing area, 23 were sexed. None of the burned bone elements could be sexed. Results are summarized in appendices 7 to 12.

There are 305 long bone elements in the kill areas and 48 in the processing area. As no method has been developed to sex the ulna and because it does not figure into Emerson's (1990) utility indices, it has not been included in these numbers. Of the remaining long bone elements, 166 (82 male and 84 female) in the kill area and 23 (10 male and 13 female) in the processing area could be assigned to sex. There were 86 (30%) mature long bone elements from the kill and 15 (27%) from the processing area that as a result of cultural and taphonomic processes could not be assigned to gender.

An MNI of 49 for the complete assemblage has been derived from the central and fourth tarsal. Combining the results derived from the distal metapodials, over two-thirds of this MNI could be assigned to gender or age. There is a minimum of 13 bulls (left metacarpal), 11 cows (left metatarsal), 4 unidentifiable to sex matures (left metatarsal) and 5 juveniles (unfused left metatarsal) represented at the site. Walde's equations indicate that there is an almost even number of male and female bison.

By block, the MNI for bulls was 11 (distal metacarpal) in the kill and 3 (distal humerus) in the processing area. Female MNI was 11 (distal metatarsal) in the kill and 2 (distal humerus, proximal radius, proximal metacarpal and distal tibia) in the processing area. Immature MNI was 5 (distal tibia) in the kill area and 2 (proximal radius) in the processing area.

The gender-produced MNE for each limb element is presented in Figures 7.10 and 7.11. Comparing these results to the tabulated MNI it becomes clear that some elements were more successfully sexed than others. Almost all the complete bones were identified to gender. Virtually all the distal humeri and distal metacarpals were also sexed, as were the majority of the proximal radii, proximal metacarpals, proximal tibiae, proximal metatarsals and distal metatarsals. Less successfully sexed were the complete and distal femora, the distal radii and distal tibiae. None of the proximal humeri were assigned to gender. Determining gender derived meat, marrow and grease indices on some of the latter elements becomes problematical and will be explored more fully in Chapter 8.

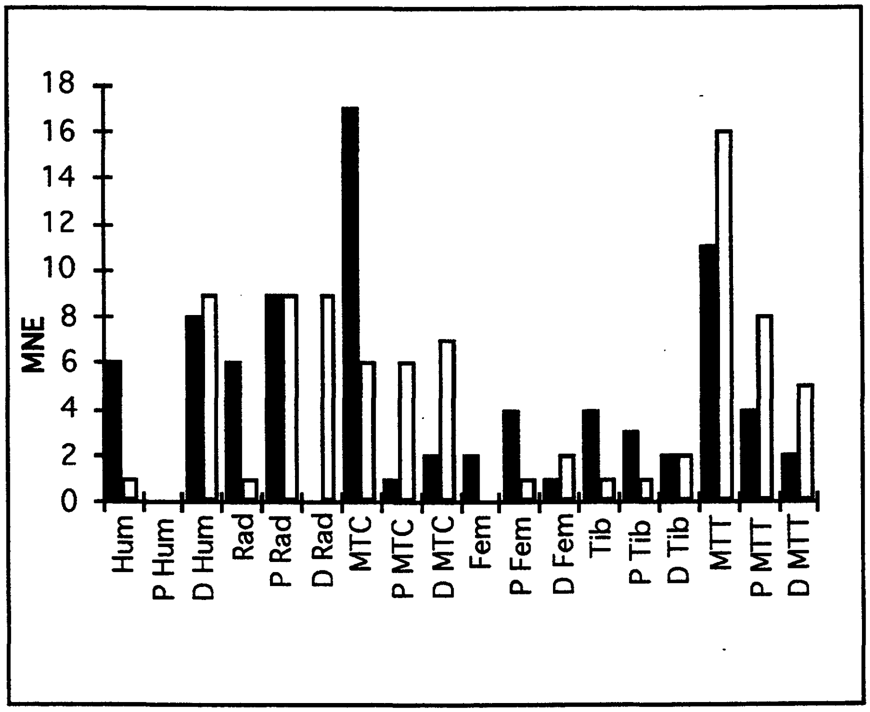


Figure 7.10: Number of Male (Black) and Female (White) Long Bone Elements in the Kill Area

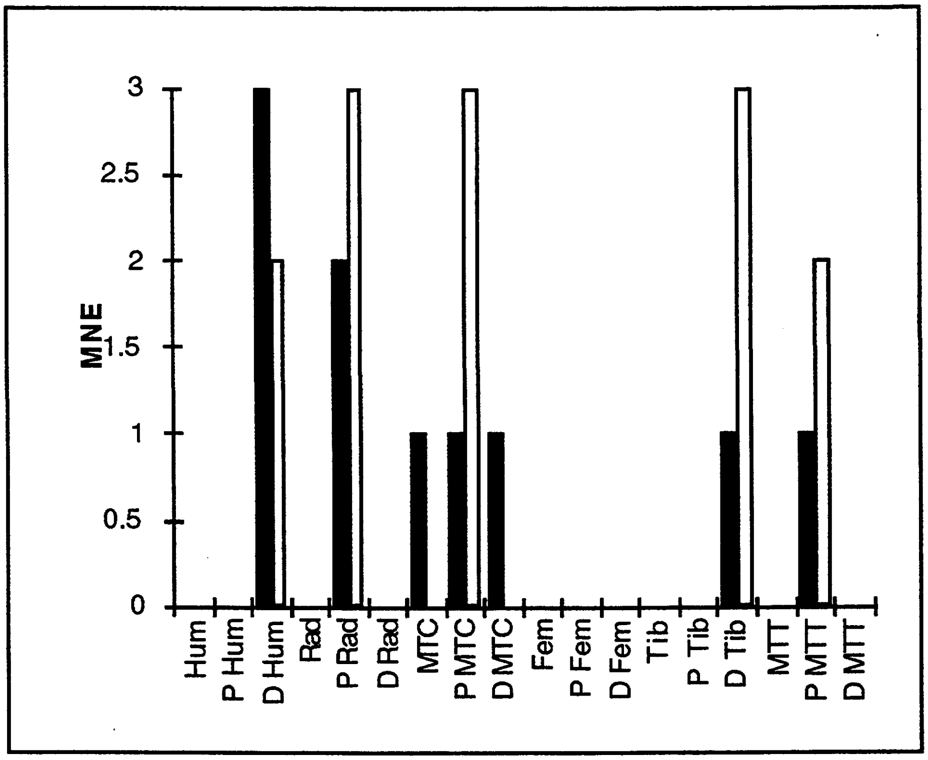


Figure 7.11: Number of Male (Black) and Female (White) Long Bone Elements in the Processing Area

Almost all the complete elements from the kill that could be assigned to gender are male. This includes 85% of the humeri (N = 6), 85% of the radii (N = 6), 74% of the metacarpals (N = 17), 100% of the femora (N = 2) and 80% of the tibiae (N = 4). The only broken element dominated by males is the proximal tibia (N = 3 of 4). Female dominated elements in the kill include 100% of the distal radii (N = 9), 75% of the proximal metacarpals (N = 6), 78% of the distal metacarpals (N = 7), and 71% of the distal metatarsals (N = 5).

Male elements were obviously being selected against in the kill area. A large number of the male elements remained unbutchered. Male metapodials in particular were completely ignored in the butchering process; only 6 of the 34 (17%) male metapodials in the kill were broken open to extract the marrow. Similarly, 43% of the male humeri (N = 6), 40% of the male radii (N = 6), 33% of the male femora (N = 2) and 57% of the male tibiae (N = 4) elements were left intact. In contrast, only 1 of 10 female humeri, 1 of 10 female radii, 0 of 2 female femora and 1 of 3 female tibiae elements were left intact. In the processing area, there are equal numbers of male and female metacarpal elements. Females form the majority of the proximal metacarpals (N = 3), distal tibiae (N = 3) and proximal metatarsals (N = 2).

Morlan (1991) developed a series of measurements on bison carpals and tarsals to help sex prehistoric bison populations. Morlan's methods rely on plotting a series of measurements on a bilateral scattergram. Bimodal distribution is interpreted as the result of gender. Recent work by Walker (personal communication 1995) on known-sex bison carpals and tarsals found no gender specific cohorts except with the calcaneus. Nevertheless, all measurements on carpals and tarsals are found in appendices 13 to 21.

Walde's methods only allow for slightly more than half the posited MNI for the Fitzgerald to be identified to sex. These results could be skewed by various cultural and transformation factors. For instance, certain long bone elements have higher amounts of grease and may be selected for. Conversely, calcanei have little food utility and would likely be removed from a site only as riders. Using the calcaneus, Morlan's method offers a useful check of the postulated gender MNI.

Strong bimodality was noted in a number of cross-tabulations using the mature calcaneus. As the calcaneus does not fully fuse until the age of 5 years in bulls and 6 years in cows of *Bos bonasus* (Dyck and Morlan 1995: 580), epiphyseal fusion was used to remove juveniles from the sample. Length seems to be the defining factor in determining sex in bison calcanei. Using length and proximal width (Figure 7.12), 17 elements are identified as bull and 19 as cow. Length and proximal depth (17 male and 18 female) and length and distal depth (17 male and 18 female) produced similar results (Figures 7.13 and 7.14). An MNI of 9 males and 11 females for mature calcaneus is postulated from these results.

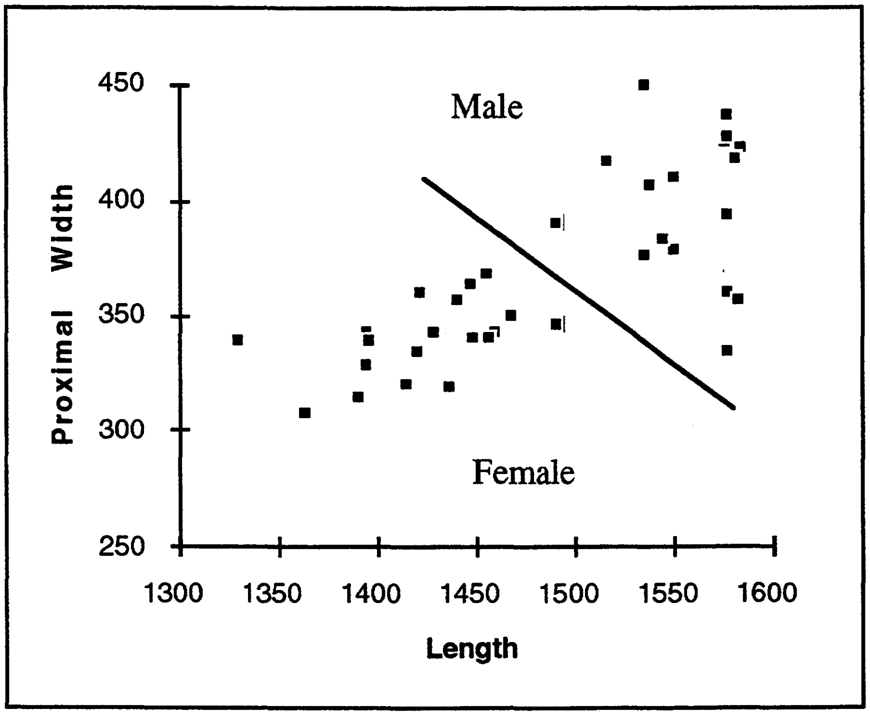


Figure 7.12: Mature Calcaneus Proximal Width and Length Bilateral Scattergram

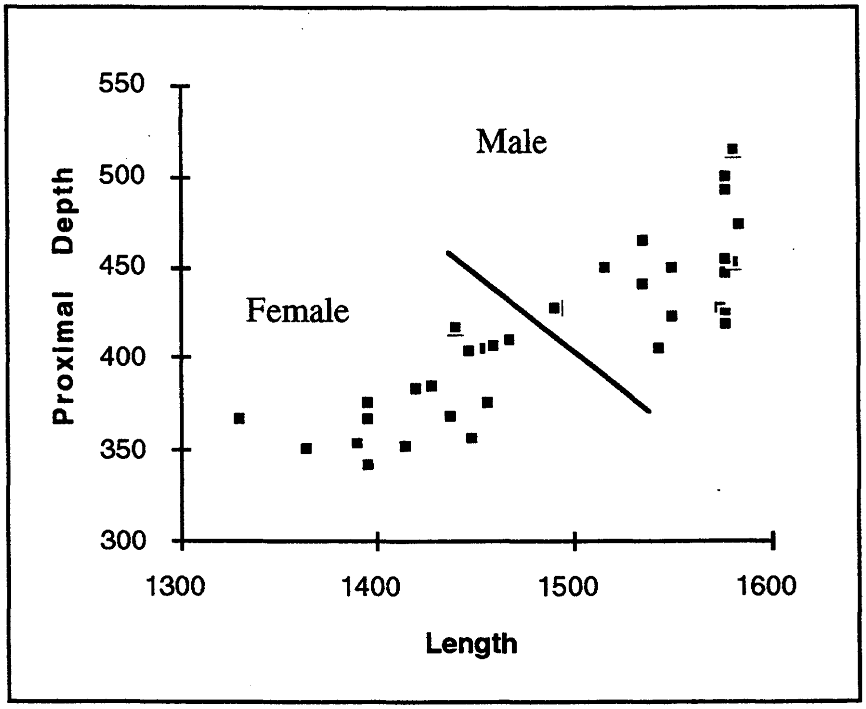


Figure 7.13: Mature Calcaneus Proximal Depth and Length Bilateral Scattergram

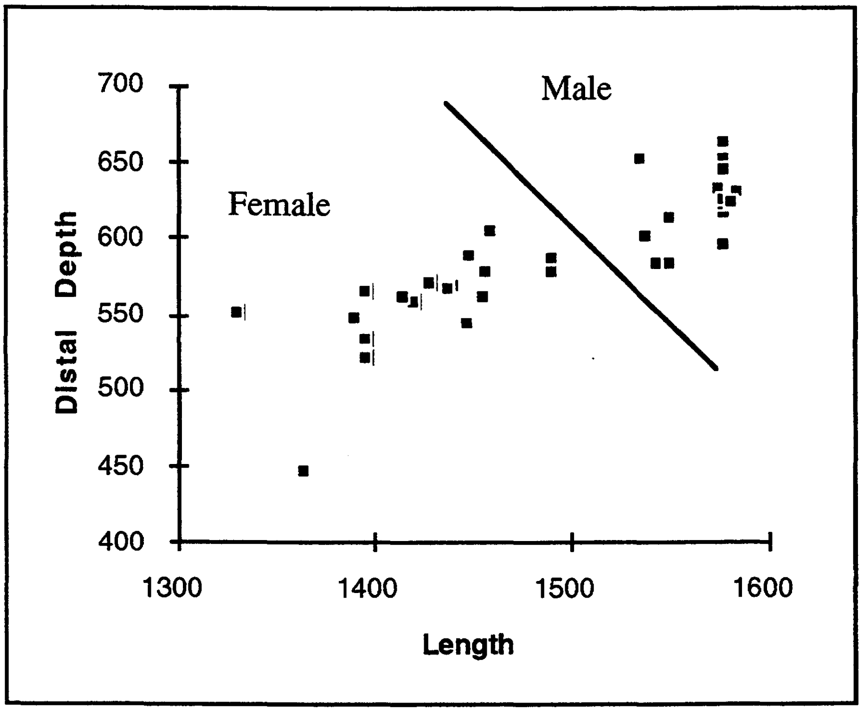


Figure 7.14: Mature Calcaneus Distal Depth and Length Bilateral Scattergram

There were 27 unfused and partially fused calcaneus elements (MNI = 15) at the site. Combining this information with the gender analysis, the herd composition can be portrayed with some confidence. It would seem that the herd consisted of a fairly large number of immatures (MNI = 15) and similar numbers of males (MNI = 9) and females (MNI = 11). These results compare favorably with those obtained on long bone elements using Walde's discriminant function analyses.

These results can be broken down into two of the three identified activity areas. In the kill area, eighty percent of the mature calcaneus (MNE = 38) were successfully assigned to gender. In total there were a minimum of 9 males, 10 females, 5 matures unidentifiable to sex and 15 immatures in the kill.

Only seven calcaneus elements (MNI = 4) were recovered from the processing area. There were no unfused elements and only three of the matures could be assigned to sex. A gender derived MNI of one male and one female and no immatures is posited for the processing area. No calcaneus from the burned bone area could be assigned to gender.

7.4 Discussion and Conclusions

It has been demonstrated that the Fitzgerald kill took place in the fall, likely between late October and early December. Almost 95% of the juvenile mandible and maxillary elements represent animals in seasonality groupings between x.5 and x.7. The separation of the mature maxillary and mandible M1 enamel heights into distinct clusters is also indicative of use over a single season.

Examination of the bison population structure has identified a number of unusual features (Figures 7.15 and 7.16). By employing both Walde's and Morlan's analytical approaches, it has been determined that mature bulls and cows are found in similar numbers. Coupled with the data on immatures derived from the mandible and maxillary sample (31%) and the fusion of the calcaneus (38%), it would seem that there are roughly equal numbers of juveniles, cows and bulls in the Fitzgerald assemblage. Most kills are either dominated by cows and calves, like the Glenrock (Frison and Reher 1970) and Wardell sites (Frison 1973), or by bulls as at the Norby (Zurburg 1991) and Finley Sites (Hapsel and Frison 1987).

In general terms, bison herds are known to be gender specific. While some bulls will remain with the cows and calves for most of the year, the majority of the males tend to graze in separate herds. Only during the late summer rut is this trend reversed; from late July until late September the bulls will join the cow and calf herds. Communal hunting at this time of year might result in a herd composition similar to that postulated for the Fitzgerald assemblage. Two of the mandibles that were recovered at the site might have been from juveniles that were slaughtered in the late summer or early fall.

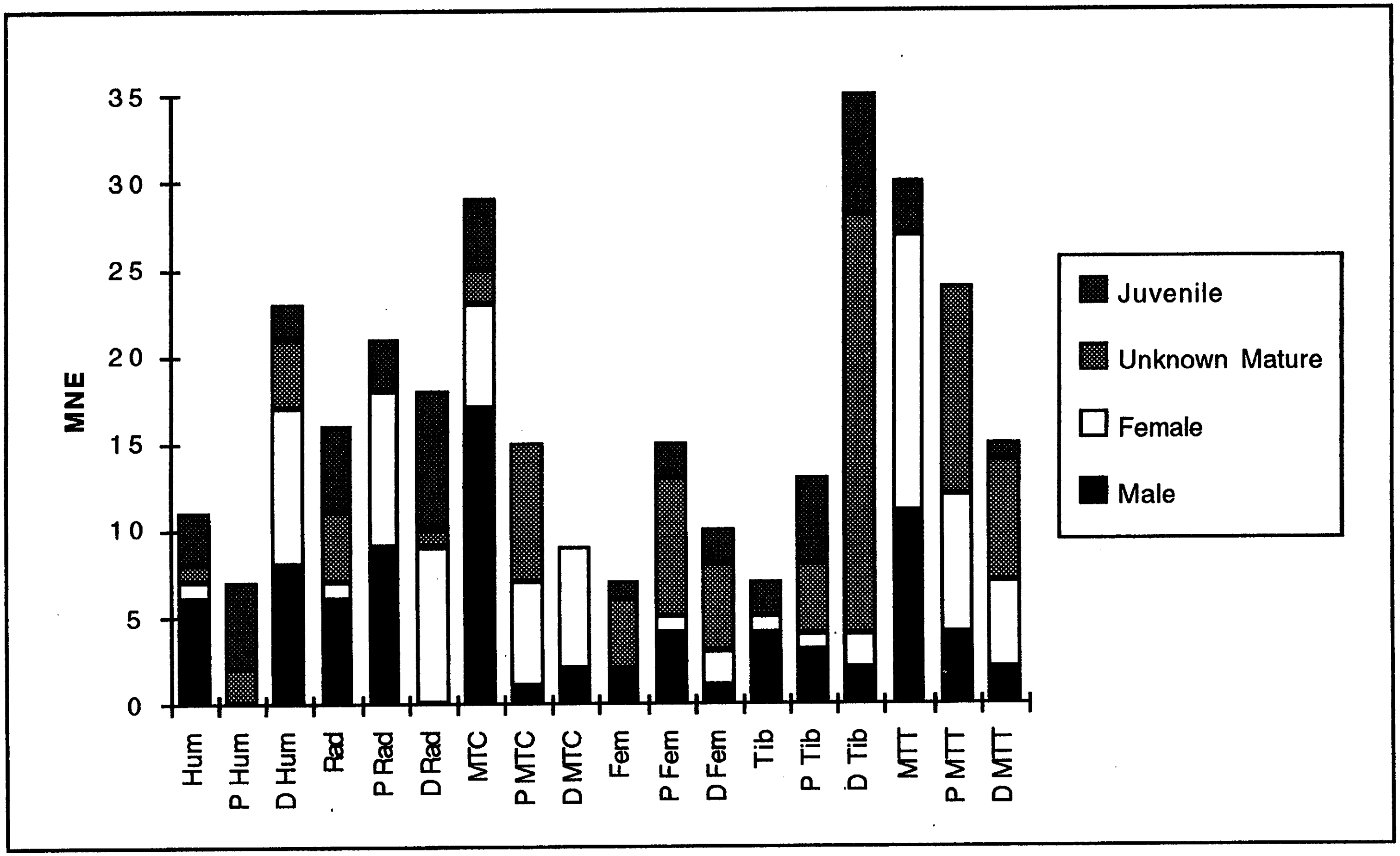


Figure 7.15: Demographic Profile of Long Bone Elements from the Kill Area

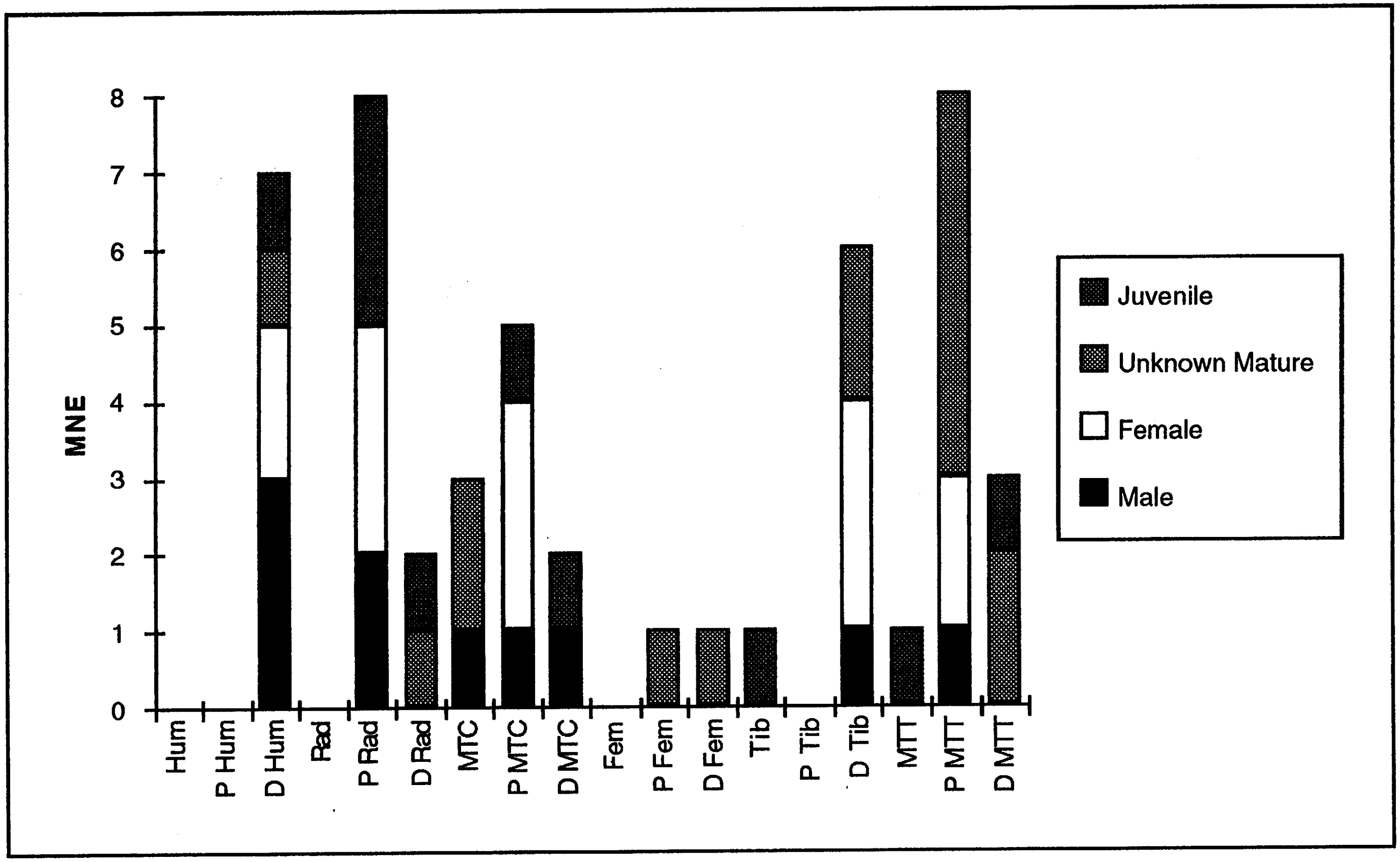


Figure 7.16: Demographic Profile of Long Bone Elements from the Processing Area

It is unlikely that the kill took place in the summer. First, nearly 95% of the juvenile mandibles indicate that the hunt occurred at least two months after the end of the rut. Second, historic and ethnographic accounts are clear that communal hunting during the rut was not practiced on the Plains. The herd, especially the bulls, was described as being very difficult to manage properly (McHugh 1958, Frison 1974). The meat was also said to taste bad at this time. This may be the result of heavy adrenaline flow and the fact that the bulls virtually stop eating during this period, losing 100s of kilograms of weight within a few months.

A more likely scenario is that the Fitzgerald site represents an aggregate of numerous separate kill episodes. If these events involved both bull and cow/calf herds, the result would be an assemblage similar to that found at the site. That is, the bulls from the Fitzgerald site represent one kill event and the cows and calves characterize another separate event.

This scenario can also be criticized. Recent work by Emerson (1990) and Brink (1994) suggest that male and female bison go through a yearly cycle where the amount of available fat, marrow and grease varies considerably from one season to the next. Most importantly, the bulls and cows are on considerably different cycles. As a result, the optimum time to hunt bulls would be in the early summer and the worst time would be in the early fall. For cows, the optimum time to hunt would be in the late fall, the worst time would be in the spring. Presuming that the Fitzgerald hunters were aware of this trend, it is doubtful that they would have hunted these two types of herds at the same time of year.

An attempt was made at dividing the mandible sample into two units representing the cow/calf herd and the bull herd. By eliminating the bulls from the sample it was postulated that the cow/calf herd might better correspond to Reher's normal population structure. Because the mandibles could not be successfully sexed, the mature population was divided equally between the bulls and cows. Immatures were included with the cow population. These results show that the cow/calf herd (Figure 7.17) and the bull herd (Figure 7.18) are still quite dissimilar to what Reher (1970) describes as a normal bison population structure. There is a noticeable absence of bison from the 6 month old age categories and an overabundance of older mature bison.

Strong arguments can be made questioning if bison populations were as predictable as McHugh suggests. Indeed, fluctuations in the number of calves in a caribou herd has been known to vary by as much as 400% (Driver 1983: 145). Similar variance may be the result of predation. Wolves, coyotes and other predators are known to cull herds of the weakest members of the population. For instance, though elk calves make up only 28% of a normal population, 53% of the animals that fall prey to predators are calves (Collier and White 1976: 99). The assumption that there is a "natural population structure with certain invariate proportions of all age and sex classes" may indeed prove fallible (Collier and White 1976: 97).

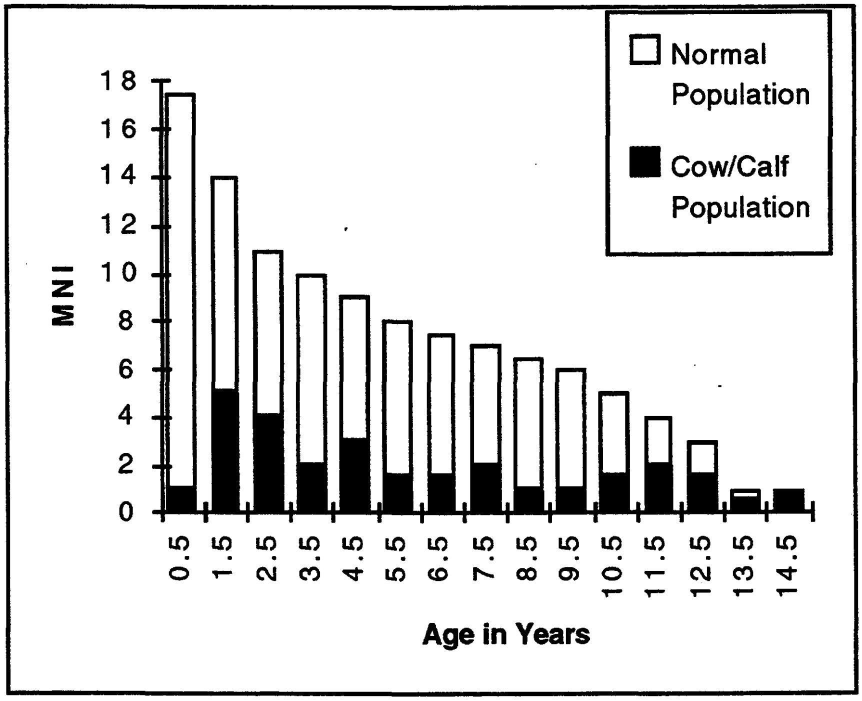


Figure 7.17: Age Distribution of an Hypothetical Cow/Calf Population and a Normal Population

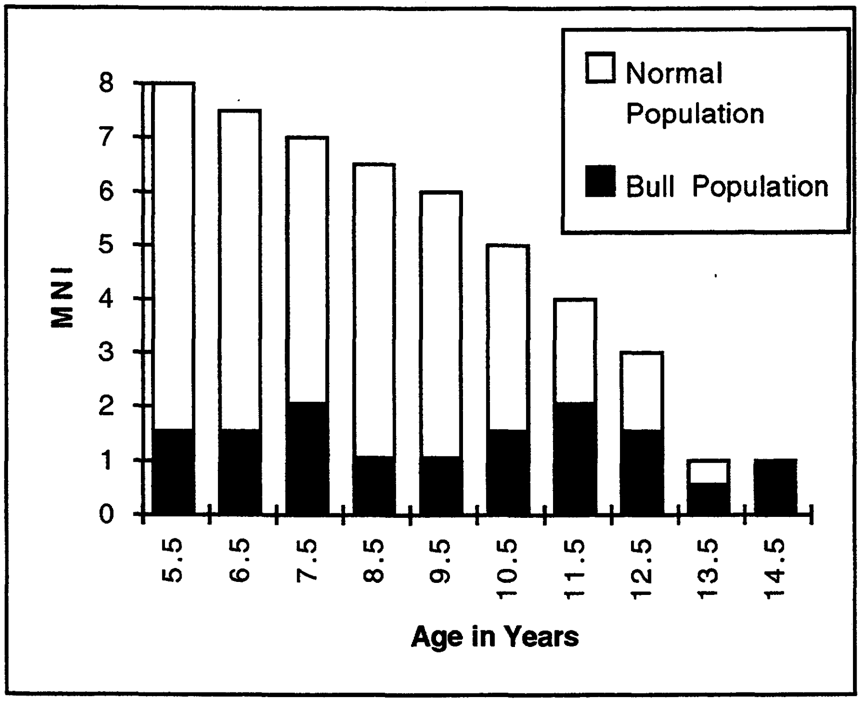


Figure 7.18: Age Distribution of an Hypothetical Bull Population and a Normal Population

Another unusual feature at the Fitzgerald site is that there is only one immature under the age of one year. This is a situation that seems at odds with McHugh's (1958: 31-32) suggestion that in a normal, healthy herd, yearlings should make up the largest number of bison of any age class. With a 85-90% pregnancy rate and a calf survival rate into the first winter of 70%; calves should comprise 50-80% of the cow population in a kill (Reher and Frison 1980: 75).

It must be asked whether these results are the product of natural, ecological or cultural processes. For example, immature animal bone is more susceptible to weathering and carnivore ravaging (Kurten 1964; Munson 1991). However, natural taphonomic processes are unlikely to eliminate a single age cohort from an archaeological assemblage (Driver 1983: 142). As has been previously demonstrated, carnivore chewing seems to have had a minimal affect on the Fitzgerald faunal assemblage.

The sample of bison mandibles and maxillaries is quite small. Any conclusions are based on an assemblage of only 54 mandible corpus elements, far fewer then the 200 that Reher (1970) recommends to reconstruct an adequate demographic profile of a bison population. As a result, the absence of certain age categories may reflect nothing more then the relatively small amount of excavation that was conducted in the kill area.

The absence of 6 month old bison is likely cultural. Other researchers have recognized that foetal and yearlings constitute a disproportionately low number of the bison population in kill assemblages. Reher and Frison (1980: 75) have found that the majority of the expected juvenile population was missing from bison kill sites like Vore, Wardell, Glenrock, Olsen-Chubbock, Bonfire Shelter, Jones-Miller and Casper. On the Canadian Plains, calves constitute only a small number of the assemblage at the Melhagen (Ramsay 1991: 157) and Happy Valley Sites (Shortt 1994).

Cultural factors that could explain these shortages include either differential hunting or butchering processes. Suggestions have been made that communal hunting practices might have accidentally or deliberately allowed juvenile calves to escape death. For instance, young calves may have been lost as they were physically unable to keep up with the main herd as it stampeded into the corral (Wilson 1980). Agenbroad (1978) states that calves were also able to escape from certain types of traps. McHugh (1958) dismisses these types of scenarios as unlikely. The people that operated these corrals were too knowledgeable in the behavior of bison to 'accidentally' lose on a regular basis what was likely considered a food delicacy. Bison were not forced to stampede until they were as close to the corral as possible so there would be little room for the calves to be somehow left behind.

Roe's (1970: 62-64) argument that a deliberate conservation strategy was employed by the pre-contact hunters also seems doubtful. There are no historic or ethnographic references of this phenomenon. In fact, historic observers like Fiddler and

McDougal are adamant that it was bad luck to let any bison escape as they could inform the other herds of the pound and "therefore render it useless in the future" (Verbicky-Todd 1984: 52). There are also many accounts of calves being hunted in the pound. John McDougal comments on how young boys were "turned into the pound to fight the calves" after the adults had been killed (Verbicky-Todd 1984: 97). Hind writes of the "piteous moaning of the calves" (Verbicky-Todd 1984: 91) as they were slaughtered and of an abandoned pound with over 200 dead buffalo ranging in age from "old bulls to calves of three months old" (Verbicky-Todd 1984: 89).

The most reasonable explanation for the lack of neonates in the Fitzgerald sample would be differential butchering processes. While young animals do contain less meat, marrow and grease (Emerson 1990), other factors would suggest that these animals would be selected for specialized butchering practices. The most likely scenario would be that the complete calf would be removed from the kill unbutchered and taken to either the margins of the kill, a separate processing area or the camp site (Reher, 1973: 103). Ethnographic accounts would seem to confirm this hypothesis. For example, Wissler (1910: 25-26) describes how "(d)ressed calves were wrapped in fresh hides" and roasted whole in a hide covered pit. Bedord (1978) has also argued that because of the softness of calf hides, they would be selected to make clothing.

The maxillary and mandible population also indicates that there are a considerable number of older animals in the Fitzgerald sample. Normally, it would be expected that there would be a steady decline in the numbers of bison as they became older. Instead, the herd population seems to have remained stable over time; there are as many 11 year olds as there are 2 and 7 year olds. That the attrition rate is so low, suggests that the Fitzgerald population was exceptionally healthy.

The overabundance of older bison is difficult to explain, though these results are somewhat consistent with Reher and Frison's (1980) Vore model. At the Vore site, communal kills were found to have occurred only once every 25 years. Reher and Frison argue that humans aggregate only after years of peak environmental conditions. Taking a cultural ecological approach, they concluded that there was a critical number of bison needed for a successful communal hunt. As moisture patterns are on a ten year cycle and bison populations were closely correlated with grassland productivity and hence precipitation, this critical number was only reached every ten years (Reher and Frison 1980: 40). Communal hunting was, then, a relatively rare phenomenon.

That so many of the adult bison survived to such a great age at the Fitzgerald site would suggest that they were living during a period of peak environmental conditions. Indeed, the Fitzgerald kill took place near the end of a period that was more moist than today. As has been discussed in Chapter 2, this was an optimum time for bison, and hence bison hunters, to live on the Plains. The bison population may have rarely, if ever, declined below the "critical number" needed for successful communal hunting (Frison 1980).

Chapter 8

Butchering Analysis

8.1 Introduction

Butchering is "a set or series of sets of human activities directed towards the extraction of consumable resources from a carcass" (Lyman 1994b: 297). Analysis has shown that the butchering practices at the Fitzgerald site can be identified. This section seeks to reconstruct how major elements of the bison were treated during the butchering process. All major elements will be examined individually; differences between the kill, processing and burned areas will also be investigated. Analysis will seek to reconstruct the butchering sequence at the Fitzgerald site.

8.2 Butchered Elements

8.2.1) Axial Skeleton

The axial skeleton has undergone heavy processing, especially in the kill area. There are few complete elements, but substantial numbers of articulations. This is likely the result of the uneven distribution of meat and fat associated with these elements. Specific portions of some elements were removed from the kill area, while other portions were abandoned.

a) Skull

Kill Area (%MAU = 98.6)

Bison skull elements constitute the second largest portion of the Fitzgerald assemblage, accounting for nearly 99% of the MAU for the site. It must be noted that the MAU for the Fitzgerald site is based on the petrous portion of the skull, which because of its density and low food utility survives taphonomic and cultural processes better than most faunal elements. Only eight complete or near complete skulls were recovered from the site.

The high MAU count on the bison skull is consistent with most other kill sites on the Plains. At the Garnsey and Olsen-Chubbock sites, skulls were used to infer the MAU on bison species (Speth 1983; Wheat 1972). An exception to this routine is the Melhagen site where the skull %MAU is less than 25% (Ramsay 1991: 310).

Contrasted against the large number of petrous portions, the recovery of only eight complete skulls indicates that most of these elements were highly fragmented. Determining whether this is the result of cultural or taphonomic processes is difficult. Because skulls are highly fragile, they are quite susceptible to trampling, weathering and other post depositional stresses.

The eight skulls that were recovered were in excellent condition. They demonstrate no adverse effects from the taphonomic processes previously mentioned. As well, there are no concentrations of cranial fragments that might be indicative of fragmented skulls (Lawrence Todd, personal communication 1993). The processes that resulted in the scattered quantities of fragmented cranial bone are likely cultural.

That the majority of the skulls at the Fitzgerald Site are highly fragmented is not unusual. This situation is repeated at such Besant kills as Kremlin (Keyser and Murray 1979), Melhagen (Ramsay 1991), and Muhlbach (Gruhn 1971). Skulls contain some edible meat and for that reason were often deliberately fragmented. The skull could be opened through the frontal or occipital to remove the brain. The palate (Frison 1973) or nasals (Keyser and Murray 1979) could be split to obtain the gristle beneath. The maxillae would be broken just above the molars "to gain access to the large marrow cavity dorsal to these teeth" (Lyman 1978: 7).

There is considerable evidence that some of the skulls were treated with some care. The eight complete skulls remain remarkably intact; there is no evidence of the removal of the articulating elements or evidence of brain extraction.

Archaeologically, complete skulls are located in abundance at the Olsen-Chubbock (Wheat 1972), Vore (Reher and Frison 1980) and Garnsey sites (Speth 1983). However, specialized treatment of the skull is most often associated with the Besant phase. Numerous sites have demonstrated the Besant people placed a special, spiritual importance in the use of the bison skull. This point is most amply demonstrated at the Ruby site in Wyoming (Frison 1971) and the Sonota burial mound sites along the Missouri River in North and South Dakota (Neuman 1975).

At the Ruby site a small structure was found seven meters east of the main kill (Frison, 1971). This feature has been interpreted as a ceremonial structure linked to the calling of the buffalo to the pound. Several skulls were found placed along the outer edge. At many of the Sonota burial mounds located along the banks of the Missouri River in North and South Dakota, bison skulls feature prominently (Neuman 1975, Frison 1971). For instance, the Grover Hand Mounds (39DW240) contained a number of bison elements in association with the human burial chambers (Neuman 1975). The second of the three mounds contained 25 secondary burials, Besant points and a number of bison skulls. An immature bison was recovered on top of the burial chamber.

At the Fitzgerald site, the skull was removed either at the joint of the atlas and the occipital condyle or at the atlas and the axis. Unfortunately, none of the skulls was found in articulation with other elements, including the atlas and the mandible. This makes it difficult to reconstruct exactly how the head was removed.

The large number of atlases recovered in the kill (%MAU = 55.6) indicate that these elements were deliberately segmented from the skull. This could indicate that the skull was removed from the vertebral column at the articulation of the atlas and the occipital condyle. The skulls from Garnsey (Speth 1983) and Wardell (Frison 1973) are reported to have been removed in a similar fashion.

However, at the Fitzgerald site, there is much stronger evidence that the skull was removed instead at the atlas/axis joint. A considerable number of articulations of the axis and the third cervical were recovered. This includes two nearly complete articulations of the spinal column beginning at the axis, not the atlas. There are no butchering marks on either the occipital condyles or the atlases. In contrast, the axis odontoid process was segmented in four separate cases.

The removal of the skull at the atlas-axis joint is quite common in other Besant kill sites. The Muhlbach, Happy Valley (Shortt 1993), and Kremlin (Keyser and Murray 1979) kill sites exhibit similar butchering patterns. This pattern is repeated at non-Besant sites like the Glenrock Buffalo jump (Frison 1970), the Archaic occupation at Bonfire Shelter (Dibble and Lorraine 1968) and the kill sites located along the Lower Granite Reservoir in Washington (Lyman 1978).

It is possible that the skull was removed both at the atlas-axis and atlas-skull articulation at the Fitzgerald site. A similar situation is reported at the Donovan Site (24HI91) (Keyser and Murray 1979). Here, the majority of the crania (75%) had chopping marks on the occipital condyle or atlas. In another 25% of the instances, the separation occurred at the atlas/axis. A different scenario is preferred. Rather than a case of two separate butchering practices for the removal of the skull, the data suggest that the skull was first removed from the spinal column at the joint between the atlas and axis. The atlas was then removed from the skull after it had been disarticulated from the vertebral column. This explanation would account for the large number of atlases located in the kill area and the recovered articulations. It also suggests that the skulls were removed from the vertebral column early in the butchering process.

Processing Area (%MAU = 57.1/43.8)

There were moderate quantities of skull specimens in the processing (NISP = 46) and burned (NISP = 92) areas. The MAU counts were based on the petrous portion. The skulls had been highly fragmented; no complete or near complete elements were recovered. As a result reconstructing past butchering patterns was extremely difficult.

b) Mandible

Kill Area (%MAU = 75)

There were 54 mandible elements recovered from the kill. They form a significant proportion of %MAU for the site, over 75% in the kill. The high %MAU counts are partially based on the ability to separate age groups based on tooth eruption schedules and the metaconid height of the first molar (Frison and Reher 1970).

There are three major butchering activities associated with the mandible. They include the removal of the hide, tongue and marrow. Pemmican manufacture is not usually associated with the mandible because of the low grease content found in the element (Emerson 1990).

Evidence of hide removal is usually found in the form of cut marks on the ventral side of the mandibles directly below the second and third premolars (Frison et al. 1976) or on the anterior-ventral border of the corpus (Frison 1970; Keyser and Murray 1979). Unfortunately, due to the poor condition of the Fitzgerald bone, cut marks were only observed on one mandible (artifact number 5963). Here, a series of 13 cut marks were found 2.5 to 4.5 cm below the second molar on the ventral surface of the corpus.

No articulations of the mandible and the skull were recovered at the Fitzgerald site. Neither were there any mandibles still fused at the symphysis. That separation might have occurred naturally can be discounted; pairs of mandibles were only rarely encountered.

Only 12 of the mandibles were left completely unmodified in the kill area; another 11 mandibles were nearly complete. The %MAU of 26.8 on the ramus and 39 on the corpus indicates that a significant proportion of the Fitzgerald mandible sample had the ramus broken off. The break usually occurred along a line running from the angular process to just posterior to the third molar. Where the ascending ramus was left intact, the coronoid process was broken off in nearly half (43%) the cases. Significant numbers of coronoid processes were also recovered separately in the kill area. The mandibular condyle was usually left intact.

The shattering of the coronoid processes and the ramus is consistent with efforts to disarticulate the mandible from the skull. Severing the mandible at the juncture of the corpus and ramus is a common pre-contact butchering practice. This pattern is repeated at the Happy Valley (Shortt 1993), Muhlbach (Shortt 1993), Piney Creek (Frison 1967), Kremlin (Keyser and Murray 1979) and Garnsey (Speth and Perry 1980) kill sites.

Evidence of tongue removal is usually found in the form of cut marks on the lingual surface of the mandible or on the hyoid (Frison 1967, 1970 and 1973). These cuts would be used to help remove the mylohyoideus muscle that suspends the tongue. Cut marks of this type were found on only one of the Fitzgerald mandibles (artifact number 13894). This mandible had four cut marks located on the lingual surface of the corpus, posterior to the third molar.

Of the seven complete hyoid specimens found in the kill, two (one right and one left) had a series of cut marks along the proximal-anterior portion of the body. Cut marks were also found on the side of another anterior fragment of indeterminate side. These cut marks are likely associated with cutting of the same mylohyoideus muscle.

As previously described, no mandibles were found still fused at the symphysis. It is likely that the mandibles were being deliberately segmented to process the tongue. The tongue was considered one of the most desirable portions of the bison (Wheat 1972). Disarticulation was achieved by splitting the mandible at the symphysis and by breaking the mandible at the diastema. This method of removing the tongue is found at only two other kill sites, English (Keyser and Murray 1979) and Muhlbach (Shortt 1993).

Including the complete mandibles, there were 54 complete or near complete corpus in the kill. About half of these (48%) had the diastema removed. This was achieved with a blow to the ventral surface anterior and posterior to the second premolar. As a result, this area was often spirally fractured.

That there are 12 completely unmodified mandibular bodies is unusual. Only at the Ruby Site were complete and paired mandibles recovered in significant quantities (Frison 1971). It is possible to remove the tongue without damage to the mandible or ascending ramus. Kehoe's Blackfoot informants state that the "tongue could be pulled out without breaking the jaw" (Kehoe 1967: 69-71). This would be achieved "by making an incision in the middle of the under jaw and pulling the tongue through the slit and then cutting it off at the roots" (Wheat 1972: 100).

At the base of the corpus there exists a large marrow cavity that is often exploited. At the Happy Valley, Hawken and Wardell kills, the mandibular corpus was split horizontally, distal to the molar and premolar roots, in an effort to remove this marrow. Fifteen of the Fitzgerald mandibles are also split along this same ventral border. There were also a significant number of fragmented mandibles with seemingly random portions of the molars and premolars still in articulation. The fragmenting of the corpus is also consistent with the opening of the marrow cavity.

Processing Area (%MAU = 78.5/62.5)

Similar large numbers of mandible elements were recovered in the processing area. Only three of these mandibles are complete. All but three (70%) corpus have the diastema broken off below the second premolar. Significantly, only one diastema specimen was recovered in this area; the disarticulation of the mandible took place in the kill. These butchering practices could indicate that the corpus was used to carry the tongue out of the kill area (White, in Brumley 1973).

However, this hypothesis is contradicted by the fact that only one hyoid element was recovered in the processing area. If the corpus still had the tongue in place, the hyoid might remain in articulation. If the tongue was being processed, the hyoid would have been removed and abandoned in this area.

More likely, the mandibles were taken from the main kill for marrow processing. Only half of the 14 corpus elements are complete, the rest are split horizontally along the distal border. Marrow rather than tongue processing was the dominant activity in the processing area.

c) Cervical Vertebrae

Atlas

Kill Area (%MAU = 55.6)

There are numerous atlas elements at the site. Most of these elements in the kill site remain complete (N = 16). No articulations of the atlas and the skull and only one articulation of the atlas and axis were recovered. As has been previously discussed, this is a result of the atlas being removed from the skull after disarticulation from the axis. The Muhlbach site demonstrates a similar butchering style (Shortt 1993).

Axis

Kill Area (%MAU = 61.1)

Axis vertebrae are mainly found in the kill site. Most (86%) of these elements remain fairly complete, with some minor damage to the spinous and transverse processes. This is a pattern repeated at the Happy Valley site in south-central Alberta (Shortt 1993).

A small sample of odontoid processes (MNE = 5) that have been split from the axis centrum were also found in the kill area. Only a strong, direct blow with a chopping tool to the base of the odontoid would successfully remove this portion. This butchering practice is not reported at other archaeological sites.

Four axes were found in articulation with the third cervical. One axis was in articulation with the atlas. The relative absence of atlas/axis articulations and the removal of the odontoid are consistent with the hypothesis that the skull was first removed at the atlas-axis joint.

Cervical 3 to 7

Kill Area (%MAU = 53.3)

Most of the cervical vertebrae remain unmodified. In the kill area there were 96 complete or near complete examples of this element. Consistent with this fact is that five articulations of the cervical were also recovered in the kill.

Many of the Cervicals 3 to 5 recovered have some damage to the spinous processes but it is difficult to decide whether to attribute this to cultural or other taphonomic processes. Consistent damage to the spinous processes of cervicals 6 and 7 is likely cultural, a result of the removal of the hump meat and the depouille, a "strip of fatty tissue" that runs along the base of the spine (McHugh 1972: 92). Usually associated with this process are cut marks along the base of the spinous processes (Frison 1970 and 1973); however, none were recognized at the Fitzgerald site. This is likely a result of the poor condition of the bone.

A consistent butchering practice is the fracturing of the pre and post-zygapophyses. There were 116 examples of these elements recovered in the kill area. The disarticulation of the vertebral column is the most likely explanation for this phenomenon. Similar butchering practices have been noted at the Happy Valley and Muhlbach kill sites (Shortt 1993). That there are no chop or cut marks on the centrum may be attributable to root etching, weathering or abrasion (Frison 1973).

That the cervicals were disarticulated is not surprising, as this portion of the bison contains a large proportion of the bison meat and intermuscular fat (Emerson 1990). The large number of vertebral centra in the kill can be explained by the fact that these elements have little grease value. The Fitzgerald site cervical assemblage is consistent with most other kill sites on the Northern Plains.

Processing Area

Atlas (%MAU = 28.6/37.5)

Axis (%MAU = 28.6/100)

Cervical 3 - 7 (%MAU = 20/85)

There are no articulations of the cervical in this area. In contrast to the kill, only one zygapophyses specimen was found. This would indicate that the disarticulation of these vertebrae was completed exclusively in the kill area.

In the processing and burned areas there was only one complete atlas element. Most are highly fragmented portions of the articular facets. A single axis was found in the processing area, two were recovered in the burned area. Only six other complete cervical elements were recovered, all in the processing area. Deboning of the meat in the neck was completed almost exclusively in the kill area.

d) Thoracic Vertebrae

Kill Area (%MAU = Centrum 57.3; Spinous Process 13.7)

There are 77 complete thoracic vertebrae at the Fitzgerald site. However, their abundant numbers are somewhat misleading. Nearly half the unmodified thoracic vertebrae come from two almost complete articulations of the spine found in the kill area. Another 18 articulations of the thoracics were located in the kill area.

Most thoracic centra from the kill (N = 212) have had the spinous process removed. The spine is usually broken off between two and ten centimeters from the base of the arch. A small percentage (12%) of these thoracic centra have the complete arch removed.

In contrast, thoracic spinous processes account for a quite small proportion of the sample in the kill. While there are over 128 of these specimens, most of these elements are quite small and/or are part of the proximal portion of the process. Only eight distal fragments were identified.

That most of the thoracic spines have been separated from the centrum, and then removed from the kill area, is consistent with other Plains kill sites. This portion of the axial skeleton contains exceptionally large quantities of meat and fat. Most of these resources are fixed to the spine, so the centra could be easily discarded in the kill area to remove bulk. The large number of articulations of the thoracic vertebrae would indicate that even the splitting of the vertebral column was of low priority.

Consistent with the removal of the depouille, there is some evidence of cut marks on the proximal portion of the spinous processes (Frison 1970, 1973). Three proximal spinous processes were recovered with cut marks (artifact numbers 18, 63 and 1194). Upwards of ten cut marks were found on these specimens just distal to the posterior portion of the vertebral arch. The poor condition of the bone may have resulted in cut marks not being identified on the other spines. However, the only other sites where no cut marks are reported are the Fresno (Keyser and Murray 1979), Melhagen (Ramsay 1991), Muhlbach and Happy Valley kills (Shortt 1993). Interestingly, all of these sites are Besant. This might suggest that a specialized butchering technique virtually unique to Besant was in place.

More thoracic vertebrae were found in articulation than any other element. Seventeen articulations, involving 68 thoracic vertebrae, were observed. There are no chop or cut marks on the thoracic centra that would help explain how the remaining thoracic vertebrae were disarticulated. After removal of the spinous processes, the vertebrae underwent very little further processing.

Processing Area (%MAU = Centrum 14.3/8; Spinous Process 6.1/22.3)

In the processing and burned areas, there were no complete thoracic vertebrae. Thoracic centra (N = 13) compose only a small percentage of the sample. None of these elements are in articulation. There are also relatively few spinous processes (MNE = 6) in these areas, only two of which are distal end fragments. No cut marks were identified.

Obviously, processing of the thoracic vertebrae was not an important activity in these areas. Spinous processes would be separated in the kill and further processed in an undetermined location. Thoracic centra would be abandoned in the kill area after the spinous process had been removed.

e) Lumbar Vertebrae

Kill Area (%MAU = Centrum: 50.6; Transverse Process: 1.9)

There is a relatively large number of lumbar vertebrae in the kill area. About half of the 91 elements are complete; the remaining 42 lumbar have had the spinous process and/or the transverse processes removed. The removal of these processes is common in most bison kills (see Frison 1970, Frison 1973, Keyser and Murray, 1979, Shortt 1993 and Speth 1983).

The spinous and transverse processes seem to have been removed by chopping at or close to the arch and centrum. A minimum of only four lumbar arches have been fragmented. There is no indication of any chopper marks on the centra as seen at the Wardell bison kill (Frison 1973). Neither are there any cut marks thought to be associated with the removal of the depouille (Frison 1973).

Few transverse processes were recovered. This may partially be the result of identification problems. The wing, when fragmented, is easily misidentified as a rib body or thoracic spinous process. However, the almost complete absence of these elements is consistent with other kill sites like Happy Valley (Shortt 1993), Garnsey (Speth 1983) and Wardell (Frison 1973) and processing sites like Wardell (Frison 1973).

There were ten articulations of the lumbar involving 29 elements abandoned in the kill area. In contrast, a large number of zygapophyses were recovered. As has been previously demonstrated, these segments were broken off when the vertebral column was disarticulated.

Processing Area (%MAU = Centrum: 8.6/17.5; Wing: 7.1/1.3)

There are also very few lumbar in the processing and burned areas. No articulations and only a single zygapophysis was recovered from these locations. There are also few spinous and transverse processes (MNE = 6). Two of these transverse processes had a series of up to 39 cut marks on the distal portion. Irrespective, most lumbar processes, after being initially butchered in the kill, were removed to another location for further processing.

f) Sacrum

Kill Area (%MAU = 44.4)

Sacrae are found in relative abundance at the Fitzgerald kill site. At other kill sites like Melhagen (Ramsay 1991: 310), Evans (Schneider and Kinney 1978), Happy Valley (Shortt 1993) and English (Keyser and Murray 1979), they are notable for their absence.

The sacrum was removed from the rest of the axial portion during the butchering process. They are rarely found in articulation with either the innominate (N = 1), lumbar (N = 3) or caudal vertebrae (N = 0). It is often reported that the sacrum was chopped to help disarticulate it from the lumbar and innominate (Frison 1970, 1973). As a result, impact marks could be visible either on the centrum or along the transverse processes (Frison 1973). At the Fitzgerald site, the proximal portion of the sacrum remains complete. However, three specimens show evidence of impact at the transverse process. This would suggest that removal from the lumbar was done relatively carefully, while the pelvis was disarticulated with some force. At the Fitzgerald site over a third of the sacrae were unmodified, indicating that the caudal vertebrae were removed without damage to the distal end. Many other sacra (N = 6) were broken at the first sacral. The break at this point would be the result of either trying to disarticulate the sacrum from the pelvis or the caudal vertebrae.

These methods of disarticulating the sacrum and caudal vertebrae have not been reported at other sites. At the Glenrock and Wardell sites, the removal of the caudal vertebrae occurred at either the fifth sacral or at the sacral-caudal border (Frison 1973). At the Hawken site, the distal portion of the sacrum was crushed to remove the tail.

Processing Area (%MAU = 14.3/50)

Sacrae are almost completely absent from the Fitzgerald processing and burned areas. The anterior portion of a single centrum broken at the first sacral was the only specimen recovered. It was not in articulation with any other elements, including the caudal vertebrae.

g) Caudal Vertebrae

Kill Area (%MAU = 4)

There are virtually no caudal vertebrae found in the Fitzgerald assemblage. There are only 29 elements represented in the kill, 86% of which are complete. None of these elements were found in articulation.

While the fragility of these elements might explain their absence, examination of other sites would suggest that their absence from the assemblage is cultural. At every kill site excavated on the Plains, it has been noted that caudal vertebrae are either completely absent or present only in exceptionally low numbers. Processing sites like Piney Creek and Wardell also contain a dearth of these elements. Considering the low food utility value associated with this element, their absence must be for other reasons. One explanation is found in a document by Tixier who reported that the "tail is the trophy of the conquerors" (Wheat 1972: 98). Another, more common, suggestion for their absence is that they were removed from the kill area with the hide (Dibble and Lorraine 1968, Frison et al. 1976). Frison explained that the caudal "served as a handhold to pull the hide loose from one side" (Frison 1970: 11).

Processing Area (%MAU = 2.9/1.3)

Only four caudal elements were found in the processing area, and two in the burned bone area. All of these elements are complete, none are in articulation. Clearly, the tail was removed to another portion of the site.

h) Rib

Kill Area (%MAU = Proximal: 39 Distal: 22.3)

Ribs compose a comparatively large proportion of the MAU for the Fitzgerald site. There are also large quantities of rib bodies in the kill site (NISP = 1993), but because of the fragmented nature of these remains, it is extremely difficult to sort them to individual element. Any MNE count on rib bodies would be comparatively low.

Ribs were butchered in a quite consistent style at the Fitzgerald site. Many of the proximal ribs show evidence of cut marks on the proximal lateral portion of the body. These cut marks were probably the result of the removal of the depouille. Rather than remove this portion of meat by cutting dorsally at the spinous processes of the thoracic, this cut was made laterally from the proximal end of the rib. This pattern is repeated at the Melhagen site (Ramsay 1991: 192-193).

After extracting the depouille, the rib meat was removed. Analysis of the proximal ends suggests that the rib bodies were removed in one of two ways. The majority were broken approximately five centimeters distal to the tuber. Evidence of spiral fracturing at this location would suggest that this break was achieved with a large chopper. The large numbers (MNE = 153) of individual head elements recovered in the kill also indicate that many ribs were broken at or near the articulation with the thoracic portion of the vertebral column.

This method of disarticulating the rib from the thoracic vertebrae is consistent with other kill sites such as Glenrock, Wardell, Ruby, Melhagen, Happy Valley and Muhlbach. Some variation does exist in how the ribs were broken. Most similar to the Fitzgerald materials is again the Melhagen site (Ramsay 1991). At Happy Valley the breakage occurs either within 10-20 cm of the proximal end or at the tubercle (Shortt 1993). At the Glenrock and Wardell kills, ribs were broken either close or far from the proximal end (Frison 1970, 1973).

The large number of rib body specimens in the kill area suggests that some processing of the ribs occurred *in situ*.. Similar high numbers are found at the Happy Valley site. Many of the ribs would be later removed to another location for further processing.

Processing Area (%MAU = Proximal: 9.2/4.5 Distal: 3.6/4.5)

Ribs form a fairly small proportion of the faunal remains from the processing area. There are similar numbers of proximal and distal portions of the rib. The small number of these elements would indicate that processing did not continue outside the kill area. Similarly, few ribs were found in the processing area at the Wardell processing site.

8.2.2 Appendicular Skeleton

Most of the appendicular skeleton has been heavily processed. Only portions of low economic utility like the metapodials, phalanges, carpals and tarsals have been left unmodified. There are only 111 complete long bone elements and 26 articulations from this portion of the bison. Half of these articulations are of the complete forelimb (excepting the scapulae and phalanges). None of these were in articulation with the axial skeleton.

a) Scapula

Kill Area (%MAU = 54.2)

Scapulae were found in quite large quantities in the kill. The %MAU is based on portions of the glenoid cavity. Only 12 complete or near complete elements were recovered. None of these were in articulation with the humerus, but four were in articulation with the axial skeleton. The majority of the scapula specimens are highly fragmented. Most of these elements are either fragments of the intra- and supraspinous fossa, the acromion spine, or the glenoid cavity. Only one of these fragments (artifact number 1296) had cut marks. These were located on the proximal-anterior portion of the left caudal border.

It seems likely that much of the damage to the scapula is the result of taphonomic rather then cultural processes. The blade in particular is susceptible to damage. However, it does seem that the glenoid was subject to specialized butchering practices. The scapula was broken transversely between the glenoid fossa and the acromial spine.

The scapulae were likely split to remove the abundance of meat and intermuscular fat associated with the scapula blade. There is a large number of glenoids (MNE = 34), the result of trying to remove either the humerus or scapula blade. This pattern of removing the glenoid is repeated at the Muhlbach (Shortt 1993), Wardell (Frison 1973) and Hawken sites (Frison et al. 1976). There is no evidence of cut or hack marks on any of the scapulae. However, four scapulae found in articulation with the axial skeleton are not broken at the neck. The humerus was also disarticulated without damage to the glenoid. This could indicate that the forelimb was removed early on in the butchering process.

Processing Area (%MAU = 100/25)

A large number of scapulae were recovered in the burned areas of the kill. This element is used to establish the MNI (8) in the processing area. Most of the processing area scapulae are incomplete; the majority of the fragments are of the glenoid cavity. The few blade fragments recovered in this area make it implausible that the scapula was processed in this region. The glenoid might have acted as a rider. However, no articulations of the humerus and scapula were recovered.

b) Humerus

Kill Area (%MAU = Complete: 15.3; Proximal: 9.7; Distal: 31.9)

Humeri comprise only a small portion of the Fitzgerald site assemblage. Considering the large amount of meat, marrow and grease associated with the element, it is not surprising to note that the majority of the elements are highly fragmented.

Only eight complete humeri were recovered from the site. All are from the kill area. Only one of these elements is from a mature female. Three other nearly complete male humeri have been split at the greater trochanter, probably in an effort to access the marrow. Marrow could have been extracted with a sharp object such as a stick or rib body.

The proximal end of the humerus is rich in grease and as a result only seven elements, two of them juvenile, were recovered in the kill. The five mature proximal elements could not be identified to sex. Distal elements were found in relative abundance. Most of these elements were either male (5 left and 3 right) or females (5 left and 4 right). Two of the distal elements (1 left and 1 right) were identified as immature.

Most complete and proximal humeri have had the shaft removed. Proximal ends were removed proximal to the deltoid. The greater tuberosity is usually missing or extensively damaged. This may be the result of this portion being "used as a handle in separating the supraspinous and infraspinous muscles" (Shortt 1993: 106). This hypothesis is supported by the fact that no greater tuberosities were recovered anywhere at the site.

Distal ends were usually removed five to ten centimeters proximal to the proximal portion of the epicondyles. In four instances, larger portions of the shaft were left attached the distal portion. There was considerable damage to the lateral and medial epicondyles in three elements. There were also a large number of fragmented condyles (NISP = 27) recovered. This was likely the result of trying to disarticulate the humeri from the radius and ulna with a chopping tool.

The pattern of small numbers of proximal, medial numbers of complete humeri pieces and relatively large numbers of distal humeri fragments is to be expected. The large number of spirally fractured shaft specimens (NISP = 48) indicates that while many humeri were removed from the kill, the majority were processed for marrow removal *in situ*. The proximal portion was then later taken from the kill area for grease retrieval. Male and juvenile humeri were being selected against during the butchering process.

The general patterns outlined above are repeated at most other archaeological sites on the Northern Plains. Few sites have many complete elements or proximal elements, and distal portions have undergone varying levels of butchering. It is expected that male and juvenile humeri would be selected against in the butchering process. The removal of the greater tuberosity occurs at the Happy Valley (Shortt 1993) and Glenrock kill sites (Frison 1970).

Processing Area (%MAU = Complete: 0/0; Proximal: 14.3/0; Distal: 50/18.8)

No complete or proximal humeri fragments were recovered in the processing area. The only proximal humeri elements recovered were two immature heads. Nearly all (83%) of the distal humeri elements are either from bulls (3 right) or cows (2 left).

Almost certainly then, processing of the humerus was completed out side of this area. Only mature animals would be exploited for their bone marrow and grease.

c) Radius

Kill Area (%MAU = Complete: 22.2; Proximal: 29.2; Distal: 25)

Recovered radii elements account for a somewhat larger proportion of the Fitzgerald assemblage than would be expected for their economic utility. By element, there are an especially large number of proximal radii.

There were twelve complete radii found in the kill. All but one of these represent male (1 left and 5 right) or juvenile animals (2 left and 3 right). A comparatively large number of proximal elements (MNE = 30) were recovered. Proximal elements are dominated by mature males (4 left and 5 right) and females (4 left and 5 right). The few distal elements recovered are either cows (5 left and 4 right) or immatures (5 left and 3 right). The proximal and distal elements have substantial portions of the shaft still attached to the end. The removal of the marrow dominated radius processing.

There were eight articulations of the radius and ulna found in the kill. Two of these were also in articulation with the humerus. There were no articulations of the radius with the carpal array. Proximal and distal elements remain relatively free of further butchering. On five elements, some damage was noted to the proximal posterior portion. This may have been a result of trying to disarticulate the radius from the ulna.

The fairly large number of radius elements is not uncommon in other kill assemblages. The Muhlbach (Shortt 1993), Happy Valley (Shortt 1993), Donnovan, Piney Creek (Frison 1967), Glenrock (Frison 1970), Wardell (Frison 1973) sites all report large quantities of distal and proximal ends. Unusual are the large number of complete elements and radius-ulna articulations at the Fitzgerald site. Only EdOn-15 and Muhlbach report such large quantities of complete elements (Shortt 1993). No other sites contain radius-ulna articulations in such abundance as the Fitzgerald site.

The kill area assemblage demonstrates that sex was important in determining which animals were used for marrow and grease extraction. Apparently, these female and juvenile radii were processed only for marrow; the male proximal radii were removed for more systematic grease processing. The distal radius is the only element where bulls were selected over the cows.

Processing Area (%MAU = Complete: 0/0; Proximal: 57.1/18.8; Distal: 14.3/37.5)

There were no complete radii in either the processing or burned area. The considerable numbers of proximal radii (MNE = 8) indicate that substantial processing of this element occurred in this area. Distal radii are virtually absent, likely removed for grease manufacture. No sex or age group was selected for for any of these elements. There are equal numbers of juveniles (1 left and 2 right), mature males (2 left) and females (2 left and 1 right). Cut marks are located on only one element (artifact number 15527). Five cut marks were found on the proximal-lateral portion of a shaft specimen.

d) Ulna

Kill Area (%MAU = 55.6)

Ulnae are found in high frequencies at the Fitzgerald site. A fairly large proportion of the ulnae are juveniles; nearly 40% of the olecranon processes from the kill have not yet fused. No methods have been yet developed for sexing the ulna.

Most of the ulnae are broken, usually proximal to the trochlear notch. Breaking the element here would be consistent with disarticulation of the ulna and radius from the humerus. This practice is common in other archaeological assemblages as well. It is seen in Besant sites like Muhlbach, Happy Valley and EdOn-15 (Shortt 1993), and other Late Prehistoric sites like Glenrock (Frison 1970) and Garnsey (Speth and Perry 1980). As already noted, articulations with the radius have not been found in abundance at other archaeological sites.

Processing Area (%MAU = 57.1/18.8)

Fifty percent of the ulna sample are juvenile. None are in articulation with the radius. Similar to the kill, most of the sample is broken proximal to the trochlear notch.

e) Carpals

Kill Area

Substantial numbers of carpals exist at the Fitzgerald site (Table 5.1). In the kill the %MAU on the internal carpal is 94.4. The vast majority (92%) of these elements remain complete. No evidence of cut or chop marks exists and only three carpal arrays were found in articulation.

The large numbers of complete and articulated elements argue strongly that these elements were deliberately discarded. It is doubtful that more then a few of these elements entered the processing area as riders. This pattern is also represented at the Happy Valley and Muhlbach sites (Shortt 1993).

Processing Area

In the processing and burned areas, the carpals %MAU is about 50%. Most carpal elements are unmodified, none are in articulation. They likely entered this part of the site with either the radius or metacarpal and then were removed and discarded.

f) Metacarpal

Kill Area (%MAU = Complete: 41.4; Proximal: 19.5; Distal: 9.8)

There are a large number of metacarpals in the Fitzgerald assemblage. Most of the metacarpals are complete; there were 29 complete elements in the kill. There are about half as many proximal and distal elements. Only five of the proximal and distal elements have been fragmented.

Evidence of cut marks was found on two metacarpals. One proximal metacarpal portion (artifact number 4944) had a series of 19 cut marks on the anterior surface between six and ten centimeters from the proximal end. A single cut mark was found on a complete metacarpal in a similar location 7.5 cm from the proximal anterior end. As little edible meat is found on the metacarpal, these cut marks are likely associated with hide removal. Similar cuts have been found on metacarpals from the Kremlin (Keyser and Murray 1979), Melhagen (Ramsay 1991) and Happy Valley sites (Shortt 1993).

In the kill area, the great majority of the unmodified metacarpal elements are male (10 left and 7 right); there are only six female (3 left and 3 right) and four juvenile completes (3 left and 1 right). In contrast, there are very few juvenile and male distal and proximal elements. Over three-quarters of the broken metacarpals that could be sexed are female (4 left and 2 right proximal elements, and 3 left and 4 right distal elements). There was 1 right proximal male and 1 left and right distal male element. No immature broken distal metacarpals were recovered during excavation.

Over 60% of the distal and proximal portions of the metacarpal in the kill have large portions of the shaft still attached. This fact, coupled with the abundance of these elements indicates that marrow removal was the dominant activity associated with metacarpal processing. Gender analysis indicates that marrow removal concentrated almost exclusively on female elements, a feature echoed at the Melhagen site (Ramsay 1991).

The large number of metacarpal elements recovered at the Fitzgerald site is not unique. Most kill sites contain an abundance of these elements. Sites where there are also substantial numbers of complete metapodials include Muhlbach, Happy Valley, EdOn-15 (Shortt 1993), Kremlin (Keyser and Murray 1979) and Garnsey (Speth and Perry 1980).

Gender analysis indicates that marrow removal concentrated almost exclusively on female elements. However, it must be remembered that there is no epiphyseal closure in proximal metapodial elements. There is also a tendency for "three year old males to be identified as females" (Walde 1995: 25). As a result, some of the proximal elements that have been identified as females are likely juvenile.

Processing Area (%MAU = Complete: 21.4/0; Proximal: 35.7/12.5; Distal: 14.3/6.3)

Considerable numbers of metacarpal elements were recovered in the processing area. Only three metacarpals are complete, the rest are proximal and distal elements with large portions of the shaft still attached. Only one of the three complete metatarsals could be identified to sex (right male). Three of four proximal units represent female (1 left and 2 right); the only identified distal element was a left male. None of the elements were juvenile.

The sample would indicate that age and sex played an important role in deciding whether to process the metacarpal. Processing concentrated on mature females. That most of the shaft is still attached to the metacarpal ends and that shaft elements are relatively scarce is indicative of marrow processing.

g) Phalanges

Kill Area (%MAU = First: 77.8; 2nd: 85.4; 3rd: 68.4)

There were more phalanges identified in the kill than any other element at the Fitzgerald site. They form a substantial percentage of the MAU. They were likely deliberately abandoned because of their low utility. The somewhat smaller number of third phalanges may indicate that these elements were deliberately removed from the kill area, maybe to made into glue.

Most phalanges (90%) remain unmodified. However, there were 34 first phalanges that were broken near the distal end. This may be a result of an attempt to disarticulate these elements from the metapodials. This practice is unusual. Most archaeologists speculate that phalanges were removed at the tibia or tarsals (Frison 1973). Whichever the case, these elements were treated as waste elements.

Processing Area (%MAU = First: 48.2/32.8 2nd: 25/26.6 3rd: 23.2/23.4)

There were 54 phalanges identified in the processing area. However, there were no articulations. The considerably smaller MAU counts in the processing and burned areas would indicate that the hoof was usually first removed in the kill area. The few phalanges that were found in the processing area likely entered the location as riders with the metapodials.

h) Innominate

Kill Area (%MAU = 56.9)

There are a considerable number of the various portions of the innominate in the kill. None of the innominates were assigned to a particular age or gender group. The pelvic elements from the Fitzgerald site are highly fragmentary; only two complete innominates have been identified. There are also relatively few ilium, ischium and pubis specimens in the kill. Most pelvic fragments are broken portions of the acetabulum. Because of the fragmented nature of the remains, it is impossible to discern any recognizable butchering patterns.

A single articulation of the ilium and the sacrum, and of the acetabulum and the femur, were recovered. The pattern recognized at Bonfire Shelter (Dibble and Lorraine 1968) and the Piney Creek site (Frison 1967) where the acetabulum was removed from the kill site in articulation with the femur is unlikely to have occurred at the Fitzgerald Site. The acetabula are consistently split into small fragments, possibly to facilitate the removal of the femur. This pattern is repeated at the Happy Valley Site (Shortt 1993) and the Melhagen site (Ramsay 1991: 193).

Processing Area (%MAU = 42.9/6.3)

There are no complete innominates or articulations with the sacrum and femur. The most complete specimen is a left acetabulum; the remaining elements are highly fragmentary. Like the kill, there are also relatively few ilium, ischium and pubis specimens in the processing areas. Compared to the kill and processing areas, there are relatively few pelvic remains in the burned area.

i) Femur

Kill Area (%MAU = Complete 9.7; Proximal: 20.8; Distal: 13.9)

Femora form a small proportion of the Fitzgerald assemblage. There are especially few distal elements. Emerson (1990) has found that the femur provides more economic utility then any other long bone, so these low numbers are to be expected.

Most of the femur elements were broken. The majority of these proximal elements are either male (41%) or juvenile (33%). An additional 31 spirally fractured shaft specimens (MNE = 9) were recovered. At the proximal end, most femora are broken distal to the lesser trochanter. At the distal end, breakage occurs 5 to 10 cm above the proximal end of the trochlea. A small number (N = 5) have nearly the complete shaft still attached. These patterns are all consistent with marrow removal.

All but six of the proximal femur specimens recovered had extensive damage to the greater trochanter. Only one of these complete elements represents a male. However, no separate greater trochanter specimens were recovered. It might be that the greater trochanter was used as a handle to carry the meat from the kill area.

Interestingly there were seven complete femora recovered in the kill. Considering the high utility that this element has, the presence of even a small number of completes is quite surprising. One of these elements was immature and was not subjected to gender analysis. Unfortunately, only two of the mature specimens could be identified to sex; both are considered to be from adult males.

There was one articulation of the femur and the acetabulum. There were also no cut marks on either the head of the femur or the acetabulum. None of the proximal femur elements had the head removed. However, a large number (N = 11) of separate femur head and neck specimens were recovered. The femur could be broken at the neck for one of two reasons. One is to disarticulate this element from the pelvis. The paucity of articulations of the femur and acetabulum would argue against this hypothesis. A second, more likely, explanation is that the femur was disarticulated from the pelvis by smashing the acetabulum. Then the head and neck were removed to reduce bulk. This would explain why there are no proximal elements without the head and neck. This is a pattern witnessed at EdOn-15 (Shortt 1993), Muhlbach (Shortt 1993), Glenrock (Frison 1970) and Kremlin (Keyser and Murray 1979).

There were no articulations of the femur and the tibia. Evidence of chop marks on the proximal portion of the trochlea was found on six elements (2 left and 4 right). These marks are likely the result of the butcher disarticulating the femur, patella and tibia. This evidence is supported by the recovery of a fairly large sample of patellae (MNE = 30). Damage to the posterior condyles is minor.

Processing Area (%MAU = Complete: 0/0 Proximal: 21.4/31.3 Distal: 7.1/12.5)

In the processing area, there are no complete proximal or distal elements. There is a minimum of two femur heads and two condyles. A large quantity (NISP = 20) of shaft elements were recovered. The processing of the proximal and distal ends for grease occurred in an as yet unidentified area. However, the number of shaft elements would indicate that some marrow processing was completed in this area.

j) Tibia

Kill Area (%MAU = Complete: 9.7; Proximal: 18.1; Distal: 48.6)

Most of the tibia elements present in the kill and processing areas are distal ends. The large amounts of grease associated with the proximal tibia explains why there are so few complete and proximal ends. Distal tibiae are found in relative abundance. A reliable assessment of what percentage of the distal elements were male or female could not be established.

The complete (86%) and proximal (92%) tibia units are dominated by bulls (3 left and 1 right) and immatures (2 left). Female tibiae were being selected for during marrow and grease manufacture. The proximal tibia was systematically removed from the excavated portion of the site to another area for heavier processing.

There are only three articulations of the tibia, all with the tarsal array and metatarsal. One of these elements (artifact number 8841) has chopping damage to the proximal-anterior portion indicative of disarticulation from the femur and patella. Cut marks were only found on a single proximal-lateral shaft portion (artifact number 2742).

The butchering of the tibia follows a pattern set at the Muhlbach and Happy Valley sites (Shortt 1993). After disarticulation and meat removal, the tibia would be broken near the proximal and distal ends of the shaft to facilitate marrow removal. Breaking the distal end might also have served as a way of removing the tarsal array from the more utilitarian upper leg portion (Shortt 1993). Distal and shaft elements could then be discarded to help reduce bulk. The proximal end would be later removed for further processing. The small proportion of female tibia elements indicates cows were selected for in both of these activities.

Processing Area (%MAU = Complete: 0/0 Proximal: 7.1/31.3 Distal: 42.9/6.3)

The processing area tibia assemblage is dominated by distal ends. There was one proximal tibiae recovered and it was immature. Spirally-fractured shafts were also found in abundance. One proximal-medial shaft element (artifact number 15527) had two distinct sets of cut marks.

The relatively large number of distal tibia elements and shaft specimens is indicative of marrow processing. The proximal elements were removed from this area for grease manufacture. Processing concentrated almost exclusively on female elements that were brought from the kill.

k) Tarsals

Kill Area (%MAU = 90.3)

Tarsals were found in significant numbers throughout the Fitzgerald site. Summaries of counts can be found in Table 5.1. Bivariate analysis using the calcaneus indicates that there are nearly equal portions of male, female and immature tarsal elements.

There are only three articulations of the tarsals. All are part of complete hind limb articulations. Most tarsals are complete and have no evidence of cut marks on the surface. About 25% of the calcanei are broken at the tuber; a smaller proportion of the astragalii (10%) is split in to two or more pieces. The shattering of these elements might be a result of a blow to the posterior portion of the tarsal group to remove the gastrocnemius muscle that is attached to the tuber calcanei. Astragalii might have split as a result of this blow to the calcaneus.

This pattern of breaking the calcaneus at the tuber is repeated only at the Happy Valley and Muhlbach kill sites (Shortt 1993). No other authors report this pattern of splitting the astragalii. More often, tarsals are left intact in kill sites.

Numerous other sites have these same cut marks. These marks could be associated with severing the tendon (Frison et al. 1976) or with hide removal. None were found in the Fitzgerald assemblage.

Processing Area (%MAU = 57.1/50)

There were 30 tarsal elements found in the processing area. All but three of these elements are unmodified. Modified elements include two calcaneus elements that have had the tuber removed, a pattern repeated in the kill area.

l) Metatarsal

Kill Area (%MAU = Complete: 41.7; Proximal: 33.3; Distal: 20.8)

Like the metacarpal, a considerable number of metatarsals are found in the Fitzgerald assemblage. There were but a few articulations abandoned in the kill area.

There are more complete metatarsals (MNE = 30) in the kill area than any other long bone at the Fitzgerald site. The kill assemblage contains similar amounts of male (7 left and 4 right) and female (8 left and 8 right) elements. There are only three immature elements (1 left and 2 right).

About half of the metatarsals were broken open for marrow extraction. The great majority (71%) of the distal and proximal portions of the metatarsals have substantial portions of the shaft still attached. The broken elements are usually female (68%); there are almost no juvenile elements (10%).

Finding large numbers of metatarsals in a kill site is fairly common. The small amount of grease discouraged efforts to remove these elements for pemmican production. If the metatarsal was to be broken for its marrow, female elements were much more likely to be selected. This pattern is similar to that noted at the Melhagen site (Ramsay 1991). There are also large numbers of complete elements at EdOn-15 (Shortt 1993), Happy

Valley (Shortt 1993) Muhlbach (Shortt 1993), 24GL302 (Kehoe and Kehoe 1960) and Garnsey (Speth and Perry 1980).

Processing Area (%MAU = Complete: 7.1/0; Proximal: 57.1/31.3; Distal: 21.4/6.3)

Metatarsals were brought into this area to be processed for their marrow. Substantial numbers of metatarsals were found throughout the processing area. None of these elements were in articulation; only one was complete. Poor preservation made it difficult to ascertain whether these elements were male or female.

Only one complete juvenile element was located in the processing area. Only three of the eight proximal elements could be assigned to sex. One was a right male and two were right female.

8.3 Analysis Summary

Butchering was not a random undertaking but occurred through a number of predefined stages. For instance, Frison (1973: 87-88), in his research at the Glenrock and Wardell kill sites, identified 38 and 39 separate butchering units, respectively. Each of these units encompasses the removal of particular portions of the bison. While Frison acknowledges that all butchering units cannot be identified archaeologically, he ambitiously recreates the complete butchering sequence at both these kills. Testing Frison's butchering processes using the Fitzgerald site was a major objective of this thesis.

Lyman (1978: 6) has attempted to simplify matters by dividing the butchering sequence into three phases which he has termed primary, secondary and tertiary butchering units. The primary unit consists of the "gross units into which a carcass is first butchered" and may include the "hide, viscera, head, four quarters, rib cage and vertebral column" (Lyman 1978: 6). While not defined archaeologically, visible primary units would include unmodified skulls and complete and near complete articulations of the vertebral column, rib cage and appendicular elements. Hide removal would be identified by cut marks in such areas as the proximal metapodials, the carpal and tarsal arrays and on the lateral surface of the mandibular ramus and corpus.

Secondary units are less well defined. Basically, secondary processing would encompass the further disarticulation of the primary units into smaller, more manageable, elements. Complete, disarticulated long bones and semi-disarticulated vertebral columns would identify this processing unit archaeologically.

Tertiary processing is the final stage in the butchering process. Tertiary units include "the brains, bone marrow, and deboned meat that is jerked or dried" (Lyman 1978: 6). Tertiary processing can be recognized archaeologically by such byproducts as fragmented crania, broken distal and proximal long bones, and quantities of fragmented, sometimes burned, bone.

Lyman's units are a useful method for distinguishing between the gross butchering processes that are found in most kill sites. However, they fail to account for the diversity of activities that are undertaken, especially in the tertiary butchering sequence. As defined by Lyman, tertiary units encompass a variety of very distinct processing activities like tool construction, brain removal, marrow processing, grease manufacture and burning bone for fuel. Many of the tertiary activities can be distinguished in analysis. For instance, brain removal can be identified by the fragmentation of the cranium. The skull is most commonly entered through either the frontal or the foramen magnum.

Marrow removal is associated with the cracking open of individual faunal elements. This activity is usually associated with the various long bone elements and, to a lesser extent, the mandible and maxillary. Archaeologically, quantities of proximal, distal and spirally-fractured long bone shaft elements are considered evidence of marrow removal.

Most archaeological kill sites have few complete long bone elements. These bones were usually split, presumably to remove the inner marrow. Brink (1994) has devised a method of distinguishing marrow processing through an examination of element completeness. Theoretically, most complete bone will be of low marrow utility.

Because marrow and grease indices are so similar in bison long bones, it is difficult to ascertain which elements were being processed for marrow and not for grease. It is theorized here that element completeness might distinguish between these processes. Removal of the marrow from a long bone can occur in one of two ways. The least destructive means is to remove one of the proximal or distal ends and use a stick to spoon out the inner pulp. A much more common method is cracking open the bone with a blow to the shaft and then removing the sausage-like marrow as a whole. While this second method entails considerable damage to the shaft, it does not necessitate the removal of even the majority of the shaft from the distal or proximal ends.

If the marrow is all that the long bone is processed for, there is little motive to remove the rest of the shaft from the proximal and distal ends. Elements that have little or no shaft still attached must have had it removed when they were being prepared for grease manufacture or, less likely, for fuel. Most of the grease in long bones is found in the proximal and distal ends; there is almost none located in the shafts. After removal of the marrow, it would be logical to trim the ends off any remaining shaft elements to reduce bulk. Long bone ends could then be transported from the kill for further processing.

As a result, marrow processing can be recognized archaeologically in two ways. Quantities of unmodified elements of high marrow utility provides indirect evidence that these elements were not being marrow processed. Proximal and distal elements with large amounts of marrow and low grease utility will be abandoned in the kill with little of the shaft removed.

Direct evidence of grease manufacture would include quantities of fragmented pieces of bone in association with fire broken rock and associated features like boiling. Indirect evidence of grease manufacture in kill sites would be the removal of the long bone shaft.

8.3.1 Primary Processing in the Kill Area

Little direct evidence of hide removal was found at the Fitzgerald site. Because hides provided clothing and shelter, it would be expected that hide processing would have been undertaken. Unfortunately, natural taphonomic processes have for the most part removed any evidence of cut marks that might once have existed. However, the cut marks found on the lateral surface of a mandible and the proximal-anterior shaft of two metacarpals recovered in the kill area are probably the result of skinning. The 14 end scrapers found in the kill and nearby processing site offer secondary evidence of hide processing.

Ethnographic evidence suggests that the tongue was one of the first things to be processed (Wheat 1972). The mandibles would be removed from the skull by either chopping at the coronoid or the distal anterior portion of the ramus. The tongue then could be easily removed by splitting the mandible at the diastema and/or cutting the mylohyoideus muscle from the lingual portion of the mandibular corpus.

Segmentation of the bison carcass into the primary units occurred early in the butchering process. Because of the size of the animal, all of these activities would have had to occur in the kill site. Little evidence exists, though, for the order in which these primary activities might have occurred. The two nearly complete vertebral columns located in the kill area are missing only the skull, atlas, fore limbs and hind limbs. This demonstrates that these missing elements would have been removed early in the butchering process.

The recovery of a number of axis odontoid processes provides telling evidence that the skull was removed at the atlas/axis joint. The complete absence of axis and atlas articulations and the pristine condition of the occipital condyles provide further evidence for this hypothesis. Some time after the disarticulation of the skull, the atlas was removed from the skull and abandoned in the kill area.

Fore and hind limbs would also have been disarticulated early in the butchering process. Fore limbs were removed at the scapula/humerus joint. The complete scapula elements found in articulation with the axial skeleton would indicate that this was done with little damage to either the humerus or scapula. However, the large number of glenoid cavities located in the kill could indicate that disarticulation was achieved by breaking the scapulae at the neck.

The hind limb was removed by smashing the innominate at the acetabulum or at the femur neck. During the former operation, the proximal femur would be left intact. The absence of proximal femora without heads coupled with the relatively large number of head and neck specimens could indicate that the head was removed later in the butchering process to reduce bulk.

Removal of the ribs and vertebral spinous and transverse processes would likely be undertaken soon after the removal of the fore and hind limbs. Especially heavily processed were the thoracic and cervical 6 and 7 spinous processes. These were removed with blows at or near the vertebral arch. Less heavily damaged were the lumbar vertebrae. Only on half of these vertebrae were the spinous and/or transverse processes removed.

Also processed at this time was the depouille, a two meter long piece of fatty tissue found along the base of the vertebral spinous processes. This muscle was removed by cutting along the base of the thoracic spinous processes and the edge of the proximal lateral portion of the rib body. Ribs were removed by either smashing the head/neck articulation or, more likely, in the first five to ten centimeters of the proximal end of the rib body. The large number of rib body fragments indicates that further processing of the rib body continued in the kill after their disarticulation from the thoracic column.

8.3.2 Secondary Processing in the Kill Area

Considerable evidence of secondary butchering activities is found at the Fitzgerald site. Almost all primary units has been disarticulated into single faunal elements with most activities centered around the four appendicular units. The large number of complete, disarticulated elements indicates that disarticulation occurred before individual faunal elements were cracked open for marrow removal and grease manufacture.

As mentioned before, humeri were first separated from the scapulae during the primary butchering process. During secondary butchering, the greater tuberosity of the humerus would be smashed to remove the supraspinatus and infraspinatus muscles. Damage to the medial and lateral condyles and the olecranon process of the ulna indicate that the disarticulation of the humerus and the radius-ulna occurred by chopping at the posterior portion of this joint. There is no evidence of how the forelimb below the distal radius was disarticulated.

The hind limb was separated into individual faunal elements in much the same way as the forelimb. Chop marks on the trochlea and the proximal-anterior portions of the tibia testify to how the elements were separated. There is also extensive damage to the distal tibia and less often to the calcaneus tuber and astralagus. This would indicate that the posterior portion of the tibia and tarsal array was smashed to disarticulate the lower limb from the tibia.

The axial elements underwent much less rigorous secondary butchering activity than the appendicular portions. The small number of articulations and the large number of zygapophyses indicate that most cervicals 3 to 7 were disarticulated culturally. This was probably completed to remove bulk when accessing the large amounts of attached meat and, more importantly, fat. The large number of articulated thoracic vertebrae indicates that this portion of the bison anatomy underwent the least amount of secondary processing in the skeleton. The removal of the spinous processes and ribs leaves little meat or fat for further processing and all vertebrae have little associated grease. The large number of lumbar zygapophyses and the relatively small number of articulations indicate that the lumbar, like the cervical, underwent extensive secondary processing.

8.3.3 Tertiary Processing in the Kill Area

Further processing of the skull is much in evidence. There are considerably more petrous portions and maxillary elements than complete skulls. The removal of the brain is consistent with this evidence. The large numbers of maxillary fragments suggest that the marrow cavity located behind the maxillary was heavily processed. The mandibular corpus would also be split horizontally to access the marrow cavity beneath the back tooth row.

Appendicular elements underwent considerable tertiary processing. As evidenced by the large number of spirally fractured shafts, proximal and distal elements, all long bones except for the ulna and to some extent the metapodials were processed to some extent for their marrow. Marrow processing was restricted to the mature animals; the juvenile long bone was usually left unbroken. If unfused elements were broken, they would be abandoned in the kill, even those of high utility.

Of the mature specimens, the female bones were the most likely to be processed for both marrow and grease. Almost all of the relatively few complete female long bones are metapodials. There is a strong inverse relationship between grease utility and female proximal and distal elements. In contrast, there are considerably more complete and proximal and distal male long bone ends. The same correlation between number of ends and grease exists.

The distal humeri, distal radii, distal femora, distal tibiae and proximal and distal metapodials were found with significant portions of the shaft still attached. If these elements were being selected for grease extraction, the shaft elements would have been removed to reduce bulk. Thus, grease manufacture concentrated for the most part on the proximal humerus, proximal radius, proximal femur, proximal tibia and to a lesser extent, the distal femur and distal radius.

No evidence of tertiary processing of the axial elements is found in the kill. There are considerable numbers of vertebral centra and proximal ribs, but they remained largely unprocessed. This is likely a result of their low grease utility. Most food value is found in the bulk surrounding the spinous and transverse processes and the ribs. These portions would have been removed during primary butchering activities to an area not identified in excavation.

8.3.4 Primary and Secondary Processing in the Processing Area

There were no articulations in the processing area. Complete long bone elements were limited to one immature tibia and three metapodials. Disarticulation of the appendicular units was limited to the kill area.

The absence of axial units in the processing area is the firmest evidence of differential processing between the two activity areas. It is very likely that these elements either never entered the processing area, or were systematically removed from the processing area after the removal of the meat and fat. Considering the relatively small amount of grease associated with axial elements, it seems unlikely that these would have been removed wholesale from the processing area. Other low utility appendicular elements are found in similar numbers to the kill. A scenario where the axial units were almost entirely processed in the kill is preferred. Portions of the axial skeleton with high meat and fat utility like the spinous processes and rib ends were processed in an as yet unidentified area.

8.3.5 Tertiary Processing in the Processing Area

Tertiary processing was completed only on the appendicular units. Most of the activity focused on marrow removal; mature elements with high quantities of grease were then removed to another portion of the site. Any juvenile elements were broken and then abandoned in the processing area.

8.3.6 Processing in the Burned Bone Area

Primary and secondary butchering activities were not undertaken in the burned bone area. Like the processing area, no articulations of any faunal elements were recovered. Neither were there any complete appendicular or axial elements.

The degree of tertiary processing is difficult to ascertain because of the fragmented nature of the bone. Almost all identifiable elements from the burned bone area are less than 5 cm in diameter. How they were fragmented is difficult to ascertain. Burned bone is quite fragile, as a result breakage patterns may be the result of post-depositional factors like load casting and removal following excavation. Anticipating this argument, special care was taken during excavation to distinguish larger (≤ 5cm) individual elements; very few were identified.

Such a small number of larger burned bone specimens would suggest that a considerable amount of this bone was fragmented by cultural processes. It also seems likely that these materials were moved from another location and deposited here. If the bone was from a pound that had been burned to complete a new hunt in the same location, it would be expected that there would be remnants of larger fragments of burned bone.

A more reasonable interpretation would be that this bone was used as fuel and then dumped on the periphery of the kill. Analysis of an Emerson's (1990) economic utility indices from the burned area supports this argument. Bone of both high and low utility is found in almost equal numbers. There is no indication that these particular faunal elements were being actively selected for meat, marrow, fat or grease. The bone that was being burned for fuel was scrap left over from the butchering process.

8.4 Discussion and Conclusions

It has been demonstrated that the Fitzgerald site faunal materials underwent extensive processing. The butchering of the bison seems to have been along predefined cultural patterns; individual elements were being broken in demonstrably consistent ways. These patterns were consistently practiced across the breadth of the site; materials from the kill and processing area were treated in the same manner. However, there are differences between the two areas in the degree of processing. For instance, while there were over 51 articulations in the kill area, there were no articulations observed in the processing area. This would indicate that the bison were first slaughtered in the kill area then selected elements were brought into the processing area.

There are differences in the types of faunal materials found in the kill and processing areas. While appendicular elements are found in equal numbers across the breadth of the site, there are relatively few axial elements in the processing area when compared to the kill. The axial skeleton was only butchered in the kill area; portions were not moved out of this area for more intensive processing, likely because of their considerable bulk. In contrast, appendicular elements are easily removed from the axial skeleton and could be transported without difficulty. These elements were equally well processed in both the kill and processing areas. These differences will be more fully explored in the following chapter.

Butchering patterns at the Fitzgerald site are very similar to those reported at other Late Prehistoric bison kill sites on the Northern Plains. Element portions with the most amount of meat, fat, marrow and especially grease were the most heavily butchered. Cultural differences in butchering are, as a result, quite subtle. Considering the large number of kill sites that have now been excavated, the following discussion will examine similarities and differences in Besant butchering techniques.

The unusual treatment of the axial skeleton at the Fitzgerald site most closely resembles the Muhlbach kill site. Both sites have a considerable number of cranial fragments, indicative of heavy processing of the brain and possibly the marrow. At both these sites, the mandibles were usually smashed at the coronoid, diastema and symphysis to disarticulate the element from the skull and to remove the tongue. Unique to these sites is that no one vertebrae or rib is found more frequently than another. However, the Muhlbach site has far fewer of these elements than the Fitzgerald site. In both these sites, the thoracic spines are almost always broken off to remove the hump meat. Finally, ribs were usually smashed just distal to the tuber.

The treatment of the appendicular skeleton at the Fitzgerald site also resembles the Muhlbach site. Similarities include a relative abundance of complete metapodials, distal tibiae, carpals and tarsals. The scapula was usually broken at the scapular neck. The calcaneus tuber was usually broken at both the Fitzgerald and Muhlbach sites. While there are relatively few proximal femora at the Fitzgerald site, the greater trochanter and head and neck were commonly broken off like at the Muhlbach site. Substantial numbers of distal tibia indicate a common process of removing the tarsal array.

There are some differences between the Fitzgerald and Muhlbach sites. At Muhlbach there were many complete radii. This may be the result of the Muhlbach site being a winter/late spring event; these elements would have relatively little grease at this time of the year.

Chapter 9

Economic Utility

9.1 Introduction

Utility indices were first introduced by Lewis Binford and have now become a regular feature in the analysis of large faunal samples. They are useful as they help explain how people butchered the animals they hunted. Indices can then be used to demonstrate which animals, and which parts of the animals, were being selected for and why. It is implied that cultural differences will eventually be delineated after the accumulation of data from a number of different sites.

Over the last ten years, increasingly elaborate indices have been developed specifically for the bison. This chapter will apply these indices to the Fitzgerald sample. Differences in butchering practices will be demonstrated between age and sex, the kill and processing area and between the Fitzgerald kill and other Besant sites on the Canadian Plains.

9.2 Methodology

Binford (1978, 1981) was the first archaeologist to quantify the economic utility of animal anatomy based on associated faunal elements located in archaeological sites. Rejecting the assumption that the animal was completely processed at the location of the kill, he hypothesized that particular segments of the body were selected for during butchering. Animals are dismembered in what he termed units and those units of highest food utility will be either removed from the site or fragmented to the point where they become unidentifiable. These units became the basis for the Minimum Animal Unit (MAU).

Much of Binford's work concentrated on determining the amount of meat, marrow and grease associated with particular animal units of the caribou and mountain sheep. He derived three indices that demonstrate the quantity and quality of these items. These indices were used to develop the Meat Utility Index (MUI), the Marrow Index (MI) and the White Grease Index (WGI). Determining what percentage of the caribou and sheep anatomy meat, marrow and grease formed, Binford was able to standardize these indexes by multiplying each of the three unweighted index values with this percentage and summing. This standardized index is called the General Utility Index (GUI).

Binford recognized that when an animal is dismembered, the butchering does not necessarily divide the carcass into the same animal units that were used to derive the GUI. Certain low utility elements could be removed from the site, not because of their high utility, but because they were articulated to high utility units. An overabundance of these 'riders' in a camp or processing site could bias the sample. The GUI index was weighted to account for the effect of these riders and called the Modified General Utility Index (MGUI).

Using a faunal sample derived from his work with the Nunamiut, Binford then plotted MGUI against his own modified MNI count, %MAU. He correctly hypothesized that a reverse parabolic curve would be formed with the kill site data. Bones of low utility would be found in abundance as they were abandoned by the Nunamiut. In contrast, higher utility items would likely be missing as they were taken from the site for further processing.

Binford anticipated that there will be two types of kill sites recognized when these indices are plotted. These would be associated with the degree of processing based on what he termed a "gourmet strategy" or a "bulk strategy". What separates these two strategies is the basic choice between quality and quantity. Gourmet strategies reflect a butchering practice where only the elements with the highest amounts of meat, marrow and grease are removed. Bulk strategies are consistent with the practice of removing all but the poorest quality elements from the site. It is unclear whether these strategies represent specialized butchering practices or "situational differences in transport capacity" (Metcalfe and Jones 1988: 495).

Another problem is that while Binford subtracted bone weight from his utility indices, he did not remove other non-edible tissues like ligaments and tendons (Emerson 1990: 422) Even more importantly, he dismissed the notion that the age, sex and condition of the animal could have anything but a minimal effect on his indices. This assumption was soon questioned by Speth (1983).

The Garnsey site is a Late Prehistoric Bison spring kill in south-eastern New Mexico. Applying Binford's MGUI, Speth (1983) was able to demonstrate that certain elements were being selectively removed from the site for further processing. A bulk strategy was implied by a comparison of the relationship between %MNI and MGUI.

Applying specially developed techniques for sexing the individual elements, Speth was also able to demonstrate that there was differential treatment of juveniles and mature males and females. Butchers were not only selecting for the highest utility parts within the carcass, but also the highest utility between carcasses. Female and juvenile elements were being systematically selected against.

Speth felt that females were selected against because of the stress associated with lactation and pregnancy. Pregnant and lactating females are in poor condition in the spring and as a result will have quite low fat yields compared to bulls and other cows. This is especially true during the winter and early spring when animals under stress "cannot compensate for low protein levels in forage by increasing their total intake, because they are limited by the rate at which food can be masticated" (Speth 1983: 120).

Juveniles were not as intensively butchered for two reasons. First, they are much smaller than other bison and as a result contain less meat, marrow and grease. More important is the fact that juveniles have "lower overall subcutaneous, intermuscular, intramuscular, and marrow fat" (Speth 1983: 115). In cattle, available carcass and marrow fat increases markedly from the ages of about 2.5 to 7.5 years (Speth 1983: 117).

Males and non-lactating females were then preferentially butchered at the Garnsey site because they contain the most fat. Fat is an extremely important dietary item for humans because it "provides the most concentrated source of energy in the diet, supplying over twice as many calories per gram as either protein or carbohydrate" (Speth 1983: 148). Lean meat can actually sicken humans if the total "intake of carbohydrate and total energy is restricted" (Speth 1983: 157). As a result butchers would choose the animals with the most fat to hunt and butcher, and augment their diet with pemmican (Speth 1983: 157-158).

The utilization of Binford's utility indices was once standard practice on the Plains. However, criticism was directed at its application because the data are derived from a relatively small caribou and sheep sample. Foregoing arguments about sample size, there was a strong suspicion amongst Plains archaeologists that bison anatomy was sufficiently different from the caribou and sheep that any conclusions drawn could be compromised. These concerns were alleviated with the completion of Emerson's (1990) dissertation which produced a series of utility indices from a sample of four bison. Following Binford, Emerson established indices based on the caloric value of the bison. She divided the skeleton into 19 animal units including the skull, cervical, thoracic, rib, sternum-distal rib cartilage, lumbar, sacrum-pelvis, caudal, scapulae, humerus, radial-ulnar, carpals, metacarpal, anterior phalanges, femur, tibia, tarsals, metatarsal and posterior phalanges.

Emerson's indices differ significantly from Binford's caribou and sheep indices in a number of respects. No doubt influenced by Speth's arguments from the Garnsey Site, she created a new utility item based on intermuscular fat. As a result, four separate indices were derived based on meat and protein, carcass fat, bone marrow, and skeletal fat (bone grease).

Recognizing Speth's arguments about variation in utility within the bison species, Emerson augmented her sample by selecting bison of different ages, sex and health. To account for seasonal variation, animals that had been slaughtered in the fall and the spring were also chosen. Her sample included an immature male that had died in the fall, a spring mature male, a fall immature female, and a spring mature female in poor condition. Differences in utility between these animals could then be demonstrated quantitatively.

Differences in age, sex and condition were compared in three separate ways. First, the carcass weight was analyzed to determine the overall differences in meat, white (appendicular) and yellow (axial) fat, marrow and bone grease. Second, the distribution of these food items was examined to locate differences in the rank order between animal units within the study bison. Finally, it was asked "whether the weight differences between units that showed rank changes and those that are adjacently ranked were large enough that they might be perceived as being different by hunters selecting bone for processing" (Emerson 1990: 420)

Not surprisingly, differences in the amount of available meat are related to size. The ratio in total carcass yield between dried bone weight and edible muscle weight is constant between age or sex (Emerson 1990: 503). Thus, the larger mature bulls have more meat than the mature cows, who in turn carry more muscle than the immatures (Emerson 1990: 503).

The most meat in the bison is found in the axial skeleton, followed by the hind and fore limbs (Emerson 1990: 504). By sex, females carry proportionally more meat in the hind limb than the adult male; males have proportionately more meat in the fore limb

(Emerson 1990: 503). Because the axial skeleton is not as well developed in the immature bison, they carry far less meat in this area than would be expected for their size.

Emerson was especially interested in establishing whether there were variations in the amount of fat between different bison. In an effort to demonstrate these differences, she separated all fat from muscle. It was found that variation in the percentage of white and yellow fat within the four bison is moderate. Partially as the result of the amount of meat weight available in the appendicular skeleton, adult bulls have the most fat, juveniles the least fat (Emerson 1990: 506). In the axial skeleton, there are few differences within the species.

However, age and sex does affect the rank order of muscular fat between individual animal units (Emerson 1990: 506). For instance, the humerus in immatures is poorly developed and carries little fat (Emerson 1990: 421). Female tibiae and femora carry less fat by weight than those of the mature male (Emerson 1990: 421). In the axial skeleton, the lumbar region is ranked higher in immatures as fat deposition in the thoracic area is still quite low (Emerson 1990: 421).

However, Emerson found that not all fats are evenly distributed through the body, but some are instead concentrated in "depots" (Emerson 1990: 510). Significantly, within the bison species there is "variability in fat production (comparative weights), partitioning (division of carcass fat between the depots) and distribution (division of each depot fat between carcass units)" (Emerson 1990: 510). These differences occur by age, sex and nutrition. For instance, fat depots are relatively small in adults of poor condition and in immatures, however, these differences are not large enough to significantly change the rank order of units.

As protein and fat are mixed in the meat, butchers are faced with a decision when processing the bison for fat. They must decide whether to process fat regardless of protein count or instead try to minimize protein count at the expense of processing all fat. Using the first strategy, the femur should be preferentially butchered. In the second strategy, butchers will concentrate on the ribs and thoracic vertebrae.

To account for selective processing, Emerson suggests that the differences in use might be qualitative rather then quantitative. Qualitative differences might be a result of the degree of fat saturation. The reason appendicular elements would be selected over axial elements at certain times of the year is because they are less saturated and thus, of higher quality. For the same reasons, only the lower limb units will be selected if the bison are in poor condition. However, when the butcher wants to maximize fat recovery or when the bison are in good condition, axial units should be selected for.

Age and sex do not significantly affect the amount of bone marrow available in the bison. Only in animals of poor condition did weight "show the effects of poor nutrition", especially in the proximal end and medial portion where the major portion of the marrow is (Emerson 1990: 418-419). The size of the animal should then play the most important role in choosing which animals to hunt and butcher for these particular food items. However, the larger adult bulls are not always selected for. This is because bone grease varies between different seasons of the year. Significant "differences were found in the productivity of grease fat in males and females, and between immature and mature animals" (Emerson 1990: 419). For instance, the spring adult male had far less grease available than the spring adult female. If butchers were selecting for grease, they would be far more likely to process the spring cow rather then the spring bull. Immatures would be the least likely to be processed.

Bison do not carry the same amount of fats on their body at all times of the year. Variation is based most importantly on the sex and age of the bison (Emerson 1990: 653). Fat is most closely linked to reproduction. The bison rut is in late July to early September. This is a period of extreme physiological stress for the bulls, as they remain extremely active while virtually ceasing to eat and sleep. As a result, the bulls will have the most fat just before rut, and the lowest amount just after rut.

In contrast, female cows are most affected by pregnancy and lactation (Brink 1993). During the 9.5 month gestation period, energetic drain starts to occur only in the last trimester. After giving birth, lactation requirements peak at 6 to 8 weeks in mid-June. Lactation is a tremendous drain on the fat reserves, as it draws three to five times the amount of energy of pregnancy. After lactation, the amount of fat then slowly returns back to normal levels over the next year.

Fat reserves are thus depleted by the bulls in the rut and the cows during pregnancy and lactation. If hunters are selecting herds for fat, the worst time to hunt males is in September and females in mid-June. The best time to hunt males is in June and July and females in July through December.

Finally, Emerson has developed the Modified Averaged Total Products Index. This index is "based upon the average composition of the bison studied" (Emerson 1990: 3). It is most useful for the study of herds of mixed age and sex composition with no population analyses. As a result, it masks age, sex and condition differences in carcass units by overestimating and underestimating certain carcass units (Emerson 1990: 656). However, it can be utilized to provide a generalized picture of bison processing.

Brink (1994) and Emerson's (1991) indices will be used to determine the butchering patterns at the Fitzgerald site. Application of these indices will concentrate on identifying whether butchering concentrated on bison of particular age and/or sex. It is believed that this is the first time that Emerson's work has been combined with Walde's (1994) sexing indices to form a picture of pre-contact decision making in the butchering process.

9.3 Analysis

9.3.1) Modified Averaged Total Products Index

Emerson's (1990) Modified Averaged Total Products Index (MAVGTP) was first applied to the kill assemblage %MAU (Figure 9.1). It is obvious that specific elements of the bison are not present in the site. Almost all these missing elements are of moderate to high utility value; only units of very low utility (e.g. skull, carpals, tarsals and phalanges) were abandoned in bulk. As Emerson anticipates, axial units are not as heavily processed as would be predicted for their utility.

The relationship between MAVGTP and %MAU in the processing area is similar to that seen in the kill. Except for the sacrum/pelvis, all units of high utility are found in a range of 10 to 20% of the MAU (Figures 9.2). Unlike the kill (Figure 9.3), there are almost no axial units in the processing area.

There are over twice as many axial units in the kill as there are in the processing area. Either axial units never entered the processing area or were removed in bulk. It is difficult to discern using the MAVGTP index which of these reasons is correct.

The MAVGTP index provides an indication of the degree to which different animal units are processed in a site. The presented evidence is consistent with Binford's bulk strategy where everything but the lowest utility elements is removed from the site. However, the MAVGTP index gives little indication of the purpose for which particular units were butchered. As Emerson and Brink have demonstrated, faunal elements can be processed for certain materials and not others. For instance, the metapodials have little muscle mass and associated bone grease, so they will be processed only for marrow. Delineating between these different activities is the challenge of the archaeologist.

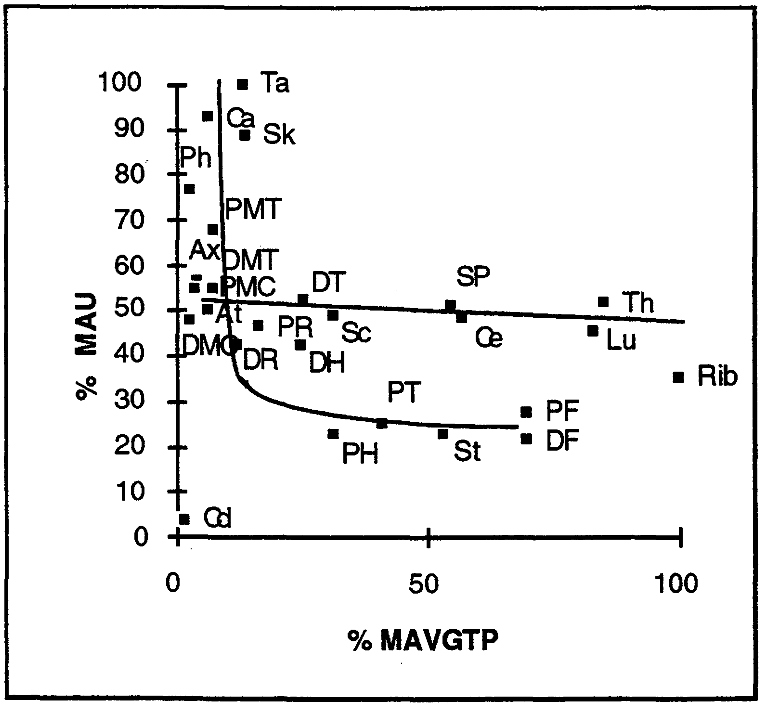


Figure 9.1: Comparison of %MAU from the Kill Area and the Modified Average Total Products Index

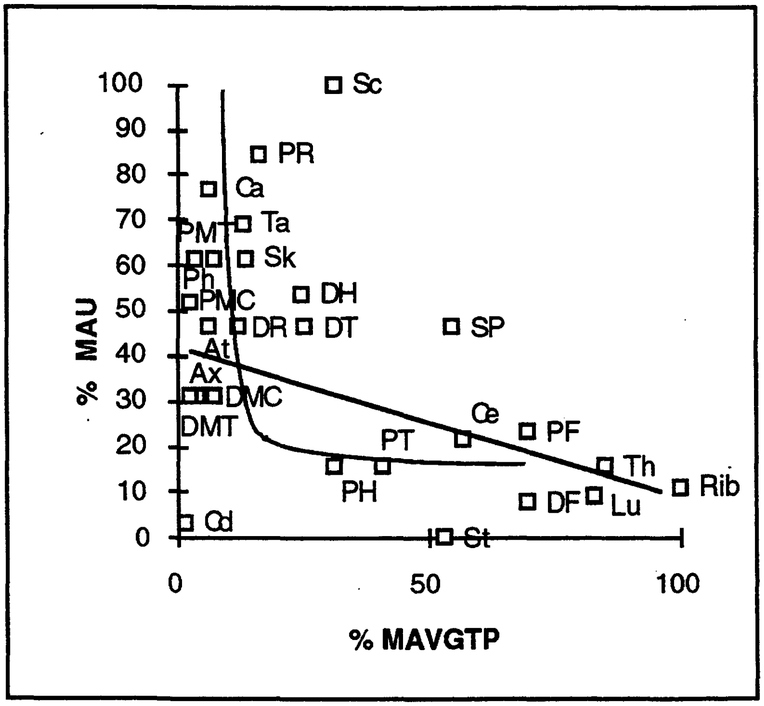


Figure 9.2: Comparison of %MAU from the Processing Area and the Modified Average Total Products Index

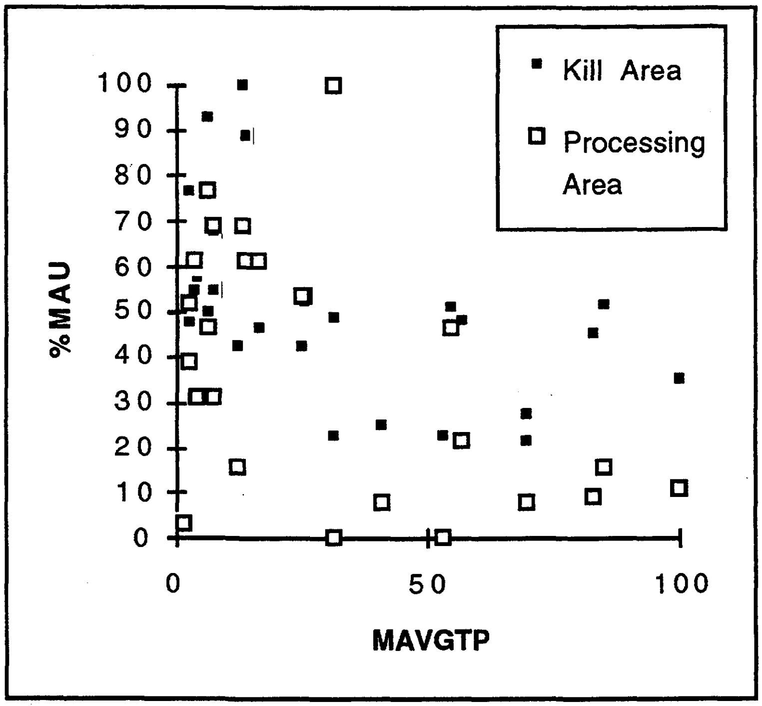


Figure 9.3: Comparison of %MAU from the Kill and Processing Areas and the Modified Average Total Products Index

9.3.2) Appendicular Skeleton

Brink (1994) has specifically examined long bone elements for grease and marrow content. Determining if long bones were subject to marrow recovery is dependent on both the frequency of complete elements and the number of proximal and distal element portions recovered. The bones "associated with the greatest amount of marrow should be least often recovered in complete condition, while those that contain small amounts of marrow should most often be complete" (Brink 1994: 2). The percentage of marrow in each element is ranked against the frequencies of complete long bone elements with the expectation that low marrow utility values will correlate with high recovery rates.

Complete elements were used to delineate marrow processing as there is "no possibility of subsequent selective use of portions of those elements as there is when proximal and distal ends are considered" (Brink 1994: 2). If particular proximal and distal elements are being selectively removed from the kill for grease manufacture, the subsequent count may mask marrow processing activities. Where proximal and distal elements are found in numbers inverse to their grease content, these bones were likely removed from the kill (Brink 1994: 6). However, in sites where these proximal and distal elements are found in quantities equal to that expected for marrow removal, it is hypothesized that there was limited further processing (Brink 1994: 6).

Considering the large number of complete elements identified in the Fitzgerald kill assemblage, decisions about marrow processing should be accurately ascertained using Brink's methods. In the Fitzgerald site, there were large numbers of metapodials, medium numbers of radii and few complete humeri, femora and tibiae. Figure 9.4 demonstrates that there is an inverse relationship between percentage of marrow and the number of complete elements. Butchers were actively selecting elements with the largest percentage of marrow.

Only five of the 48 long bone elements in the processing area were unmodified. Included in this number are one tibia, three metacarpals and one metatarsal. This suggests that marrow processing was a focal activity in this area.

There is little correlation between the combined proximal and long bone ends from the kill area and the percentage of marrow weight (Figure 9.5). In the processing area, there is an inverse relationship between these numbers (Figure 9.6). This suggests that in both these areas certain elements were being systematically removed from the site.

When proximal and distal elements from the kill and processing areas are plotted against Brink's and Emerson's combined grease indices (Figure 9.7 and 9.8), the expected inverse relationship is found. Elements with large amounts of grease are found in small numbers (especially the proximal humerus, proximal and distal femur and proximal tibia). Elements with medial quantities of grease are not processed; these include the distal humerus and proximal radius.

One problem with Brink's method is that it does not take into account the age and sex of the animals. The amount of marrow and grease present in the bison varies by such variables as the age and sex of the bison and the season of the kill. By discriminating between these different variables, butchering decisions can be reconstructed.

By applying previously derived data on the composition of the Fitzgerald herd to Emerson's marrow and grease indices for bison of different sex and age, a somewhat different picture emerges of how bone processing occurred. Apparently, some animals were excluded from the butchering process. Because it is a fall kill, it is expected that mature cows were selected for marrow and grease processing while mature bulls and juveniles were left unmodified.

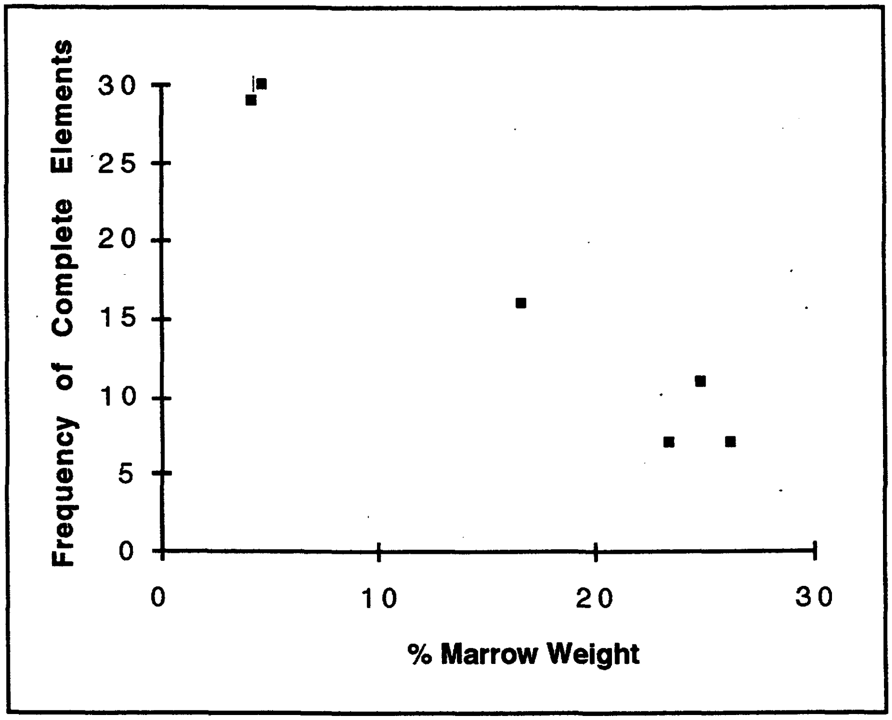


Figure 9.4: Comparison of Complete Elements from the Kill Area and Percent of Marrow Weight

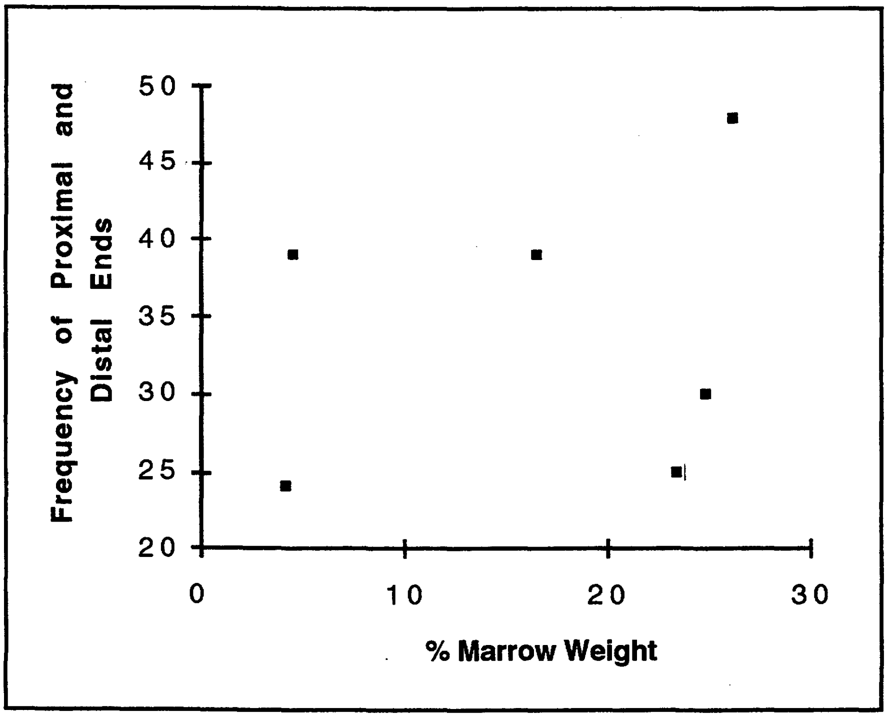


Figure 9.5: Comparison of Proximal and Distal ends for each Long Bone from the Kill Area and Percent of Marrow Weight

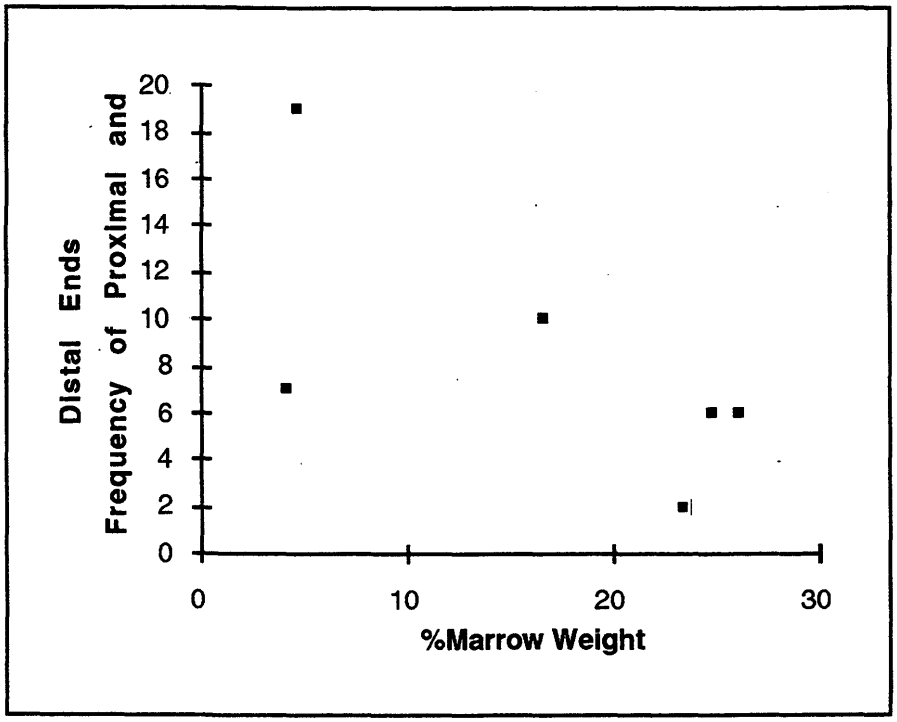


Figure 9.6: Comparison of Proximal and Distal ends for each Long Bone from the Processing Area and Percent of Marrow Weight

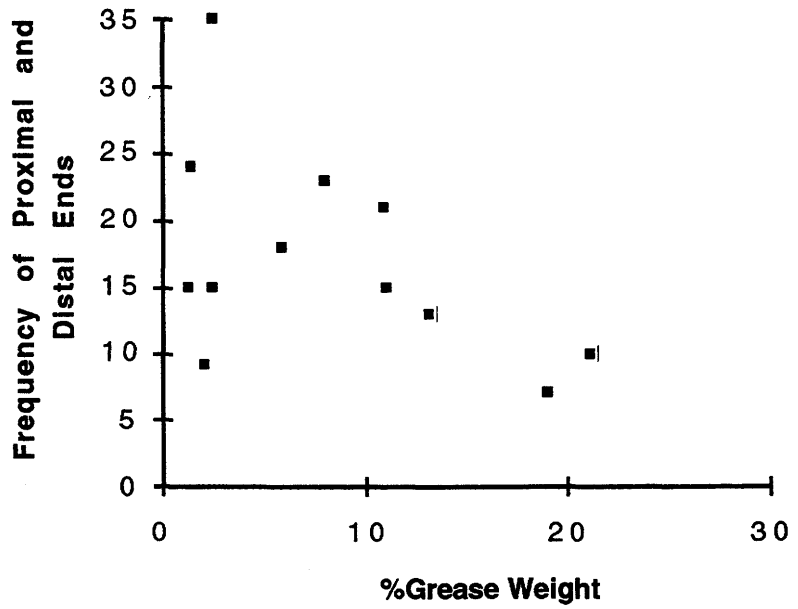


Figure 9.7: Comparison of Proximal and Distal Long Bones from the Kill Area and Percent of Grease Weight

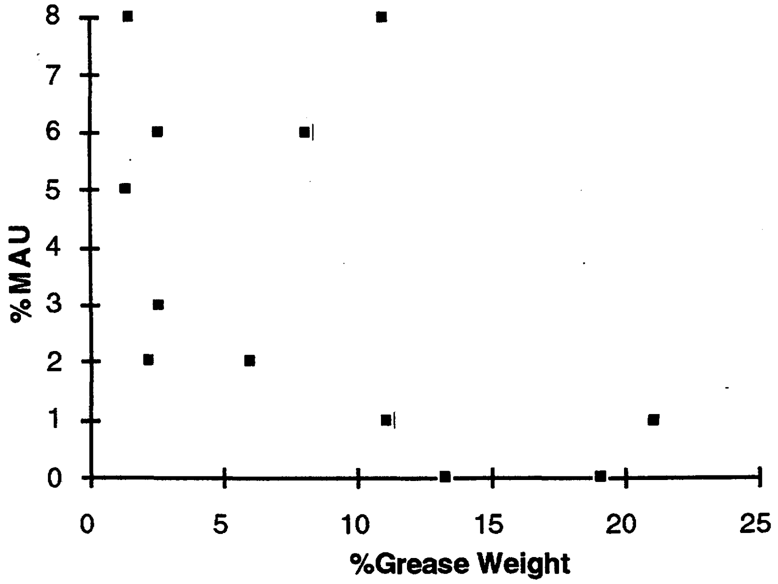


Figure 9.8: Comparison of Proximal and Distal Long Bones from the Processing Area and Percent of Grease Weight

Juveniles are defined by the absence of epiphyseal closure. As defined by the calcaneus, immatures make up approximately one third of the kill population. Because they are less ossified, juvenile elements are more prone to natural taphonomic processes than more mature bone. However, an examination of Emerson's indices indicates that cultural processes also affected the sample.

There are only a small number of unmodified immature elements (N = 18) when compared to matures (N = 100). No one complete juvenile bone was found more than another in the Fitzgerald kill. As a result, there is no correlation between the amount of marrow (in grams) and the number of unfused complete elements (Figure 9.9). This might be an indication that they were being systematically removed from the kill area. However, an examination of the marrow and grease indices applied to proximal and distal elements indicates another explanation is needed.

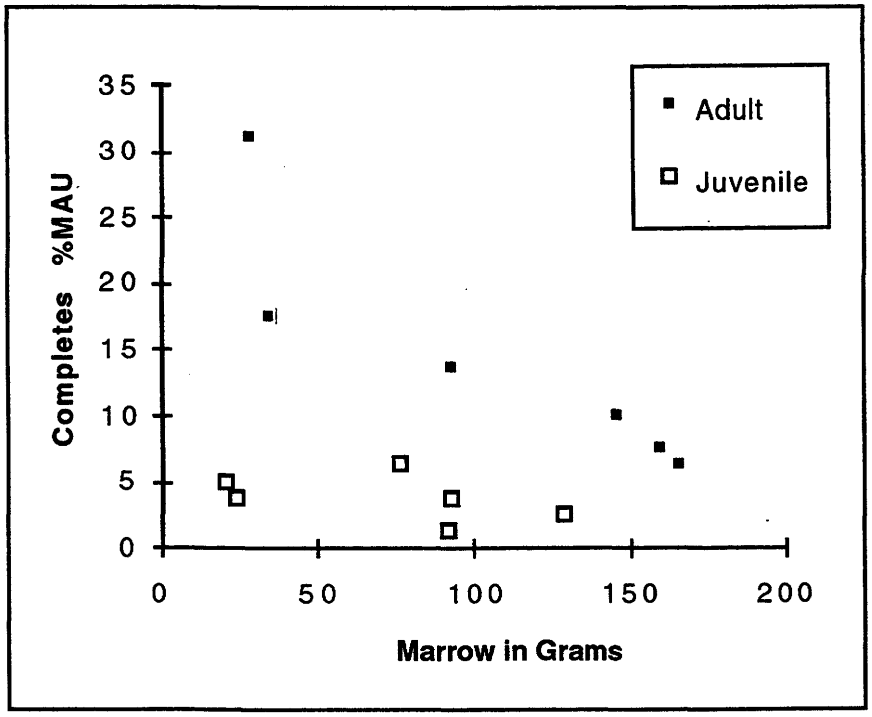


Figure 9.9: Comparison of Complete Mature and Immature Long Bone %MAU from the Kill Area and Marrow Weight

In total, there were 71 immature proximal and distal long bone ends. Juvenile long bones have very little grease when compared to fully mature specimens. As a result, immature bones that have even a moderate amount of grease were being abandoned in large numbers at the kill (Figure 9.10). In fact, when immatures are plotted against the juvenile bone grease indices, elements of high grease content are more likely to be recovered than those of low content.

Juveniles contain similar quantities of marrow as mature animals. Not surprisingly, therefore, most of the abandoned ends in the kill are from elements associated with relatively large amounts of marrow (Figure 9.11). A fairly strong relationship exists between MNE and the amount of marrow associated with each element. Immature long bones were only being broken open if they contained ample quantities of marrow. Proximal and distal ends were then abandoned in the kill area.

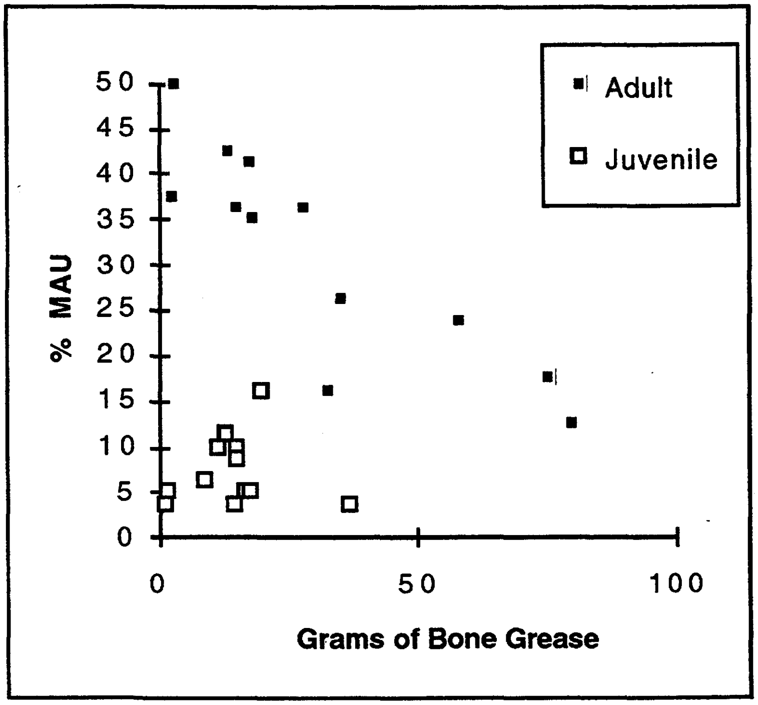


Figure 9.10: Comparison of Mature and Immature Long Bone %MAU from the Kill Area and Bone Grease Weight

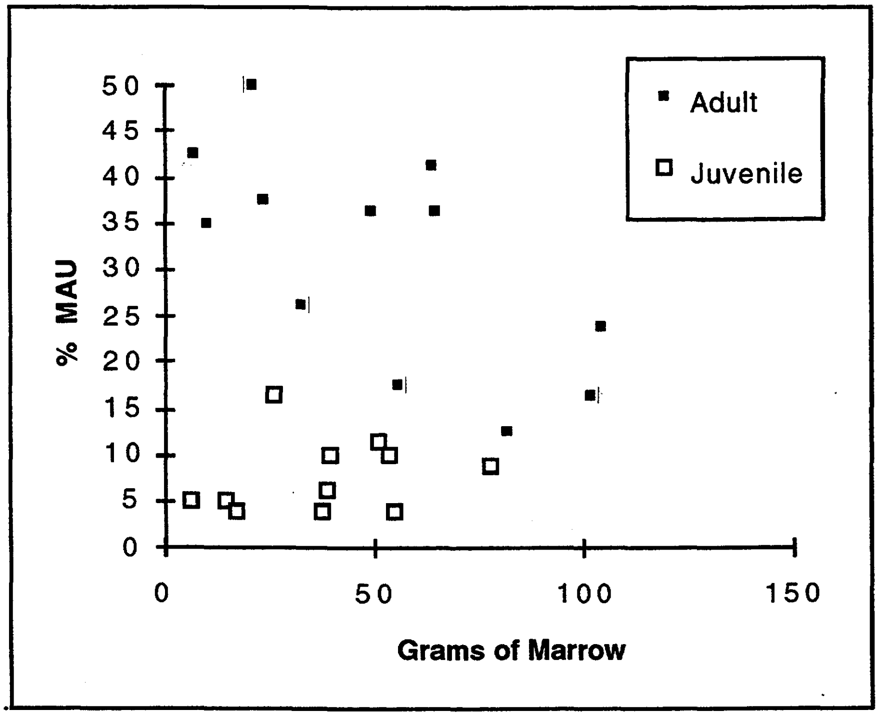


Figure 9.11: Comparison of Mature and Immature Long Bone %MAU from the Kill Area and Marrow Weight

In contrast, there is a strong inverse relationship between the number of fused complete long bones and the amount of grease associated. Mature animals were being selectively processed for marrow based on the quantity available in the bone. After being broken for their marrow, mature elements were not abandoned in the kill area as were the immatures. Fused elements were being removed from the site in proportion to the amount of grease associated with the element.

Few unmodified specimens were recovered in the processing area. Identified completes include three fully fused metapodials and a juvenile tibia. It would seem that long bones were consistently smashed for marrow removal.

There were 58 proximal and distal long bone elements in the processing area. From this sample, 12 elements were identified as immature. Examination of Figures 9.12 and 9.13 shows little indication that any particular juvenile element was being

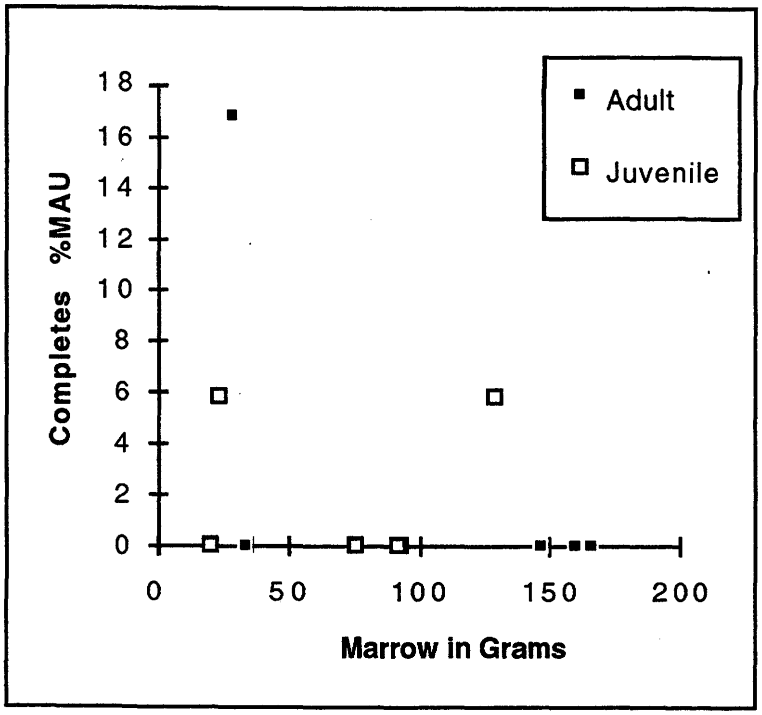


Figure 9.12: Comparison of Complete Mature and Immature Long Bone %MAU from the Processing Area and Marrow Weight

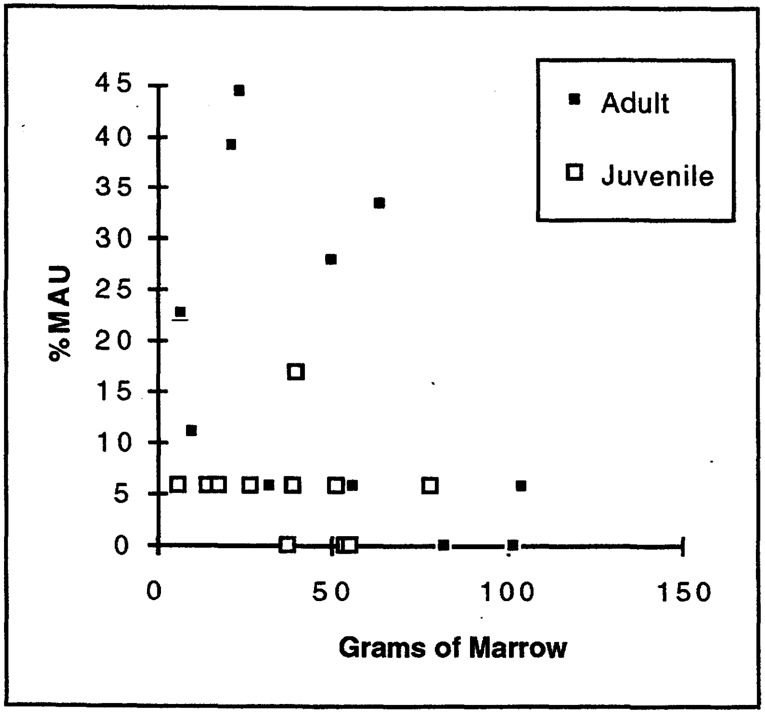


Figure 9.13: Comparison of Mature and Immature Long Bone %MAU from the Processing Area and Marrow Weight

systematically processed for marrow or removed from the site for further grease processing. These results are likely a product of sample size.

Remembering the small size of the sample, there is a minor correlation between the amount of marrow and the presence of mature elements. Those elements with larger quantities of marrow are more likely to be recovered in this portion of the site. There is an especially high inverse correlation between the amount of grease in the bone and its presence in the processing area. Elements high in grease content like the proximal humerus, proximal and distal femur and proximal tibia are almost completely missing from this area. There are also surprisingly few distal radii. There were considerable numbers of distal humeri, proximal radii, distal tibiae and proximal and distal metapodials.

These numbers indicate that some marrow processing occurred in this area. After the bone was split, portions with high grease content were removed for further grease extraction. As a result, it is hypothesized that juvenile long bone and low grease utility items were only broken open for their marrow. They were then abandoned in the processing area.

As has been noted there were 82 mature complete long bone elements found in the kill. Nearly two-thirds of the complete elements identifiable to gender are bulls (N = 46). Nearly 90% of the unmodified female elements are metapodials. The metapodials rank last in the marrow index and are often left unprocessed in kill sites.

Figures 9.14 and 9.15 clearly demonstrate that female elements were much more processed than male elements. This is especially true of the proximal humeri, proximal and distal femora and proximal tibiae, which are virtually absent from the female sample. Distal tibiae were not included in this analysis as only a small sample could be successfully sexed.

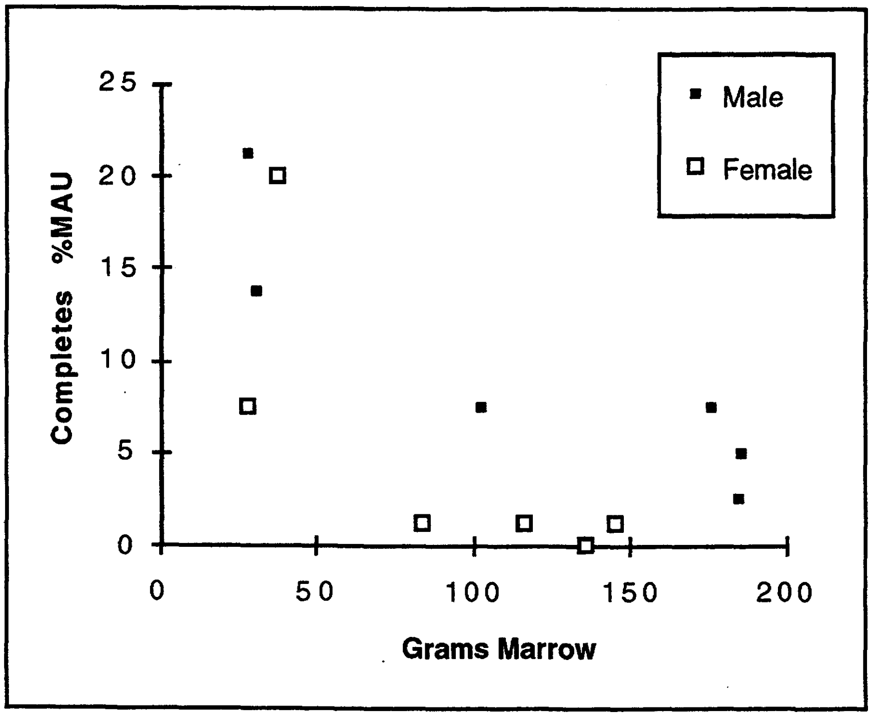


Figure 9.14: Comparison of Complete Mature Male and Female Long Bone %MAU from the Kill Area and Marrow Weight

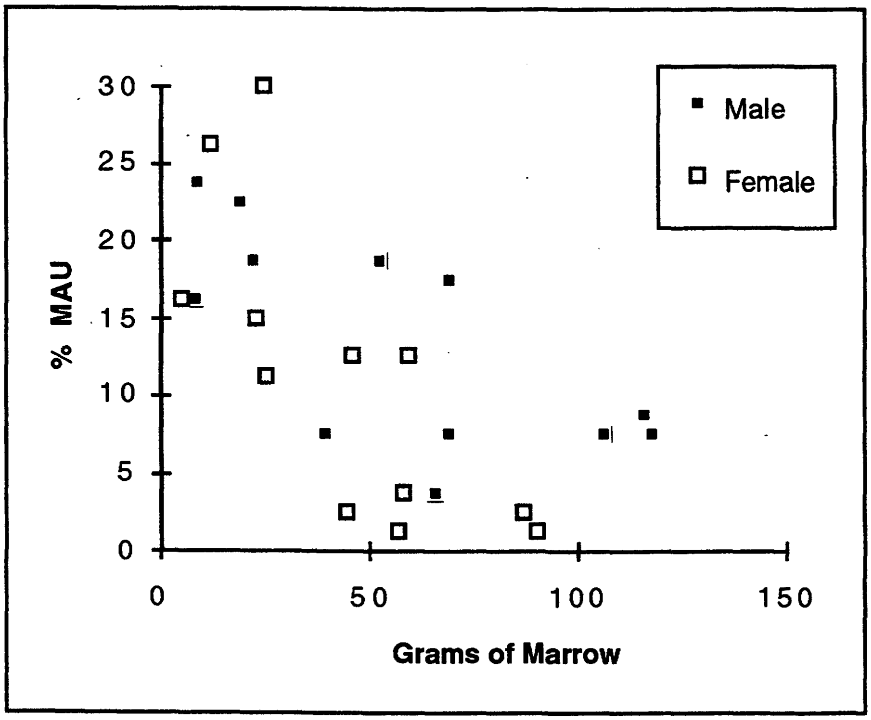


Figure 9.15: Comparison of Male and Female Long Bone %MAU from the Kill Area and Marrow Weight

Male elements are always found in larger quantities than female elements. However, there is a quite strong relationship between utility and the number of male elements recovered. The small number of complete male femora would also indicate that these elements were selected for marrow processing irrespective of sex. Not coincidentally, the femur ranks quite high on the utility scale.

Applying Emerson's marrow indices to the Fitzgerald site materials indicates that differences in the processing between male and female animals continue (Figure 9.15). Female elements are much more likely to be processed for marrow than males. These results are the more remarkable when one considers that many of the male elements contain up to 50% more marrow then even the largest female element. Virtually the only female elements that remained unprocessed were the metapodials.

Bulls were also processed for grease (Figure 9.16). Male proximal humeri, proximal and distal femora and proximal tibiae are also found in small numbers, but not as meager as the female assemblage. There were also few male distal radii in the kill.

As previously mentioned, the sample is too small to derive meaningful interpretations of marrow processing in the processing area using the methods devised by Brink. There are also insufficient numbers of proximal and distal mature elements identified to sex to analyze properly the processing sample for gender specific butchering practices. However, mature bones with considerable amounts of grease have been systematically removed from this area (Figure 9.17).

9.3.3) Axial Skeleton

While Emerson has provided means for determining differences in carcass utilization for the axial elements based on age and sex, these were not employed at the Fitzgerald site. No method has yet been devised for accurately determining the sex of any of the elements in the axial skeleton. While epiphyseal fusion could be used to separate

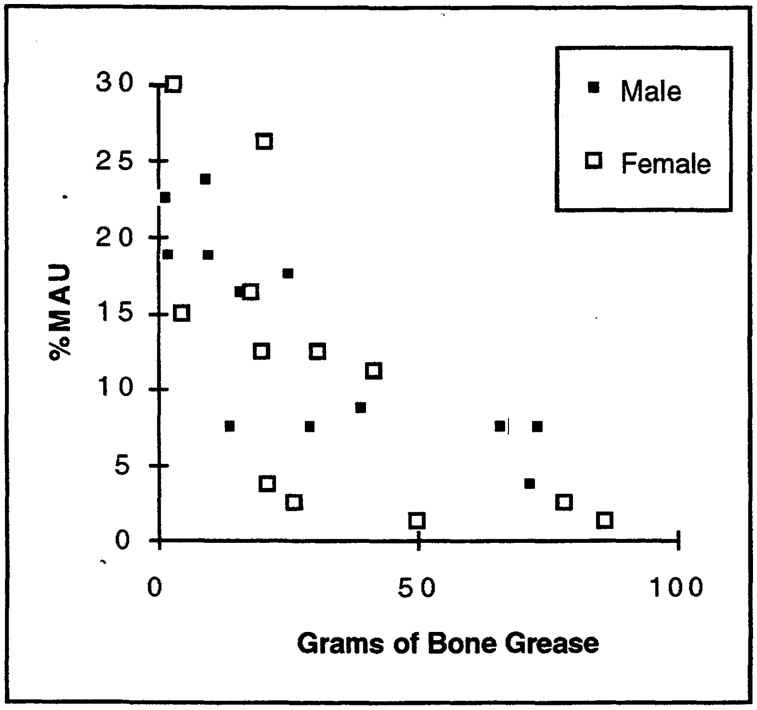


Figure 9.16: Comparison of Mature Male and Female Long Bone %MAU from the Kill Area and Bone Grease Weight

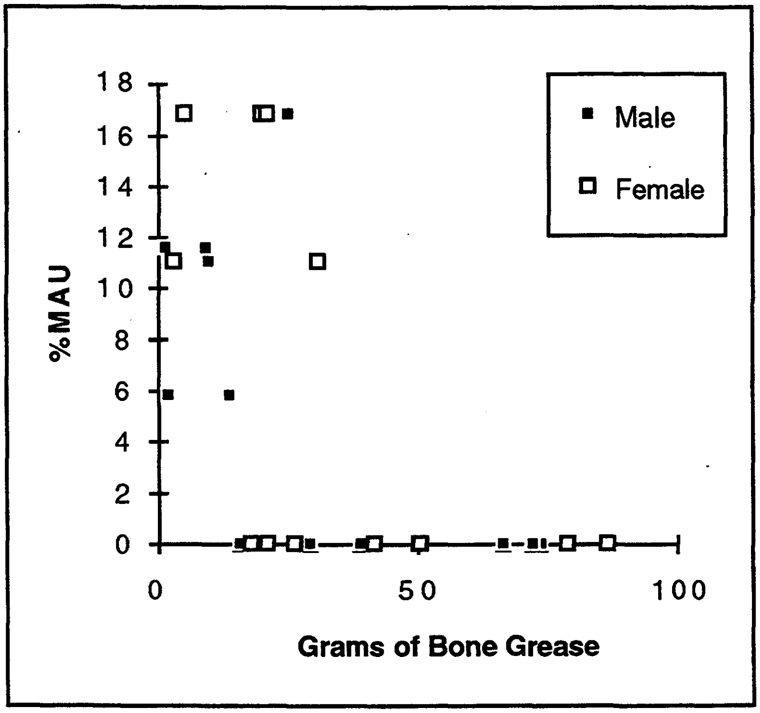


Figure 9.17: Comparison of Mature Male and Female Long Bone %MAU from the Processing Area and Bone Grease Weight

mature and immature animals, fusion occurs so late in these elements in the bison (Duffield 1973: 133; Dyck and Morlan 1995) as to make comparisons futile.

As a result axial elements were examined for the amount of meat, white grease and bone grease that is associated with each animal unit to determine if particular elements were being selected for certain utilities. The results of the Modified Average Total Products Model are found in Figure 9.18. Analysis would indicate that particular elements were not removed from the kill area as their utility increased. In the processing area there is a correlation between utility and %MAU. For instance, skull elements are found in considerable quantity and are considered to be of low utility; high utility ribs were not recovered.

Examining meat and intermuscular fat utility , there is a only a slight correlation between the amount of meat and fat and %MAU in the kill area (Figures 9.19 and 9.20). In the processing area, those axial units with large muscle mass and fat depots are not found in significant quantities. These units either never entered this area, or were removed for further processing in another part of the site.

In contrast to the appendicular skeleton, those units of high grease content were not being removed from the kill for further processing. There seems to be little correlation between bone grease and these same animal units (Figure 9.21). High utility items like the rib are found in the same quantities as those of low utility. As would be expected, the axial skeleton was only processed for the meat available and then abandoned.

The results that have been presented above may be a product of how MAU was derived. Traditionally limb bones like the humerus, radius, metacarpal, femur, tibia and metatarsal have been divided into separate proximal and distal elements. Implicit in this division is the assumption that the proximal and distal long bones were treated quite

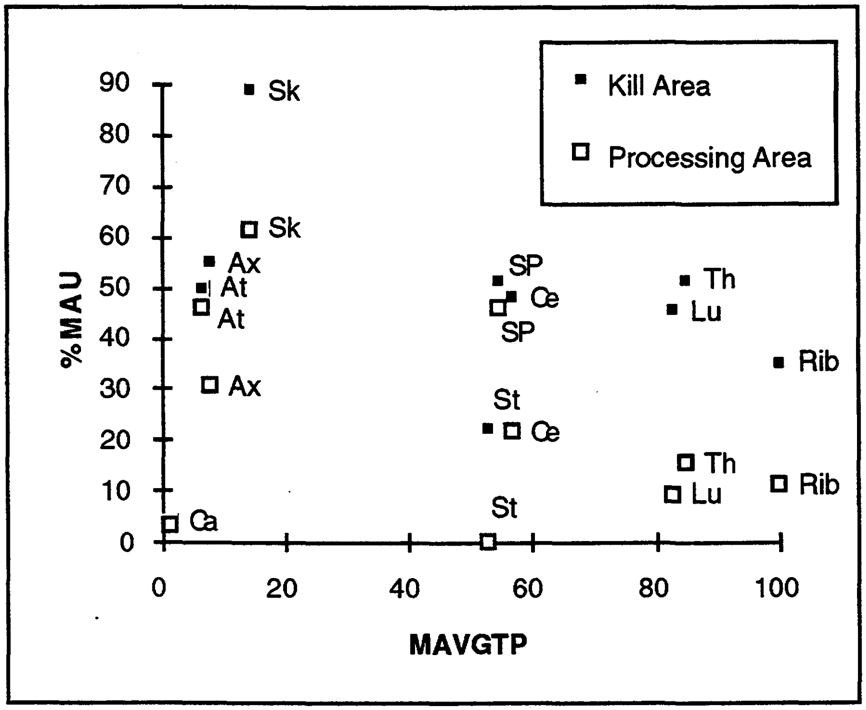


Figure 9.18: Comparison of the Kill and the Processing Area Axial Skeleton %MAU and the Modified Average Total Products Index

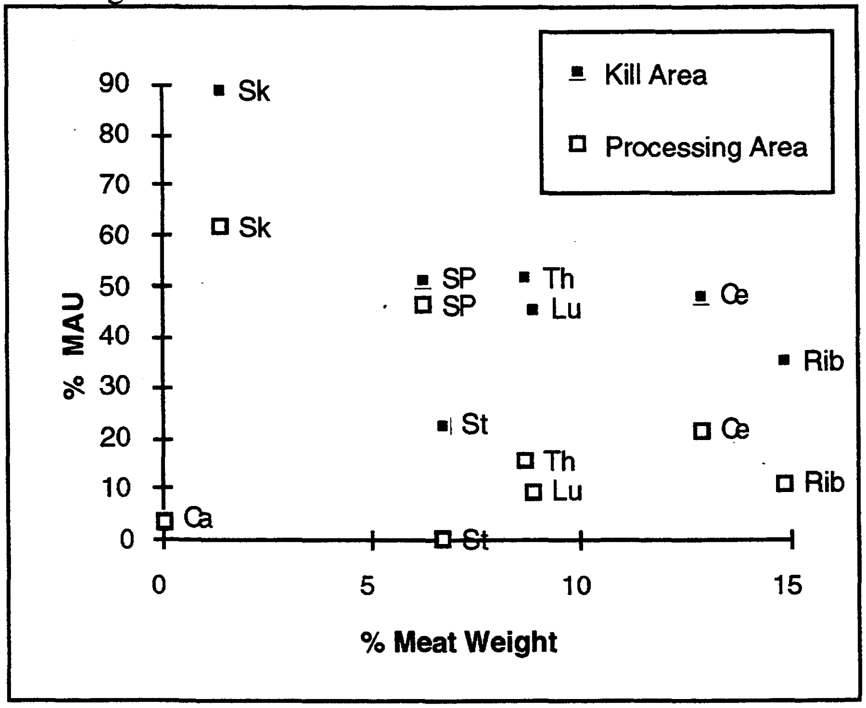


Figure 9.19: Comparison of the Kill and the Processing Area Axial Skeleton %MAU and Meat Index

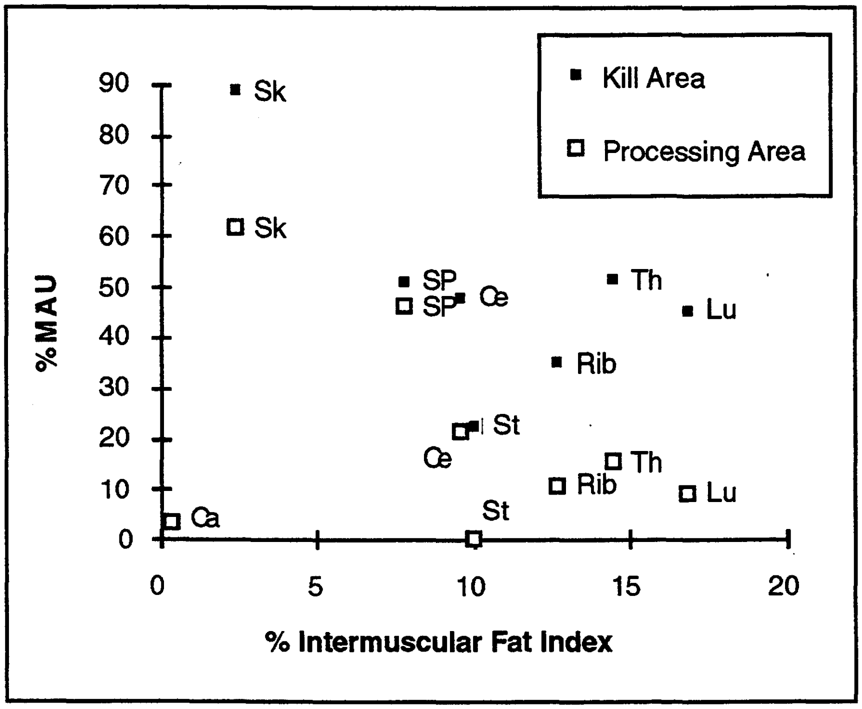


Figure 9.20: Comparison of the Kill and the Processing Area Axial Skeleton %MAU and the Intermuscular Fat Index

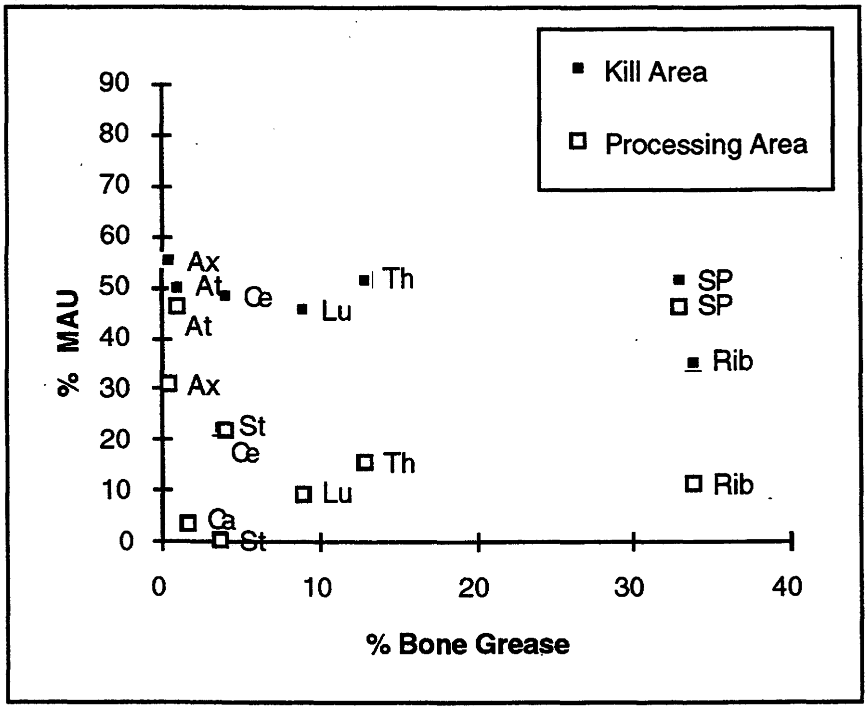


Figure 9.21: Comparison of the Kill and the Processing Area Axial Skeleton %MAU and the Bone Grease Index

differently. For instance, it has been well documented that the proximal and distal end of the tibia contains different amounts of grease. Though it has not been applied in other studies, dividing other elements into similar units could prove to be advantageous.

Emerson's work has demonstrated that the other faunal elements have a much higher utility than previously believed. Axial elements in particular have proved to contain much more edible poundage than previously thought. For instance, Emerson's (1990) utility index ranks ribs, thoracic, lumbar and cervical first, fourth, fifth and sixth of all the elements in the bison anatomy. In contrast, Binford's (1978, 1981) MGUI had ranked these same indices significantly lower at respectively, fifth, eighth, twelfth and eleventh.

Considering the great importance that the axial elements might have played in butchering strategies, it would seem opportune to consider them in more detail then previously attempted. This is especially important when one considers that certain portions of the axial elements contain the far greater proportion of meat.

Because of these demonstrated differences in meat content, vertebral and rib elements are subject to specialized butchering practices. As long bone ends are removed from kill sites because they contain disproportionate amounts of grease, it may be that the rib bodies, thoracic spinous processes and lumbar wings are removed because they contain some of the largest quantities of meat and fat on the bison body. While long bone shafts would likely be abandoned because they contain little grease, proximal rib and vertebral centra might also be abandoned for they contain little edible meat and fat. Traditional MNE, MNI and MAU counts that do not take into account these practices could result in a biased picture of butchering practices at a site.

As an example, MNE counts were derived by counting a series of land marks on the bones. The largest number of land marks present was used to derive MNE and hence

MNI and MAU counts. For instance, there were 289 anterior thoracic centra in the kill, resulting in an MAU of 20.64 for the thoracic vertebrae. However, only 77 of the thoracic vertebrae were complete; most of what was abandoned in the kill were the centra. The spinous process had been removed to another location. Considering that most of the meat and intermuscular fat is associated with the spinous process and that the bone grease is associated with the centrum, any utility counts that do not take into account these differences will be biased.

In an effort to account for biases associated with the unequal distribution of meat, fat and grease and how butchering would likely affect the skeleton, most of the axial elements were divided into two different units. Ribs were separated between the proximal (head/neck/tuber) and distal ends (rib body). Thoracic vertebrae units included the centrum (proximal) and the spinous process (distal). The lumbar was divided into the centrum (proximal) and the transverse processes (distal).

It must be recognized that there are numerous difficulties in identification with separating rib, thoracic and lumbar bones into the above elements. While proximal ribs and vertebral centra are readily identifiable, spinous processes and ribs are not. Cervical spines, thoracic spines, lumbar lateral processes and rib bodies are very difficult to differentiate. These problems are compounded by the fact that it is very difficult to distinguish between anything but the very distal and proximal ends of these bones. Where there are considerable numbers of the medial portion of these elements, distinguishing which pieces came from the same bone is virtually impossible. This makes it very difficult to obtain accurate counts of the numbers of these elements represented in a large assemblage such as the Fitzgerald site.

A review of these elements has shown that a large proportion of the identifiable specimens are of approximately the same size. As a result, this is likely a case where NISP counts more accurately reflect the numbers of these elements left at the three activity areas. NISP counts for these elements are presented in Table 5.1. Remembering this, dividing these elements dramatically changes the initial impressions about the butchering process at the Fitzgerald site. In Figures 9.18, 9.19, 9.20 and 9.21, the %MAU for the rib, thoracic and lumbar is based on the proximal ends. Virtually all axial units were found in equivalent amounts. There is a very slight correlation between %MAU and both %grease and %muscle; there is no correlation between the %intermuscular fat and %MAU.

Figures 9.22, 9.23, 9.24 and 9.25, are the same as Figures 9.18, 9.19, 9.20 and 9.21 except the %MAU for the rib, thoracic vertebrae and lumbar vertebrae is based on the distal ends. There is little correlation between the amount of grease and meat and these new axial units. However, there is a quite dramatic correlation between %MAU and fat. It is evident that the units with the most amount of intermuscular fat are found in the least quantity. Lumbar transverse processes, thoracic spinous processes and rib bodies have been systematically removed from the kill for further processing.

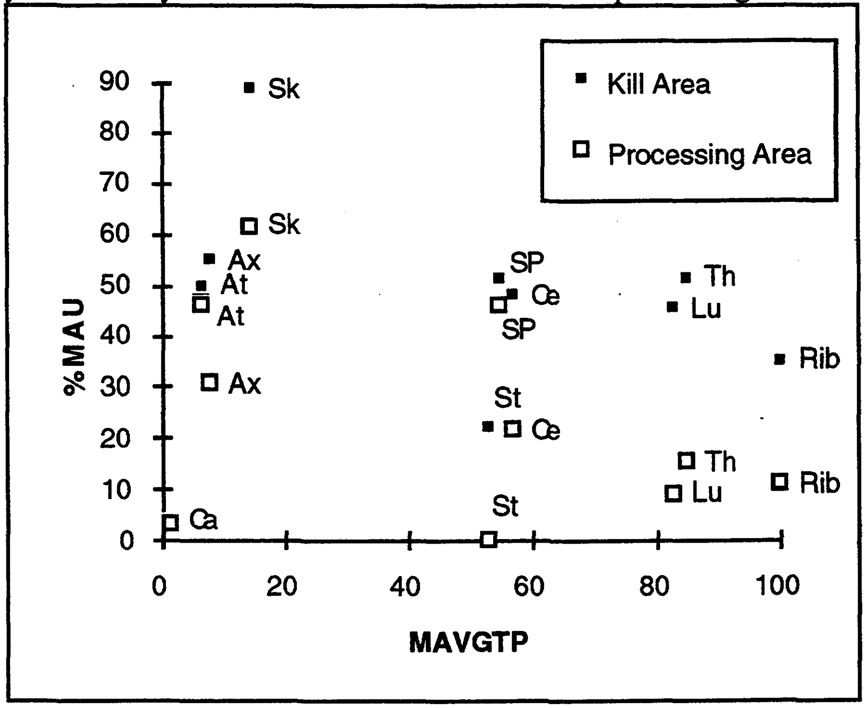


Figure 9.22: Comparison of the Kill and the Processing Area Modified Axial Skeleton %MAU and the Modified Average Total Products Index

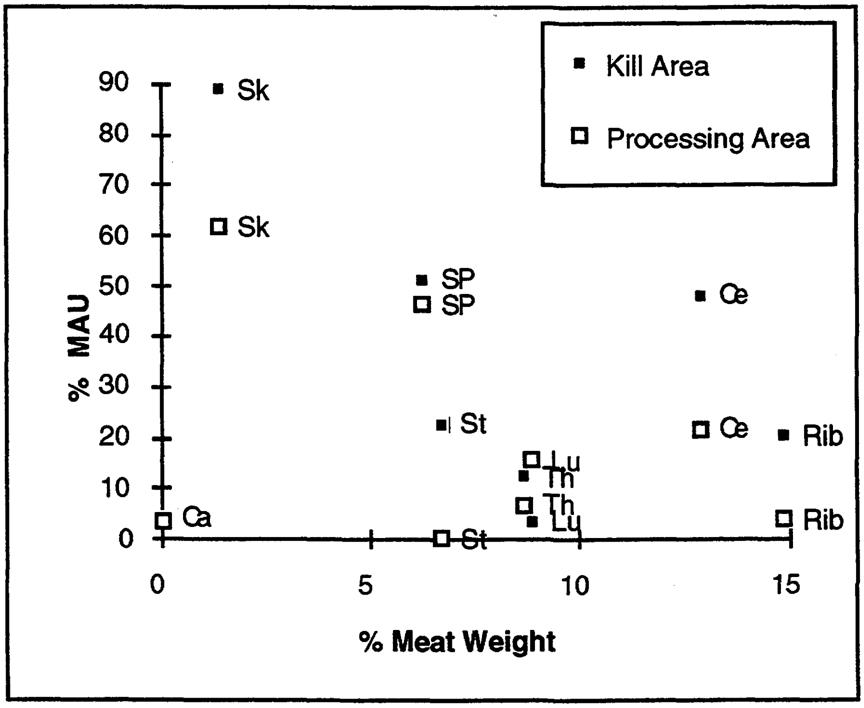


Figure 9.23: Comparison of the Kill and the Processing Area Modified Axial Skeleton %MAU and the Meat Index

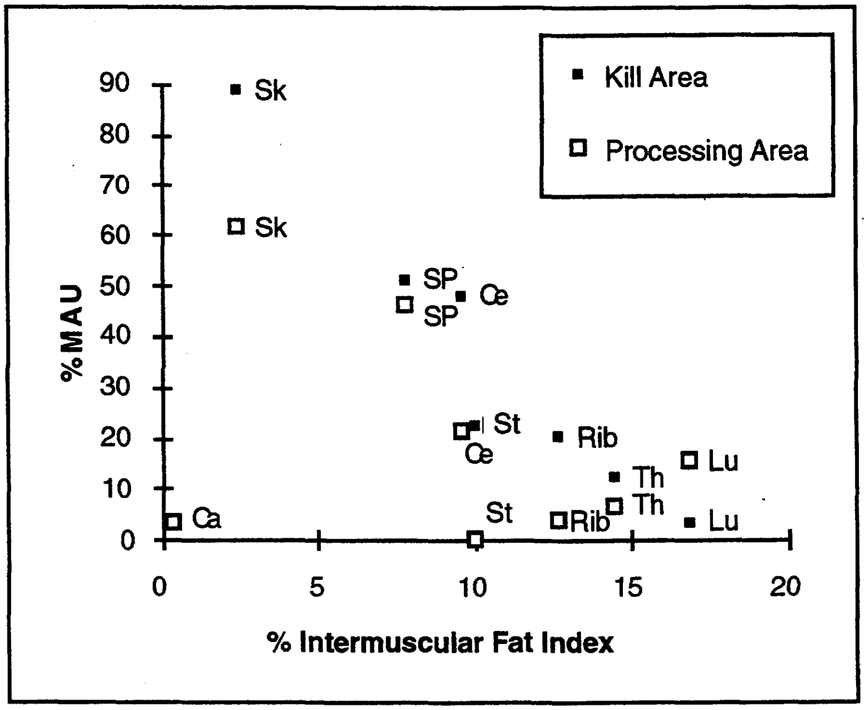


Figure 9.24: Comparison of the Kill and the Processing Area Modified Axial Skeleton %MAU and the Intermuscular Fat Index

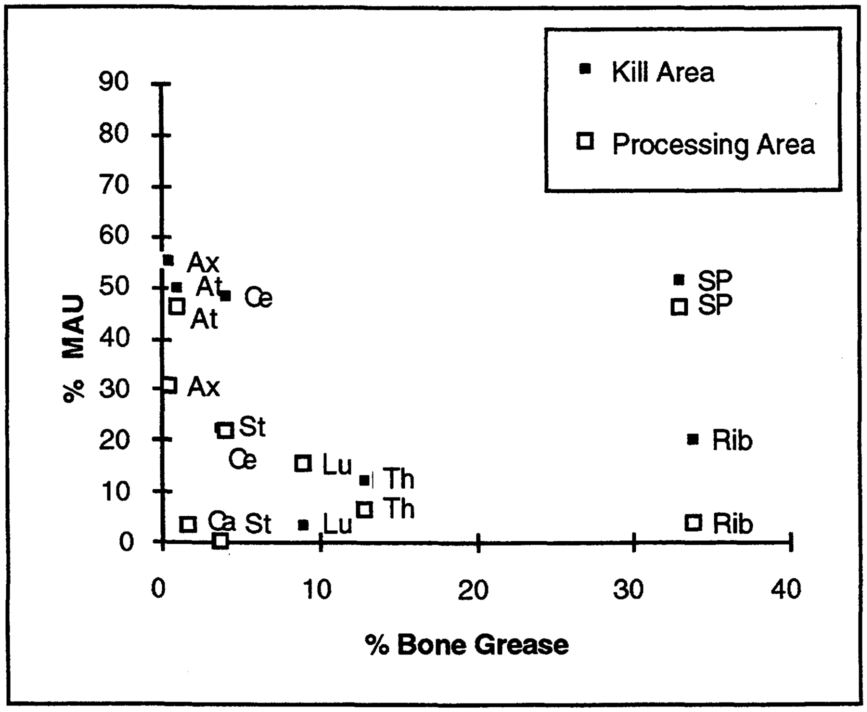


Figure 9.25: Comparison of the Kill and the Processing Area Modified Axial Skeleton %MAU and the Bone Grease Index

On the basis of these results, Speth's theory that butchering involved selecting units with the most fat for processing would be extended to the axial skeleton. These units with the highest fat content were being selected. Units with low fat content, including the proximal rib and the thoracic and lumbar centra, were abandoned at the kill.

9.4 Discussion and Conclusions

Examination of bivariate plots has demonstrated that differences in butchering patterns among the kill, processing and burned areas exist. In the kill area, appendicular elements underwent heavy processing. The majority of the long bones were first broken for marrow and then removed from the site for grease production. The proximal humerus, proximal tibia, proximal femur and distal femur specifically, are found in low frequencies. In contrast, elements of low marrow and grease utility, like the metapodials, phalanges, tarsals and carpals, were usually abandoned without modification.

Axial elements were only moderately butchered according to Emerson's (1990) MAVGTP index. Close analysis of butchering techniques has demonstrated that these elements underwent selective processing for yellow fat. For instance, abandoned in the kill were numerous vertebral centra and proximal ribs. These portions of the elements contain little of the consumable meat, fat or grease in the bison anatomy. In contrast, thoracic spinous processes, lumbar transverse processes and rib bodies are found in significant quantities. There is only moderate correlation between these elements and meat and grease indices. However, there is a strong correlation between these same elements and fat content.

It was expected that the utility curve obtained from the processing area would be opposite that found in the kill area; elements that were missing in the kill area like the distal and proximal long bone ends and the vertebral spinous and transverse processes would be found in high quantities in the processing area. This did not turn out to be the case. For instance, the MAU from the appendicular skeleton is virtually identical in the two areas. This indicates that the butchering patterns found in the kill area continued to be undertaken in the processing area. The frequency of carpals and tarsals would suggest that fore and hind limb elements entered the processing area in articulation. Limb elements would first be disarticulated and the long bones smashed to gain access to the marrow. After marrow removal, long bone portions with high grease content would be removed to an as yet unidentified location. Other portions of the fore and hind limbs like the phalanges, carpals and tarsals would be discarded in the processing area.

When compared to the kill, there are relatively few axial elements found in the processing area. Vertebral and rib elements underwent primary and secondary processing almost exclusively in the kill area. Once the spinous processes and ribs had been cut or broken from the vertebral column, the meat would likely be removed to another location to be dried. As there is little marrow or grease associated with the rest of the axial skeleton, there was no need to prepare these elements for further processing.

Depending on the age and sex of the bison, there were considerable differences in the way the animal was butchered. Within the kill and processing areas, there is an extremely strong correlation between fully mature animals and the amount of marrow and grease found in particular elements. Elements from juveniles were evidently processed for marrow and then abandoned. There is no correlation between unfused elements and grease indices in kill or processing areas.

Examining the mature elements, it would seem that elements from mature cows were more heavily processed than those from mature bulls. These results are consistent with a fall kill. During the autumn the cows are in much better condition than the bulls. During the late summer rut, the bulls lose considerable amounts of weight. If butchers are given the choice, they would be more likely to select the cow at this time of year because most fat reserves would be of considerably higher quality and quantity (Brink 1992).

In order to discern disparate utility patterns, the Fitzgerald site MAVGTP indices were compared to results from the Melhagen (Ramsay 1991), Muhlbach and Happy Valley sites (Shortt 1993). While the investigation of butchering techniques in Chapter 7 showed that the Fitzgerald site had some similarities to the Happy Valley site, analysis indicated that it most closely resembled the Muhlbach and Melhagen sites. It was expected that by comparing utility indices, further similarities and differences among the four sites could be discovered.

Using rank order correlation, a fairly high degree of correspondence (0.6) in MAU between the Fitzgerald and Muhlbach sites was found. The processing of the appendicular skeleton is virtually identical between the two sites; the %MAU counts mirror each other very closely (Figures 9.1 and 9.26). The axial skeleton counts are not

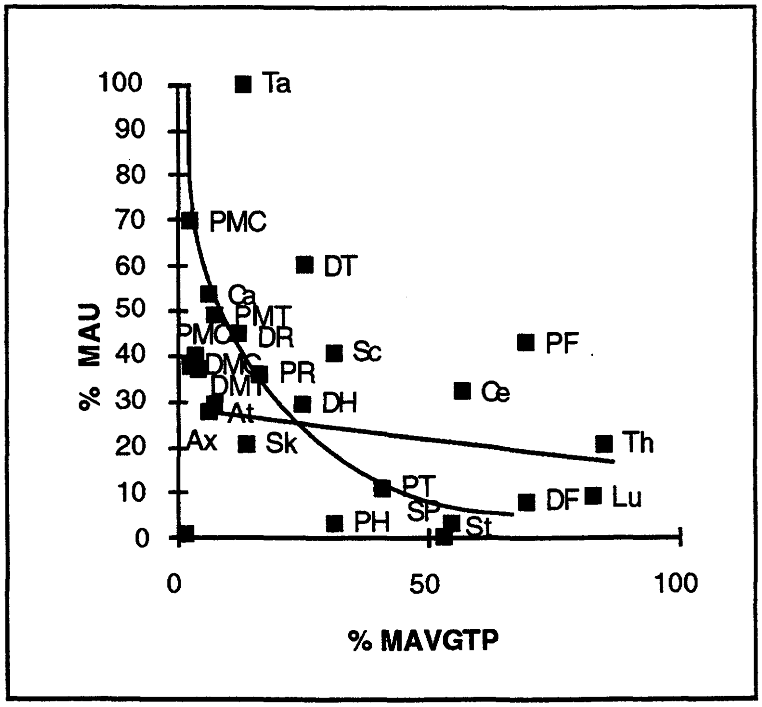


Figure 9.26: Comparison of %MAU from the Muhlbach Site and the Modified Average Total Products Index

quite as similar. When compared to the Fitzgerald site, there are substantially fewer of these elements at the Muhlbach site. The lumbar vertebrae are found in especially low frequencies; the MAU is less than 10%.

The Melhagen site bison seems to be much more heavily processed than those of the Fitzgerald site (Figure 9.27). There is only a small correlation in rank of 0.48 in MAU between the two sites. Again axial elements are found at the Melhagen site in much smaller frequencies than at the Fitzgerald site. There are also very few appendicular elements at the Melhagen site. Even elements with extremely low utility, like the metapodials, phalanges, carpals and tarsals, were seldom recovered. Only the radius was found in comparatively high frequencies. This might indicate that the fore and hind limbs were removed as one unit from the site, a pattern repeated at the Fitzgerald site where complete limb units entered the processing area from the kill area.

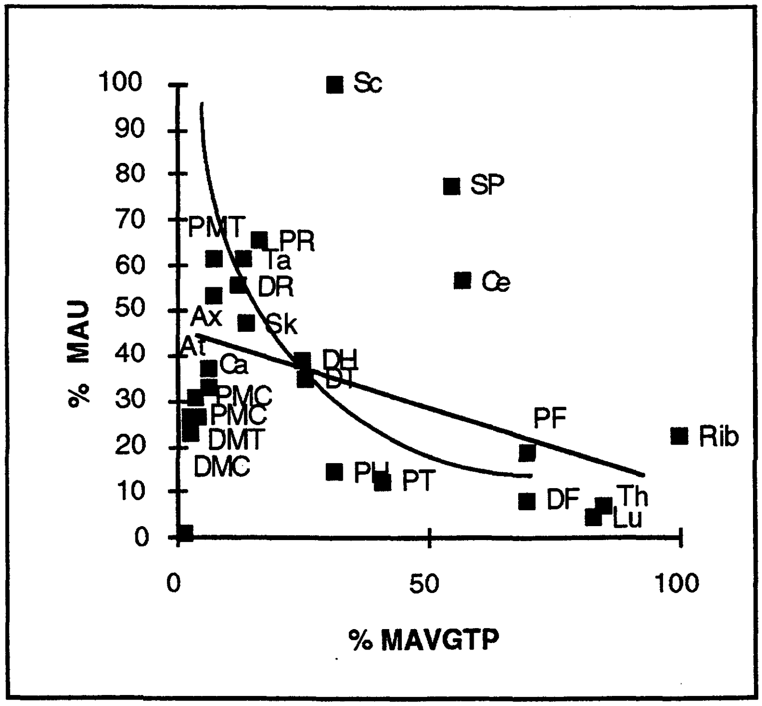


Figure 9.27: Comparison of %MAU from the Melhagen Site and the Modified Average Total Products Index

The rank correlation between the Happy Valley and Fitzgerald sites MAU is relatively low at 0.43. At the Happy Valley site, again there were relatively few axial elements like the skull, thoracic, lumbar, sacrum-pelvis or rib when compared to the Fitzgerald sample (Figure 9.28). Only the cervical (including the atlas and axis) and caudal vertebrae frequencies resemble the Fitzgerald sample. However, the appendicular element frequencies are closely aligned between the two sites. Only low utility items like the distal tibiae, phalanges and carpals are found in smaller frequencies at the Happy Valley site. Once more, this suggests that the limb elements were removed from the site as single units.

The treatment of the appendicular skeleton remained relatively consistent between the Fitzgerald and Muhlbach sites. Elements of the highest utility were consistently found in small frequencies while low utility items like the metapodials, phalanges, carpals and

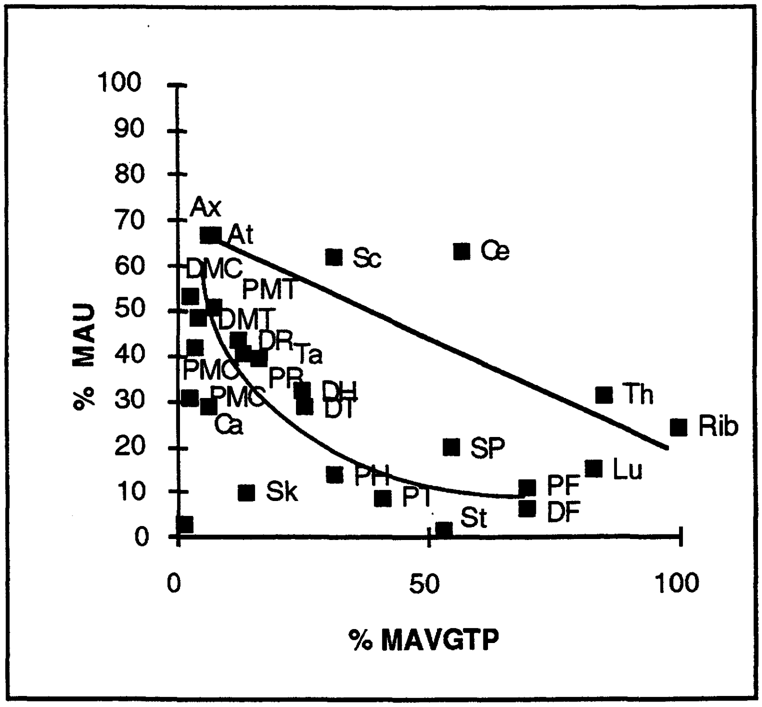


Figure 9.28: Comparison of %MAU from the Happy Valley Site and the Modified Average Total Products Index

tarsals were abandoned in the kill. This suggests that grease production was an important activity at both these sites.

This pattern is slightly different from that found at the Happy Valley site. Here there were relatively few phalanges, carpals or tarsals recovered in the kill area. This mirrors a pattern seen at the Melhagen site where these same elements and the metapodials are found in low frequencies. This pattern would suggest that many of the limb elements were removed as a single unit for processing in another location.

The axial skeleton was butchered quite differently at all four sites under review. The Fitzgerald site seems to be particularly unique; all axial elements except for the caudal vertebrae were found in equally high frequency. The skull seems to have been abandoned in especially high numbers. At other sites the axial skeleton was found in quite low frequencies, particularly the thoracic and lumbar vertebrae. However, at each of these sites certain elements of high utility were left behind. At the Happy Valley site there were large numbers of cervical vertebrae recovered and at the Melhagen site there were similarly high numbers of the sacral-pelvic unit.

Comparisons to other Besant kill sites on the Canadian Plains demonstrate that people at the Fitzgerald site butchered the bison in a quite unique way. Appendicular elements were removed from the kill only if they were of high economic utility, otherwise they were discarded. In contrast, the axial skeleton was abandoned in large numbers after the removal of the most choice portions. That the Fitzgerald site is different from the other three sites may be the result of a number of factors including sampling, seasonality, poor weather conditions, time since the last hunt, condition of the bison and various taphonomic factors. Saying this, the site that most closely resembles the Fitzgerald butchering pattern is the Muhlbach site in Alberta. That this is the only other of these sites that is completely dominated by Knife River Flint is noteworthy.

Chapter 10

Interpretation of Site Activities

10.1) Introduction

It has been argued that the hunters who occupied the Fitzgerald site originated from the region around the Knife River in present day North Dakota. The frequency of lithic materials from this region is too high to have been obtained through trade. It has also been shown that over 800 bison were killed at the Fitzgerald site. These bison were very heavily processed, with most of the elements containing large quantities of grease missing from the sample. The presence of a bone boiling pit would seem to confirm that butchering was oriented towards obtaining grease for pemmican production.

These butchering patterns are reminiscent of all other Besant communal kill sites examined to date on the Canadian Plains. Some Besant sites like Melhagen, Muhlbach and Richards also have large quantities of Knife River Flint. A number of models have been developed to explain the importance of communal hunting on the Plains. These models will be examined in order to determine why these bison hunters were venturing north on to the Canadian Plains to hunt bison communally.

10.2 Bison Processing and Utilization During the Besant Phase

Virtually since the first contact with Plains cultures, Europeans have acknowledged that much of the Plains economy was based on the hunting of bison. Early historic and ethnographic accounts are filled with sometimes contradictory descriptions of large communally run bison kills. Archaeologists have developed a number of models that would explain how communal bison hunting has influenced Plains economy and society.

Frison (1967: 32) was heavily influenced by the historic and ethnographic accounts. From his own archaeological research he developed what has been termed the

Annual Model. In this model, Native populations hunted communally each year from September to October to gather meat and pemmican stores for the coming winter. These bison kills were part of a "buffalo procurement complex" centered on the mass coordination of people towards a prescribed economic end. The result was the formation of integrated and highly structured social groups. Because of its importance in the economy, the complex was also highly ritualized.

Frison (1978) later demonstrated that the roots of this complex could be found as far back as 10,000 BP. However, it was not until the emergence of the Besant culture that bison communal hunting operations reached a "cultural climax... that was never reached again on the Northwestern Plains" (Frison 1978: 223). He hypothesized that reaching this zenith was partially the result of the Besant people building their own artificial traps separate from natural topographic features like arroyos and cliffs. The construction of bison pounds was an innovation that allowed these hunters to procure bison in the places wherever the bison might be at this particular time of the year.

Frison's (1971) excavations at the Ruby site showed how sophisticated Besant hunting had become. At this site, a well constructed corral structure and accompanying drive lanes were identified. Next to the pound what has been interpreted as a ceremonial structure was located. This structure is lenticular, 13.5 m long and 3 m wide. There were at least six bison skulls lined-up along the south edge of the structure. The placement of the skulls implied that the bison played an important role in the Besant cultural ideology. As a result, Frison (1971: 87) argued that "(c)eremonial activity is another concomitant of communal food procurement activity."

Frison's arguments that communal hunting occurred only in autumn have proved to be untenable. Subsequent re-examination of historic and ethnographic accounts (Arthur 1975; Morgan 1979) have found many references to communal hunting in the winter and spring. There are also numerous examples of kill sites in the archaeological record that were occupied in seasons other than the fall. For instance, some cultural horizons at Head-Smashed-In buffalo jump (Reeves 1985) and the Estuary pound in Alberta (Fawcett 1987), the Muddy Creek pound site in Wyoming (Frison 1991), the Henry-Smith and Bootlegger sites in Montana (Fawcett 1987) and the Tschetter pound site in Saskatchewan were utilized in the early winter (December and January). The Melhagen pound site in Saskatchewan (Ramsay 1991), the Homestead Jump in Montana (Fawcett 1987), the Big Goose Creek jump and Inman processing site in Wyoming (Fawcett 1987), and nine smaller kill sites on the Belly River (Quigg 1972) were functioning in mid-winter.

A number of examples of spring bison kill sites exist in the archaeological record. In Wyoming there is the Kobold Jump (Frison 1970), which was heavily utilized through the late winter and early spring, and the Vore kill site (Reher and Frison 1980), a large sinkhole trap with a single instance of spring use. In Alberta there is the Fort McLeod Junction site, a bison pound, processing and camp site utilized from March through to May (Umfreed, personal communication 1995). The Ramillies (Brumley 1976) and Sammis (Vickers 1986) bison pounds were also most heavily utilized in the spring.

Archaeological evidence of summer hunting activities on the Plains is rare. Only the Henry-Smith Pound site in Montana (Fawcett 1987) and the Smythe site in Alberta (Allison Landals, personal communication 1994) have definite evidence of use in the early summer. Thus, it is clear from this review that communal hunting occurred outside of the fall. Indeed, it usually occurred from late fall into the early spring. Frison's Annual Model does not correspond with the present evidence.

Expanding on much of Frison's thesis, Kehoe (1973: 195) developed what he termed the Industrial Hypothesis to explain the perceived expansion in communal hunting operations throughout the pre-contact period. Kehoe concluded that economically the communal hunting of bison can be considered an industry because it "leads to food distribution and preservation." This industry involved the coordination of large amounts of people in what became a ritualized activity with an economic motive. The goal was more efficient processing of the bison for "the prevention of starvation." It developed throughout the pre-contact period and reached full maturity with the introduction of the bow and arrow around 2000 years ago (Kehoe 1978).

This industrialization is differentiated from the later 19th Century commercialization of the bison hunt. Provisions and hides were needed to supply the burgeoning European fur trade in the period from 1780 to 1880. Thus, bison started to be communally hunted for purposes beyond the Native people's own needs. As a result:

> there was a fluorescence or enrichment of the [Native Plains] culture that came about. This included more luxury items, more leisure time activities and increase in wealth. The bison corral was enlarged for production purposes. The increased importance of women resulted in polygyny and the increase in size of the tipi (Kehoe 1973: 195).

According to Kehoe, one of the effects of these activities was that a ranked society replaced the more egalitarian band society of previous times.

Kehoe provided little archaeological evidence to support this thesis. He hypothesized that increasing numbers of projectile points in kill sites through time may be the result of increased activity. Presumably, larger numbers of points meant more hunters and larger kills. This is hard to reconcile against the fact that certain types of kills will likely have more projectile points than others. For instance, hunters using a pound would have more need to use weapons than those using a jump. It would also be expected that over time the height of any jump would decrease because of the accumulation of bone, soil and sediment deposits at the base of the cliff; as a result, projectile use would have to increase as fewer animals would be killed outright by the fall (Brumley 1990).

Speth's (1983) analysis of the faunal assemblage at the Garnsey site indicates that because the kill took place in the spring, hunters were selecting animals and elements with the most fat. This was a result of the severe dietary stress these hunters would undergo at the end of the winter because of a reduced quantity of stored foods and a corresponding high amount of protein in the diet. The combination of a high protein, low caloric and low carbohydrate diet leads to an increased need for fat. Hunters would choose to hunt and butcher animals that could provide the maximum amount of this resource. As a result, communal hunting in the spring might have been as important as in the fall.

Reher and Frison's (1980) excavations at the Vore Site, a sink hole bison trap in Wyoming, resulted in a significant reevaluation of Frison's (1967) earlier ideas about annual communal hunts. At the Vore site, communal kills were found to have occurred only once every 25 years. They concluded that there was a critical number of bison needed to carry out a successful communal hunt. As moisture patterns are on a ten year cycle and bison populations were closely correlated with grassland productivity and hence precipitation, this critical number was only reached every 25 years (Reher and Frison 1980: 40). Following this cultural-ecological perspective, Reher and Frison concluded that communal hunting was actually a relatively rare phenomenon on the Northern Plains.

Fawcett (1987: 47-49) has been critical of these interpretations of the data. For instance, he finds it unclear how a ten year moisture cycle corresponds to the 25 year gaps in kill events seen at the Vore site. He sees little evidence that the bison population ever declined below Reher and Frison's 'critical number'. As well, he points out that communal hunting does not have to be practiced at a single location like Vore on an annual basis, it can be completed at any number of different sites within an area.

Driver (1983) agrees with the assumption that communal hunts were rare. However, he proposes a model that draws completely opposite conclusions from the Vore data. First, he disputes how a peak in rainfall in one year could affect the bison population at a kill several years later. His examination of the Vore data would indicate that communal kills occurred during periods of drought. Driver (1983: 149) proposes that the "communal hunting of bison is a result of human short-term adaptation to an environment and food supply undergoing rapid change as a result of stress induced by climatic perturbation." When poor climate reduced the herd size, human bands would be forced to aggregate and hunt to survive.

Reeves (1990) disputes the notion that hunters, at least on the Canadian Plains, were under environmental stress. Pemmican provided a surplus that allowed Plains culture to flourish. He argues then that the fluorescence of communal bison hunting occurred 3000 years ago during what he calls the Late Middle Prehistoric Period (Pelican Lake and Besant). The basis for this fluorescence is a virtual technological revolution, "the perfection of a new food production and storage system (pemmican) innovated 2000 years previously" (Reeves 1990: 169). The subsequent development of the bow and arrow was "the kick that resulted in the emergence of the Classic Period of the Northern Plains Bison Hunting Culture" (Reeves 1990: 169). The result was a general increase in population, an expansion of lithic trade and exchange systems and the "eventual embellishment and elaboration of technological, social and ideological systems" (Reeves 1990: 171).

These trends should be easily recognizable archaeologically. Evidence of pemmican manufacture comes from "rocks fractured by stone boiling, bone boiling pits, extensively smashed selected bones, and bone spill piles" (Reeves 1990: 170). Reeves argues that these features first appeared in the archaeological record around 4800 BP and by 3000 BP were quite common. At this time, there was also a corresponding increase in the number of bison jumps, pounds, and other traps.

Brink's (1994) recent examination of a number of faunal assemblages from different time periods on the Northern Plains supports the basic tenets of this argument. Brink (1994) examined a large array of kill site faunal assemblages for evidence of bone elements with high grease content. Where these elements are missing, it is likely that they were being used in pemmican production. His research demonstrated that these elements start to be systematically removed from kill sites around 2000 years ago. This would indicate that pemmican production likely reached significant levels some 1000 years later than Reeves' original hypothesis.

Morlan (1994a) is also somewhat critical of Reeves' time frame for the invention and perfection of pemmican manufacture. For instance, the Gowen sites assemblages suggest that grease processing dates to the Early Middle Prehistoric Period around 5000 BP (Walker 1992). However, Morlan's (1994a) interpretation of the somewhat later Harder site assemblage would indicate that grease production was likely not undertaken. He concludes that the absence of data from Oxbow and McKean kills also makes it difficult to empirically test much of Reeves' thesis (Morlan 1994a: 757-758).

Another problem with Reeves' thesis is that this fluorescence is not based on the invention of pemmican manufacturing. Instead pemmican is supposed to have originated some 3000 years previous to Besant and steadily increased in use over the period of three millennium. The adoption of the bow and arrow then led to the Classic Bison hunting culture of the Late Prehistoric Period. The situation seems to have been much more complicated than Reeves suggests. First, it is unclear from these arguments how pemmican manufacturing can evolve over time. If people had invented such a valuable technology that would aid in their survival, it is reasonable to think that they would exploit it to its full potential from the onset. Its adoption should have been analogous to the introduction of the horse onto the Prairies; the value of the horse was immediately seen and soon after became an integral part of the plains cultures. Second, the development of the bow and arrow may have been much earlier than Reeves suggests. For instance, it is quite likely that many Pelican Lake and Besant Series projectile points are arrow heads (Brumley and Dau 1988; Dyck and Morlan 1995: 538). There must then have been reasons for this increase in communal hunting beyond that explained by the introduction or perfection of a new technology.

Fawcett (1987) has proposed a different model to explain communal hunting patterns. He believes that these hunts were only organized to feed large aggregates of people when they gathered for social and political activities (Fawcett 1987: 37-38). In addition, these hunts served two other important functions, they relieved social and political tensions and helped in the redistribution and exchange of resources. Thus, communal hunting was an activity for social not economic gain. So, while these hunts could occur at any time, even when the bison were in poor condition, they would be a relatively rare phenomenon. There were as few as 2000 kill events on the Northern Plains in the last 3000 years (Fawcett 1987: 51-52).

This model can be criticized on a number of points. Fawcett would seem to suggest that most communal hunts occurred in the summer for the annual Sun dance. However, he fails to demonstrate a strong association between sacred sites and bison kills (Duke 1991). Second of all, summer kill sites, as has been previously demonstrated, are also quite rare in the archaeological record. Finally, Fawcett's estimate of the number of kill events on the Plains is substantially lower than is traditionally believed. Some sites, like Head-Smashed-In buffalo jump in Alberta, must themselves have been used hundreds of times. Many more sites would not have survived into the Twentieth Century because of various taphonomic processes.

Duke (1991) also argues that the intensification of the bison hunt was more the result of a social rather than an economic need. The hunting of the bison was of considerable ideological importance in Plains society. As a result, it is argued that "killing, rather than the acquisition of meat and other bison materials, was the important activity" (Duke 1991: 180). This involves the process of canalization where:

> behavior becomes more involuted and thereby more *intense* by the very act of its being carried out and achieving its goals. There is, then, no need to explain all processes such as the intensification of procurement and processing by recourse to outside factors such as external trade or population increase (Duke 1991: 180).

This argument seems to break against the traditional view of Plains cultures' close interrelationship with the surrounding environment. It attributes a degree of blood lust that runs counter to most evidence from archaeological sites from the Late Prehistoric Period. Communal kills, like the Fitzgerald site, indicate that almost all the bison were heavily processed. There was an economic need for killing the number of bison that these people did.

10.3 Discussion and Conclusions

According to many of the above mentioned models, Besant played an important role in the technological, economic, social and ideological development of the Plains people. The basis for change in these models may have been economic (Frison 1967; Speth 1983), technological (Kehoe 1973; Frison 1978; Reeves 1990), environmental (Reher and Frison 1980; Driver 1983) and/or ideological (Fawcett 1987; Duke 1991). The challenge is to see if the evidence from the Fitzgerald site corresponds to any of these hypotheses. By comparing this evidence to other sites of this period, a clearer picture of the Besant communal bison hunting culture emerges.

The accepted temporal range of the Besant Series is from 2500 to 1100 BP. These dates coincide with a period of cooler and moister conditions that existed from 2650 to 1060 years BP (Vance 1991: 141). This environment would have provided an ideal natural resource base for the peoples of the Besant culture to exploit. The Fitzgerald site itself was occupied near the end of these moister conditions at approximately 1300 BP.

The Fitzgerald site is located within the Aspen Parkland ecozone. Most other Besant sites on the Northern Plains were also found within the same ecological zone. This location is where the majority of the bison are usually found from the late fall though to the early spring (Morgan 1979, 1980). As a result this region is an ideal location for hunting bison in the late fall when the need for pemmican stores is greatest (Frison 1991; Speth 1983). The Besant people were almost certainly aware of bison migratory patterns and positioned themselves to take the fullest advantage of them.

Driver (1990) has demonstrated that communal hunting is closely linked to the aggregation of the hunting prey. When the herds are small and dispersed over a large area, communal hunting is not economically viable. There is not enough food available within the catchment area to support a large human population. Driver has shown that communal hunting is contingent on five things, 1) the density of the herd; 2) the search time necessary to find a herd; 3) the number of animals that can be killed; 4) the success rate; and 5) the number of times per day the group can hunt (Driver 1990: 25). When there are only a few large herds, hunters need considerably more people to locate the herds. Concurrently, a high density of animals allows a larger human population to survive by producing a surplus to help survive leaner times.

The evidence from Besant sites conforms well with Driver's model. First, the congregation of the bison in the Parklands in the winter would have allowed the human population to concentrate at a parallel rate. When the bison moved out into the more extensive Mesic and later Xeric Prairies in the spring and summer, these groups of people would themselves be forced to disperse into smaller bands. This may explain why there are few kill sites on the Northern Plains that were utilized between May and the end of September.

With the improved climatic regime, there might also have been an increase in the number and size of the bison herds. With such a growth, hunters would have had the required numbers of bison to hunt communally hunt on a more regular and predictable basis. This may have resulted in an explosion of hunting activities.

It is possible that over 800 bison were killed and butchered at the Fitzgerald site so it is very unlikely that hunting activities were undertaken for the immediate consumption of marrow, meat and fat products. Application of bison utility indices indicate that grease processing was likely the focus activity. Vast stores of pemmican were being created that could then be distributed within the hunting group. Communal hunting had become an highly specalized activity devoted to the preservation and redistribution of food.

These processing activities are found in all Besant communal kills reported to date (Ramsay 1991; Shortt 1993). So while Fawcett (1987) and Duke (1991) are correct in saying that ritualized activities were strongly associated with the Besant communal hunting culture (e.g. Frison 1973 and Neuman 1975), it was not the reason that these hunts were undertaken in the first place. The sheer density of heavily butchered faunal deposits from these Besant sites suggests that the primary motive for the hunt remained the processing and redistribution of large caches of food.

Chapter 11

Summary and Conclusions

11.1 Summary of Research at the Fitzgerald Site

The Fitzgerald site is a Besant pound and processing area found on the border of the Aspen Parkland and the Mesic Prairie 15 km southeast of Saskatoon. The site is located in the Moose Woods Sand Hills, a series of gently rolling dunes stabilized by fescue grasses and clumps of aspen. This region provided an ideal habitat for bison, especially during the late fall through to early spring when the fescue grasses provided the best available food source for ungulates on the Plains. The surrounding poplar bluffs also acted as a shelter from the cold winter winds.

The site was discovered by Joe Fitzgerald in the summer of 1991 in a small basin formed between two stabilized sand dunes. Two seasons of testing and excavations were eventually completed, resulting in an excavated sample of 72.5 m^2. Excavations were about equally divided between the two activity areas; 42.5 m^2 were allocated to the kill area and 31 m^2 to the processing area.

All cultural materials were recovered within a single cultural component located in a brown paleosol that can be found as deep as 1.25 m below the surface. The uniformity of the projectile points, lithic materials and radiocarbon dates is consistent with the argument that the site represents a single occupation. This soil horizon is capped by a thinner, darker paleosol. Thus, after this second soil was formed, the cultural deposits were protected from many natural taphonomic processes brought on by exposure to the elements. Analysis has shown that while the faunal assemblage was subject to natural taphonomic stresses, they do not seem to have seriously affected what is one of the principal components of this analysis, the determination of which bison and which portions of the bison were being selectively processed.

Projectile point morphology and radiocarbon date analyses indicate that the site is part of the Besant Series. The diagnostic points were assigned to the Besant Side-notched type. The division of the projectile points into two distinctive styles, Outlook and Bratton Side-notched, has been rejected. The averaged calibrated radiocarbon age of 1283 +/- 20 BP is consistent with a Besant Series affiliation. The projectile points and other lithic tools and debitage are dominated by stone found almost exclusively to the south of the Fitzgerald site. Over 90% of the lithic tools and debitage are made from Knife River Flint. Other materials identifiable to source include fused shale, Tongue River Silicified Sediment, obsidian and Swan River Chert.

The number of features observed was comparatively small. In the kill area, a series of post holes and bone uprights have been interpreted as the remains of a corral structure. A multi-bone upright in the processing area was likely a tie down stake for a dog or a structure like a tipi or drying rack. A boiling pit was identified in testing 40 m south of the main kill and processing area.

Excavations of kill sites usually result in large samples of faunal materials. The Fitzgerald Site was no exception. They include approximately 250,000 pieces (6000 kg) of bison bone, about 11,250 (4920 kg) of which proved identifiable. A minimum of 49 bison were identified. As only approximately 6% of the site was excavated, upwards of 800 animals may have been killed at the site.

Various demographic indices developed exclusively for bison were applied to the Fitzgerald sample. Examination of the juvenile bison mandible and maxilla sample indicates that the site is the result of an October or November kill event. Age profiles based on first molar enamel height conform to a single seasonal event. They also indicate that the Fitzgerald herd was extremely healthy; there are a considerable number of bison older than 10 years. Long bones, carpals and tarsals were also examined to determine the age, and also the gender, of the Fitzgerald bison population. These analyses are quite consistent in suggesting that the population consists of almost equal numbers of bulls, cows, and juveniles. During the fall, the bulls usually form into herds separate from the cow and calves so it is very likely that the Fitzgerald site represents at least two different kill events.

Butchering patterns at the Fitzgerald site were next examined. The bison were heavily butchered; there were relatively few complete elements or articulations. However, it was possible to reconstruct with reasonable certainty the different stages in the butchering process. Corresponding application of Emerson's economic utility indices indicates that a bulk butchering strategy was employed. Portions with considerable amounts of muscle and fat like the hump and tongue were processed immediately. In order to extract the marrow, almost all the long bones were then broken open. Finally, proximal and distal long bone ends were systematically removed for grease processing. Utilizing the bison demographic profile, it was determined that the cows were usually selected over the bulls during the butchering process. Juvenile elements were usually not fully processed. These results are consistent with a fall kill event when the cows would be in considerably better physical condition than the bulls.

Differences between the kill and processing area were also identified. In the kill area, bison underwent heavy primary and secondary processing activities. Tertiary processing like marrow removal was also completed in this area of the site. In the processing area, activities centered on secondary processing of the appendicular skeleton and marrow processing. Axial elements were not found in abundance in this portion of the site. Direct evidence of pemmican manufacture was recovered in the form of a boiling pit in another portion of the site.

11.2 Conclusion

A considerable number of bison were killed and butchered in a highly efficient and systematic way 1300 years ago at the Fitzgerald site. A large corral was constructed in the late fall and possibly as many as 800 bison were eventually drawn into the structure and killed. Butchering would have commenced immediately with the cows being chosen first as they would have been in the best condition at the time. The bison were exploited to their full economic potential.

This hunt was not a random undertaking for the immediate consumption and use of the bison. Considerable planning and team work were necessary to capture what were no doubt a number of different herds. The sheer number of bison that were eventually killed and butchered indicate the effectiveness of the hunting strategy. It reveals that the investment in time and effort to construct and operate a corral was well rewarded. Communal hunting could result in the slaughter of numerous herds over a relatively short period of time.

The processing of the dead animals was also carefully planned. All portions of the bison of economic value were heavily butchered. Grease production, especially, played an important role in the economy of these people. The goal was to provide a suitable cache of pemmican to feed the group throughout the winter and beyond.

An examination of other Besant kill sites demonstrated that the Fitzgerald site kill was not a unique event during this period. The Fitzgerald site was part of a bison hunting culture that was found across the Northern Plains. No doubt benefiting from a favorable climatic regime, the Besant hunters were exploiting the bison herds to their maximum potential. The industrialization of the bison hunt had begun.

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Appendix

Abreviations Used in Text

A	Anterior
ANG	Angled
ASYM	Asymmetrical
AT	Atlas Vertebra
AX	Axis Vertebra
BI	Biconvex
CA	Carpals
CD	Caudal Vertebra
CE	Cervical Vertebra
COR	Corner Notched
CRSH	Crushed
CX	Convex
C 2/3	2nd and 3rd Carpal
C/4	Central and 4th Tarsal
D	Distal
DF	Distal Femur
DH	Distal Humerus
DT	Distal Tibia
DUL	Dulled
5th MTC	5th Metacarpal
FSH	Fused Shale
F Shaft	Femur Shaft
Hum	Humerus
H Shaft	Humerus Shaft
I Sesamoid	Inferior Sesamoid
JGD	Jagged
KRF	Knife River Flint
LBSL	Left Basal
LBDY	Left Body
L Malleolus	Lateral Malleolus
LGTH	Length
LM	Lower Molar
LND	Left Notch Depth
LNL	Left Notch length
LPM	Lower Premolar
LU	Lumbar Vertebra
MAU	Minimum Animal Units
MNE	Minimum Number of Elements
MNI	Minimum Number of Individuals
MTC	Metacarpal
MTT	Metatarsal
NISP	Number of Individual Specimens
OBT	Obtuse
OVT	Ovate
P	Proximal
PF	Proximal Femur
PH	Proximal Humerus
PL	Plano
PLSH	Polished
PT	Proximal Tibia
QTZ	Quartzite
RBSL	Right Basal
RBDY	Right Body
RND	Rounded
RNL	Right Notch Length
SHLD	Shoulder
STR	Straight
SKW	Skewed
SLASY	Slightly Asymmetrical
SL Sesamoid	Superior-Lateral Sesamoid
SM Sesamoid	Superior-Medial Sesamoid
SP	Sacrum/Pelvis
SQ	Square
STR	Straight
Swan River	Swan River Chert
SYM	Symmetrical
TA	Tarsal
THCK	Thickness
Thor	Thoracic Vertebra
TRSS	Tongue River Silicified Sediment
T Shaft	Tibia Shaft
T 2/3	2nd and 3rd Tarsal
UM	Upper Molar
UPM	Upper Premolar
UTIL	Utilized
Wings	Lumbar Lateral Process
WISP	Weight of Individual Specimens

										Body	Body	Trans	Long	Left	Right
CatNo	South	South	East	East	Quad	LVL	DBS	Portion	Lithic	Shape	Symmetry	Sec Shape	Sec Shape	Shldr	Shldr
17073	63	0.39	59	0	NW	10	111	No Side	KRF	EX/ST	ASYM	BI	BI	ANG	
17074	86		73		NW	2		Complete	KRF	EX/ST	SLASY	PLCX	PL/CX	RND	RND
17075	86	0.45	76	0.58	NE	2	99	Mid-Section	KRF	STR					
17076	86		77		NW	2		Base	KRF						
17077	86		77		SE	3		Body	KRF	STR	SYM	BI	BI	RND	ANG
17078	86		78		SE	1		Complete	KRF		SYM	BI	BI	ANG	OBT
17079	86		78		SE	1		No Tip	KRF	OVT	SYM	BI	BI	ANG	RND
17080	86	0.97	78	0.35	SW	2	93	Complete	KRF		SYM	BI	BI	ANG	RND
17081	86		79		NW	1		Tip	KRF						
17082	86		79		NW	2		No Tip	KRF		SYM	CX/CV	BI	ANG	RND
17083	86	0.32	79	0.21	NW	2	100	Base	KRF						
17084	86		79		NW	2		Mid-Section	KRF						
17085	86		79		NW	1		Tip	KRF						
17086	86	0.56	79	0.35	SW	2	109	Tip	KRF						
17087	86		80		SE	1		Complete	KRF	OVT	SYM	BI	BI	OBT	OBT
17088	86		80		SW	2		Base	KRF						
17089	87	0.96	80	0.7	SE	2B	130	Complete	KRF	OVT	SYM	BI	CX/CV	RND	RND
17090	87	0.98	80	0.08	SW	2	80	Base	KRF						
17091	87		81		SE	1		Base	KRF						
17092	87		81		SW	2		Mid-Section	KRF						
17093	87		81		SW	1		Mid-Section	KRF						
17094	87		81		SW	1		Mid-Section	KRF	OVT	SYM	BI			
17095	87	0.17	82	0.88	NE	2	113	Mid-Section	SWC	EXC	SYM	BI	BI	RND	RND
17096	87		82		NW	2		No Tip	KRF	OVT	ASYM	PLCX			ANG
17097	87		82		NW	2		Base	KRF						
17098	87		82		NW	2		Mid-Section	KRF						
17099	87		82		NW	1		Mid-Section	KRF					RND	
17100	87		82		NW	2		Tip	KRF						
17101	87		82		SW	2		Base	KRF						
17102	87	0.86	82	0.48	SW	2B	109	Body	KRF		SLASY	PLCX	PL/CX	OBT	OBT
17103	87		83		NE	2A		Mid-Section	KRF						

Appendix 1: Biface Projectile Points Qualitative Descriptions

	Left Notch	Right Notch	Left	Right	Left	Right	Base	Left	Right	Base		
CatNo	Orientation	Orientation	Notch Shape	Notch Shape	Notch Mod	Notch Mod	Type	Basal Edge	Basal Edge	Modific	Retouch	Utilization
17073	SIDE		SQR				CVX	ANG	SQR	TH/DUL		
17074	SIDE	SKW	ANG	SQR	RET	CRSH	CVX	ANG	ANG	TH/RET	RET	UTIL
17075			ANG								RET	UTIL
17076			SLANG		CRSH			ANG		T/R/P		
17077												JGD
17078	SIDE	SIDE	RND	RND	PLSH		CVX	OBT	SQR	TH/DUL	RET	JGD
17079	SIDE	SIDE	RND	RND	CRSH	PLSH	CVX	RND	RND	THIN	RET	
17080	SIDE	SIDE	RND	RND	PLSH	PLSH	STR	RND	SQR	THIN		JGD
17081												
17082	SKW	SIDE	SQR	RND			CVX	RND	SQR	TH/RET	RET	UTIL
17083								SQR	SQR			
17084												
17085												UTIL
17086												
17087	SIDE	SIDE	RND	RND			CVX	ANG	ANG	TH/RET		
17088				RND			STR	SQR		TH/RET		
17089	SIDE	SIDE	ANG		CRSH		STR	ANG	ANG	TH/RET	RET	JGD
17090							CCV	SQR	SQR	THIN		
17091						CRSH	CVX	RND	SQR	THIN		
17092												
17093												JGD
17094											RET	UTIL
17095												UTIL
17096	SKW	SKW	RND	SLSQ	PLSH	PLSH	STR	OBT	OBT	TH/DUL	RET	JGD
17097							STR	SQR		THIN		
17098												UTIL
17099												UTRND
17100												
17101							STR	SQR	SQR	T/R/P		
17102												SLJGDY
17103												

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

										Body	Body	Trans	Long	Left	Right
CatNo	South	South	East	East	Quad	LVL	DBS	Portion	Lithic	Shape	Symmetry	Sec Shape	Sec Shape	Shldr	Shldr
17104	87		83		NE	3		No Tip	KRF	EX/ST	ASYM	PLCX	BI	OBT	OBT
17105	87		83		NW	1		Base (c)	KRF	OVT	SLASY	BI	BI	OBT	OBT
17106	87		83		NW	2A		Tip	KRF		SYM	BI	BI		
17107	87		83		S	2		No Tip	KRF	EXC	SYM	BI	CX/CV	OBT	RND
17108	87		83		SW	2A		No Tip	KRF	EXC	SYM	BI	PL/CX	RND	ANG
17109	87	0.52	83	0.22	SW	2A	92	Tip (c)	KRF						
17110	87	0.24	84	0.84	NE	2	110	Complete	KRF	OVT	SYM	BI	BI	OBT	OBT
17111	87		84		SE	3A		Complete	KRF	EX/ST	SYM	BI	BI	ANG	ANG
17112	87	0.57	84	0.42	SW	2	99	No Tip	KRF	OVT	SYM	BI	BI	RND	OBT
17113	87	0.5	84	0.1	SW	2B	113	Body	KRF	Exc	SLASY	BI	BI		
17114	87		85		NE			Mid-Section	KRF						
17115	87	0.46	85	0.72	NE	2B	116	Base	KRF						
17116	87	0.25	85	0.25	NW	2		Body	KRF	EXC	SYM	BI	BI	ANG	RND
17117	87		85		NW	2A		Mid-Section	KRF						
17118	87		85		SE	2		Complete	KRF	EXC	SLASY	BI	BI	RND	RND
17119	87		86		NW	2		Tip	KRF						
17120	87	0.23	86	0.01	NW	2B	119	Complete	KRF	OVT	SYM	BI	BI	ANG	ANG
17121	87		86		NW	1		Complete	KRF	EXC	SYM	BI	BI	OBT	RND
17122	87		86		SW	1		Base	KRF					ANG	
17123	87		86			2		No Tip (b)	KRF	EXC		BI	CX/CV	RND	
17124	87		86			2		Tip	FSH						
17125	88		81		NE	3		Mid-Section	KRF						
17126	88		81		NE	1		No Tip	KRF	EXC	ASYM	BI	CX/CV	OBT	OBT
17127	88		81		NE	1		Base	KRF						
17128	88		81		NW	3		Mid-Section	KRF						
17129	88	0.92	81	0.72	SE	3	103	Mid-Section	KRF						
17130	88		81		SE	1		Mid-Section	KRF						
17131	88	0.82	81	0.29	SW	2A	90	Complete	KRF	OVT	ASYM	PLCX	BI	RND	ANG
17132	88	0.58	81	0.42	SW	2B	102	No Side	KRF	EX/ST	ASYM	BI	BI	OBT	
17133	88		82		NE	2A		Tip	KRF	STR					
17134	88		82		NW	2A		Mid-Section	KRF						

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

CatNo	Left Notch Orientation	Right Notch Orientation	Left Notch Shape	Right Notch Shape	Left Notch Mod	Right Notch Mod	Base Type	Left Basal Edge	Right Basal Edge	Base Modific	Retouch	Utilization
17104	SIDE	SIDE	SLANG	RND			CCV	ANG	SQR	T/R/P	RET	
17105		SIDE		RND		CRSH	ST/CV	ANG	SQR	THIN		
17106												
17107	SKW	SIDE	SLANG	RND	CRSH	PLSH	STR	OBT	ANG	TH/DUL	RET	
17108	SIDE	PRX	RND	SLSQ	PLSH	CRSH	CVX	SQR	ANG	TH/DUL		
17109												
17110	SIDE	SIDE	SQR	RND	PLSH		ST/CV	SQR	SQR	T/R/P		JGD
17111	SIDE	COR	SLANG	RND			STR	ANG	SQR	TH/RET	RET	UTIL
17112	SIDE	SKW	SLANG	RND		CRSH	STR	SQR	SQR	TH/DUL	RET	UTIL
17113												JGD
17114												
17115							CVX	ANG	SQR	TH/DUL		
17116												UTIL
17117											RET	UTIL
17118	SIDE	SIDE	RND	RND	CRSH				OBT	THIN		
17119												
17120	SIDE	SIDE	SLSQ	RND				RND	SQR		RET	UTIL
17121	SIDE	SIDE	RND	SLANG	PLSH	CRSH	ALL	OBT	ANG	TH/DUL	RET	UTIL
17122	SIDE	SIDE	RND	RND			CVX	ANG	SQR	TH/RET		
17123	SIDE	SKW	RND	RND		CRSH	CCV	SQR	SQR	TH/RET		
17124												
17125												
17126	SIDE	SIDE	RND	ANG	CRSH	CRSH	ST/CV	SQR	SQR	T/R/P	RET	UTIL
17127												
17128											RET	
17129											RET	UTIL
17130												UTIL
17131	SIDE	COR	RND	SLSQ	CRSH	CRSH	STR	ANG	ANG	TH/RET	RET	UTIL
17132	SIDE		RND		CRSH		STR	SQR	SQR	THIN	RET	JGD
17133												UTIL
17134											RET	UTIL

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

										Body	Body	Trans	Long	Left	Right
CatNo	South	South	East	East	Quad	LVL	DBS	Portion	MAT	Shape	Symmetry	Sec Shape	Sec Shape	Shldr	Shldr
17135	88	0.67	82	0.73	SE	2		Complete	KRF	EXC	SYM	BI	BI	ANG	OBT
17136	88	0.02	84	0.86	NE	2	99	No Tip	KRF	EX/ST	SLASY	BI	PL/CX	RND	RND
17137	88		87		NE	2		No Tip	KRF	STR	SYM	BI	BI	OBT	ANG
17138	88	0.08	87	0.24	NW	1	103	Body	KRF	STR	SYM	BI	BI	RND	ANG
17139	88	0.91	87	0.27	SW	1	100	Body	KRF	EXC	SYM	BI	BI		
17140	88		87		SW	5		Tip	KRF						
17141	88		87		SW	5		Tip (b)	KRF						
17142	89		82		NW	2		Mid-Section	KRF	EX/ST					
17143	89		82		SW	2		Mid-Section	KRF		SYM	BI	BI		
17144	89	0.88	87	0.74	SE	3	94	Complete	KRF	EX/ST	SLASY	BI	CX/CV	ANG	RND
17145	89		87		SE	1		Mid-Section	KRF	STR	SYM	BI	BI		
17146	89		87		SW	3		Tip	KRF						
17147	90	0.47	82	0.01	NW	2	64	No Tip	KRF	OVT	ASYM	BI	BI	ANG	ANG
17148	90		82		SE	1		Mid-Section	KRF						
17149	90		83		NW	2A		Tip	KRF						
17150	90	0.97	83	0.2	SW	2A	59	Complete	KRF	EXC	ASYM	BI	BI	RND	RND
17151	90	0.64	83	0.37	SW	2A	60	Complete	KRF	EX/ST	SYM	BI	BI	ANG	ANG
17152	90	0.66	84	0.83	SE	2	69	Mid-Section	KRF	EXC	SYM	BI	BI		
17153	90	0.75	84	0.07	SW	2	68	Body (a)	KRF	EXC	SYM	BI	BI		
17154	90	0.7	84	0.37	SW	2	69	Body (a)	KRF						
17155	90		85		NE	2		No Tip	KRF	EX/ST	SYM	BI	PL/CX	OBT	OBT
17156	90		85		SE	1		Complete	KRF	EXC	SYM	BI	BI	OBT	RND
17157	90		86		NE	2		Body	KRF	EXC	SYM	BI	BI		
17158	90		86		NW	2A		Tip	KRF	OVT					
17159	90	0.94	86	0.67	SE	2	88	No Tip	KRF	EXC	SYM	BI	BI	RND	ANG
17160	90		86		SW	1		Tip	KRF						
17161	90	0.43	87	0.96	NE	2	83	Complete	KRF	STR	SYM	BI	BI	ANG	OBT
17162	90		87		NE	2		Mid-Section	KRF						
17163	90		87		NW	2		Base	KRF						
17164	90		87		NW	3		Tip	KRF						
17165	90	0.95	87	0.73	SE	2	90	Body	KRF		SYM	BI	BI		

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

	Left Notch	Right Notch	Left	Right	Left	Right	Base	Left	Right	Base		
CatNo	Orientation	Orientation	Notch Shape	Notch Shape	Notch Mod	Notch Mod	Type	Basal Edge	Basal Edge	Modific	Retouch	Utilization
17135	SKW	SIDE	SLSQ	RND			STR	OBT	OBT	THIN	RET	
17136	SKW	SKW	RND	RND			CVX	ANG	ANG	TH/DUL	RET	UTIL
17137	PRX	PRX	RND	ANG	CRSH	CRSH	STR	ANG		TH/DUL		
17138												UTIL
17139											RET	
17140												
17141												
17142												UTIL
17143												
17144	SKW	SKW	SQR	RND	CRSH		CCV	SQR	ANG	T/R/P	RET	UTIL
17145											RET	UTIL
17146												
17147	SKW	SKW	RND	RND		PLSH	STR	SQR	ANG	T/R/P	RET	UTIL
17148												
17149												
17150	SKW	SKW	RND	SLSQ		CRSH	ST/CV	ANG	ANG	THIN	RET	UTIL
17151	SIDE	COR	RND	RND	CRSH		ST/CV	SQR	ANG	TH/DUL	RET	UTIL
17152												JGD
17153												
17154												
17155	SKW	SIDE	SLANG	RND	PLSH	PLSH	CVX	ANG	ANG		RET	
17156	SIDE	SIDE	RND	RND	CRSH	CRSH	CVX	RND	RND	THIN	RET	
17157												
17158											RET	UTIL
17159	SKW	SKW	RND	RND	CRSH	CRSH	ST/CX	SQR	ANG	TH/DUL	RET	UTIL
17160												
17161	SIDE	SKW	SLANG	RND	CRSH		ST/CV	ANG	RND	TH/DUL		
17162												JGD
17163							STR	ANG		TH/RET		
17164												
17165											RET	UTIL

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

CatNo	South	South	East	East	Quad	LVL	DBS	Portion	MAT	Body Shape	Body Symmetry	Trans Sec Shape	Long Sec Shape	Left Shldr	Right Shldr
17166	90	0.57	87	0.51	SE	2	88	Tip	KRF	STR	SYM	BI	BI		
17167	90	0.63	87	0.28	SW	2	80	Body	KRF	EXC	SYM	BI	BI		
17168	90		89		N	3		Body	KRF	EXC	SYM	BI	BI	OBT	OBT
17169	90		89		NE	3		Complete	KRF	EXC	ASYM	BI	BI	OBT	RND
17170	90	0.4	89	0.29	NW	2A	96	Complete	KRF	EXC	SYM	BI	BI	OBT	ANG
17171	90		89		NW	1		Tip	KRF						
17172	90		89		SW	3		Mid-Section	KRF						
17173	90	0.92	89	0.11	SW	2	86	Mid-Section	KRF	EXC	SYM	BI	BI		
17174	91	0.38	81	0.28	NW	2	57	No Tip	KRF	OVT	SYM	BI	BI	RND	ANG
17175	91		83		SW	1		Tip	KRF						
17176	91	0.08	84	0.78	NE	2	65	No Tip	KRF	EX/ST	ASYM	BI	BI	ANG	RND
17177	91	0.54	84	0.28	SW	1	81	Body	KRF	EXC	SYM	BI	BI	RND	
17178	91	0.23	85	0.73	NE	1	81	Body	KRF		SYM	BI	BI		
17179	91	0.1	85	0.51	NW	1	91	No Tip	KRF	EX/ST	SYM	BI	BI	ANG	RND
17180	91	0.75	85	0.98	SE	1	93	Body	KRF		SLASY	BI	PL/CX	ANG	RND
17181	91	0.74	85	0.37	SW	1	87	Body	KRF	OVT	SYM	BI	BI		
17182	91	0.03	86	0.97	NE	1	109	Tip	KRF						
17183	91	0.97	86	0.08	NW	1	102	Body	KRF	EXC	SYM	BI	BI	RND	RND
17184	91	0.57	86	0.07	SW	1A	100	Body	KRF	EXC	SYM	BI	CX/CV		
17185	91	0.2	86	0.99	SW	1	89	Tip	KRF			BI	BI		
17186	91	0.99	87	0.19	SW	1	93	Complete	KRF	EXC	SYM	BI	PL/CX	RND	RND
17187	91	0.59	87	0.24	SW	1	114	Tip	KRF		SYM	BI	BI		
17188	91		88		NW	1		Tip	KRF						
17189	91		88		SE	1A		Tip	KRF						
17190	91	0.52	88	0.02	SW	1A	115	Body	KRF	OVT	SYM	BI	BI	OBT	
17191	91		89		SW	1		Tip	KRF						
17192	102	0.08	130	0.54	NE	1		Body	KRF	EXC	SYM	BI	BI	OBT	
17193	103		130			2		Base	KRF						
17194	105	0.72	130	0.19	SW	1		No Tip	KRF	EXC	SYM	BI	PL/CX	RND	OBT
17195	106	0.58	129	0.89	SE	1		Base	KRF						
17196	108	0.25	130	0.07	NW	1		Base	KRF						

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

CatNo	Left Notch Orientation	Right Notch Orientation	Left Notch Shape	Right Notch Shape	Left Notch Mod	Right Notch Mod	Base Type	Left Basal Edge	Right Basal Edge	Base Modific	Retouch	Utilization
17166												UTIL
17167												JGD
17168												UTIL
17169	COR	SKW	RND	RND			STR				RET	
17170	SKW	SIDE	SLSQ	SLSQ	CRSH	CRSH	CVX	ANG	SQR	THIN	RET	UTIL
17171												
17172												
17173											RET	UTIL
17174	SIDE	SKW	RND	SLSQ	CRSH	CRSH	ST/CV	SQR	SQR	TH/RET	RET	UTIL
17175												
17176	SKW	SKW	RND	RND	CRSH	CSH/PSH	ST/CX	SQR	ANG	T/R/P	RET	JGD
17177												UTIL
17178												
17179	SIDE	SIDE	SLANG	RND	PLSH	CSH/PSH	ST/CX	ANG	RND	TH/DUL	RET	JGD
17180	COR	SIDE	RND	SLSQ	CRSH	CRSH					RET	UTIL
17181												UTIL
17182												
17183												
17184												UTIL
17185												
17186	SKW	SIDE	SLANG	RND		CSH/PSH	STR	ANG	SQR	THIN		UTIL
17187												UTIL
17188												
17189												
17190												UTIL
17191												
17192			RND		CRSH							UTIL
17193							STR	ANG		TH/DUL		
17194	SIDE	SIDE	RND	SLSQ	PLSH	PLSH	ST/CV	SQR	RND	TH/DUL		UTIL
17195							STR	SQR		T/R/P		
17196							STR	SQR		THIN		

Appendix 1 (cont'd): Biface Projectile Points Qualitative Descriptions

										Body	Body	Trans	Long	Left	Right
CatNo	South	South	East	East	Quad	LVL	DBS	Portion	Lithic	Shape	Symmetry	Sec Shape	Sec Shape	Shldr	Shldr
17051	63	0.47	59	0.95	NE	10	104	Base	KRF			PLCX		RND	PLCX
17052	86	0.82	78	0.44	SE	1	82	Tip	KRF	OVT					
17053	86	0.42	79	0.05	NW	2	103	No Tip	FSH	OVT	SLASY	BI	CX/CV	ANG	ANG
17054	87	0.52	83	0.14	SW	2	95	Tip	KRF						
17055	87	0	83	0	NE	1		No Side	KRF	EXC	SYM	BI	BI		OBT
17056	87	0	85	0	NW	2		Mid-Section	KRF						
17057	88	0.7	82	0.03	SW	2A		Body	KRF	EX/ST	ASYM	CX/CV	CX/CV		
17058	88	0	87	0	NW	4		Base	KRF						
17059	88	0	87	0	NW	4		Tip	KRF						
17060	89	0	82	0	NE	2		Complete	KRF	TRI	SYM	PLCX	PLCX	RND	RND
17061	89	0	87	0	SE	3		Complete	KRF	OVT	SYM	BI	CX/CV	RND	RND
17062	90	0.3	82	0.03	NW	2	60	No Tip	KRF	TRI	SYM	BI	CX/CV	RND	RND
17063	90	0	83	0	NE	2B		Base	KRF						
17064	90	0.73	86	0.32	SW	2A	84	Tip	KRF	TRI	SYM	BI	CX/CV		
17065	90	0.83	89	0.94	SE	2	101	Complete	KRF	EXC	SYM	BI	PLCX	RND	RND
17066	90	0	90	0	Auger			No Tip	KRF	EXC	ASYM	BI	CX/CV	OBT	RND
17067	91	0.59	87	0.24	NE	1	114	Body	KRF	EXC	SYM	BI	CX/CV		
17068	91	0.32	87	0.6	NE	1	114	Body	KRF	OVT	SYM	BI	BI		
17069	91	0	89	0	SE	2		Mid-Section	KRF	STR	SYM	BI	BI		
17070	105	0	130	0	SE	2		Complete	KRF	TRI	SYM	BI	CX/CV	OBT	ANG
17071	107	0	130	0	SW	10		Complete	KRF	EXC	SYM	BI	CX/CV	RND	OBT

Appendix 2: Flake Projectile Points Qualitative Descriptions

CatNo	Left Notch Orientation	Right Notch Orientation	Left Notch Shape	Right Notch Shape	Left Notch Mod	Right Notch Mod	Base Type	Left Basal Edge	Right Basal Edge	Base Modific	Retouch	Utilization
17051	SIDE	SIDE	RND	RND	CRSH	CRSH	STR	SQR	ANG			
17052											RET	UTIL
17053	SIDE	SIDE	RND	RND			STR	OBT	ANG			UTIL
17054												
17055		PROX	RND	RND	CRSH	CRSH	CVX	ANG	ANG	T/R/P	RET	UTIL
17056											RET	
17057											RET	
17058							STR	SQR	OBT	THIN	RET	UTIL
17059												
17060	SIDE	SIDE	RND	RND			CVX		ANG	TH/RET	RET	
17061	SKEW	SIDE	SLSQ	SLSQ	CRSH		CVX	OBT	ANG	THIN		
17062	SIDE	SKEW	RND	RND			CVX	SQR	ANG	TH/RET	RET	
17063							CVX	SQR	ANG	TH/RET		
17064												UTIL
17065	SIDE	SIDE	RND	SLSQ		CRSH	CVX	ANG	OBT	TH/RET		
17066	STEM						STR			T/R/P	RET	
17067										T/R/P	RET	
17068											RET	
17069											RET	JGD
17070	SIDE	SIDE	RND	RND			CVX	OBT	SQR	THIN		
17071	SIDE	SIDE	RND	RND			CVX	RND	RND	TH/RET	RET	

Appendix 2 (cont'd): Flake Projectile Points Qualitative Descriptions

CatNo	LGTH	THCK	SHLD	BASE	NECK	LBDY	RBDY	LBSL	RBSL	LNL	RNL	LND	RND
17073	*35*	6.2	*20*	21.8	17.1	25.3	25.3	10.5	*8.6*	6.8	*5*	2.1	*1*
17074	34.2	5.8	19.9	17	15	25.3	22.9	8.5	10.2	7.1	6	0.9	2.2
17075	*33*	7	18.7	0	0	0	0	0	0	0	0	0	0
17076	*11*	5.1	0	*15.9*	0	0	0	0	0	0	0	0	0
17077	*50*	5.2	20.1	0	12.7	44.3	42.8	0	0	0	0	0	0
17078	36.1	6.1	21.1	21.2	16.2	27	34.2	12.1	10.6	7	7.8	1.7	3.1
17079	*42*	6	21.8	18.9	16.4	29.3	29.1	13	12.9	6.2	7.8	1.8	1.9
17080	45.6	6.7	24.1	20	17.1	35.5	35.1	11.2	9.4	9.2	7	3.1	1.8
17081	*8.4*	4.1	0	19.2	13.7	0	0	0	0	0	0	0	0
17082	*23*	4.4	*5.5*	0	0	0	0	0	0	0	0	0	0
17083	*31*	4.8	20.9	16	14.3	21	22.8	10.7	6.4	7.3	5.1	1.2	1.2
17084	*10*	2.4	*9.2*	0	0	0	0	0	0	0	0	0	0
17085	*19*	4.2	*12*	0	0	0	0	0	0	0	0	0	0
17086	*23*	4.8	*19*	0	0	0	0	0	0	0	0	0	0
17087	38.4	5.4	20.1	19.5	15.2	28.8	29.5	8.9	9.6	6.2	6	2.2	2.2
17088	*11*	5.3	0	*12.2*	0	0	0	0	0	0	0	0	0
17089	33.4	5.2	28	17.3	15.6	27.2	23.5	6.9	9.6	6	5.7	0.8	1.1
17090	*13*	4.9	20	21.9	17	0	0	10.2	10	6.1	7.2	1.7	1.9
17091	*18*	4.7	0	21	17.9	0	0	0	0	0	0	0	0
17092	*14*	4.3	*14*	0	0	0	0	0	0	0	0	0	0
17093	*20*	5.1	20.1	0	0	0	0	0	0	0	0	0	0
17094	*15*	4.4	*14*	0	0	0	0	0	0	0	0	0	0
17095	*27*	5.8	20.2	0	15.5	*24*	*24.1*	0	0	0	0	0	0
17096	*10*	2.8	0	*11.8*	0	0	0	0	0	0	0	0	0
17097	*19*	4.3	*8.2*	0	0	0	0	0	0	0	0	0	3.2
17098	*32*	6.8	*10*	0	0	0	0	0	0	0	0	0	0
17099	*45*	5.5	24.1	19.4	16.5	36	35.1	11.1	11.1	6.2	7.1	2.5	2.2
17100	*17*	3.4	*12*	0	0	0	0	0	0	0	0	0	0
17101	*10*	4.1	0	18.2	13.9	0	0	0	0	0	0	0	0
17102	*42*	8.2	22	0	14.2	39.5	37.1	0	0	0	0	0	0
17103	*35*	5.2	*19*	19.6	16.3	0	27.2	0	9	0	6.7	0	1.5
17104	*27*	6	20	19.5	15.4	21.9	17.2	10.4	10.1	9.9	7.9	2.3	1.8
17105	*11*	6.2	*13*	0	0	0	0	0	0	0	0	0	0
17106	*29*	4.9	20.2	0	0	0	0	0	0	0	0	0	0
17107	*56*	5	24.2	22	17.4	46.8	47.6	9.5	9	6.8	6.1	2.8	2.1
17108	*26*	5.1	19.9	18.1	13.8	17.1	18	9.1	7	6.7	5.4	2	3
17109	*0*	0	0	0	0	0	0	0	0	0	0	0	0
17110	*33*	5.8	19.2	17.1	15	23	24.1	9.9	8.2	7	5.8	1.7	1.2
17111	*34*	5.2	23	22.1	17.9	23.3	24.1	10.2	11.1	8.4	7.8	2.3	1.9
17112	*36*	5.4	24.1	0	0	0	30.5	0	0	0	0	0	0
17113	*38*	5.2	23.4	19.1	15.1	27.6	25.2	9.6	10.2	8.3	8.7	2.7	2.2
17114	*12*	5.7	0	22.7	17.9	0	0	0	0	0	0	0	0
17115	*45*	6.2	20.7	0	15.5	37	34.1	0	0	0	0	0	0
17116	*5*	5	*9.9*	0	0	0	0	0	0	0	0	0	0
17117	*27*	4.8	*12*	0	0	0	0	0	0	0	0	0	0
17118	55.8	6.5	26.2	*19.6*	17.3	45.8	47.5	10.7	9	5.7	*7.5*	3.1	1.2
17119	*19*	5.4	20.7	20.7	17.5	0	0	0	0	6.7	*5.1*	1.3	1.6
17120	43.8	5.8	21.5	20.7	15.6	32.5	34.1	10.8	10	7.8	8	2.3	2.8

Appendix 3: Biface Projectile Points Quantitative Descriptions

CatNo	LGTH	THCK	SHLD	BASE	NECK	LBDY	RBDY	LBSL	RBSL	LNL	RNL	LND	RND
17121	*15*	3.6	*12*	0	0	0	0	0	0	0	0	0	0
17122	*12*	5.8	19.6	19	15.7	0	0	0	0	6.8	6.3	1.5	1.8
17123	*41*	6	21.3	19.1	15.5	33	29.1	9.7	9	7.7	7.2	2.6	2.1
17124	*11*	3.2	*13*	0	0	0	0	0	0	0	0	0	0
17125	*7.2*	4.2	*7.8*	0	0	0	0	0	0	0	0	0	0
17126	*18*	4	*16*	0	0	0	0	0	0	0	0	0	0
17127	*47*	6	21.5	19	15.1	36.3	36	12.2	10.9	7.9	8.1	3	2
17128	*6.8*	4.2	*10*	0	0	0	0	0	0	0	0	0	0
17129	*18*	4.1	*16*	0	0	0	0	0	0	0	0	0	0
17130	*25*	3	*4.5*	0	0	0	0	0	0	0	0	0	0
17131	28.9	4.8	19.9	17.1	13.8	20	19.3	8.5	9	7.2	5.1	2.1	2.3
17132	*53*	5.9	*20*	20.6	16.2	43.8	0	8.9	0	6.3	0	2.3	0
17133	*34*	5	*13*	0	0	0	0	0	0	0	0	0	0
17134	*18*	3.9	*9.8*	0	0	0	0	0	0	0	0	0	0
17135	49.2	4.8	23.9	21.7	17.1	39.1	40	9.3	8.8	7.2	6	2.5	2.6
17136	*47*	6.2	21.3	15.2	13.3	37	36	10.3	11.1	9	8	2.1	2
17137	*46*	5.3	23.7	18.2	15.7	36.3	33.8	10.2	10.6	8	7	2.8	2.2
17138	*44*	6	19.1	0	12.1	40.3	40.8	0	0	0	0	0	0
17139	*45*	5.2	23.4	0	0	0	0	0	0	0	0	0	0
17140	*11*	2.9	*9.7*	0	0	0	0	0	0	0	0	0	0
17141	*0*	0	0	0	0	0	0	0	0	0	0	0	0
17142	*23*	5	*7.8*	0	0	0	0	0	0	0	0	0	0
17143	*24*	5.1	23.1	0	0	0	0	0	0	0	0	0	0
17144	50.4	6.1	20.5	18.8	15.6	38.1	38	11.5	9.6	8.8	8.4	1.9	2
17145	*46*	6.1	22.8	0	0	0	0	0	0	0	0	0	0
17146	*11*	3.2	*13*	0	0	0	0	0	0	0	0	0	0
17147	*34*	6.3	21.2	18.9	15.6	25	25	9.1	10	6.3	5.6	2.2	2.2
17148	*15*	2.3	*12*	0	0	0	0	0	0	0	0	0	0
17149	*5.1*	2	*4.7*	0	0	0	0	0	0	0	0	0	0
17150	21.8	5.3	18.5	18.2	15	13.2	12.8	10	9.5	5.8	7.2	1.9	1.1
17151	42.4	5.8	24.1	22.5	17.2	32	32.6	10.8	10.8	8.9	7.5	2.9	2.8
17152	*34*	5.9	25.6	0	0	0	0	0	0	0	0	0	0
17153	*32*	6.2	22.7	0	0	31	*31*	0	0	0	0	0	0
17154	*0*	0	0	0	0	0	0	0	0	0	0	0	0
17155	*36*	5.7	22.2	19.6	15.5	26	25.2	9.8	9.4	7.8	7.3	2.8	2.2
17156	40.6	6.1	22.2	20.2	18	28.1	26.7	12.5	14	6.3	6.6	1.5	1.6
17157	*39*	5.6	23.9	0	0	38.9	0	0	0	0	0	0	0
17158	*15*	4.1	*16*	0	0	0	0	0	0	0	0	0	0
17159	*48*	7	24.2	22	17.4	38.9	37.9	10	8.1	6.1	6.4	1.5	2.7
17160	*15*	3.1	*13*	0	0	0	0	0	0	0	0	0	0
17161	61.1	6.7	26.2	21.9	17.2	49.2	48.1	13.2	12.2	12	9.9	2.9	3.3
17162	*20*	5.1	18.5	0	0	0	0	0	0	0	0	0	0
17163	*6.3*	6.2	0	14.8	0	0	0	0	0	0	0	0	0
17164	*14*	3.1	*14*	0	0	0	0	0	0	0	0	0	0
17165	*37*	5.5	19.4	0	0	0	0	0	0	0	0	0	0
17166	*29*	4.2	*17*	0	0	0	0	0	0	0	0	0	0
17167	*50*	5.9	21.6	0	0	0	0	0	0	0	0	0	0
17168	*44*	6.1	21.5	0	15.9	37	37.1	0	0	0	0	0	0

Appendix 3 (cont'd): Biface Projectile Points Quantitative Descriptions

CatNo	LGTH	THCK	SHLD	BASE	NECK	LBDY	RBDY	LBSL	RBSL	LNL	RNL	LND	RND
17169	*32*	5	21.2	*15.7*	14.3	25.5	24.3	7.1	9.6	5.9	6.4	2	1.2
17170	40	6.3	20.5	18.9	15.7	28.1	29.5	12.9	12.6	7.3	7.5	2.2	1.8
17171	*15*	5	*15*	0	0	0	0	0	0	0	0	0	0
17172	*12*	2.9	*12*	0	0	0	0	0	0	0	0	0	0
17173	*24*	5.3	24.4	0	0	0	0	0	0	0	0	0	0
17174	*54*	6.2	23.9	19.1	15.2	44	45.2	10.6	9	6.2	6	2.8	2.4
17175	*9.9*	3.2	*6.7*	0	0	0	0	0	0	0	0	0	0
17176	*40*	5.3	22.4	19.7	15.2	28.8	29.5	10.2	11.1	7.8	7.3	2.6	2.9
17177	*36*	4.6	20.6	0	0	33.4	34.5	0	0	0	0	0	0
17178	*46*	7.1	23.1	0	0	0	0	0	0	0	0	0	0
17179	*27*	5.1	18.2	19.8	15.9	18	18.5	10	8.1	6.1	6.2	1.2	1.8
17180	*27*	5.3	17.8	19.2	15	19.2	20.2	0	0	5.6	5.8	2.1	1.2
17181	*43*	6	24.2	0	0	0	44.3	0	0	0	0	0	0
17182	*15*	3.2	*14*	0	0	0	0	0	0	0	0	0	0
17183	*66*	6.1	24.6	0	17	*61.3*	*60.2*	0	0	0	0	0	0
17184	*34*	5.8	20.8	0	0	0	0	0	0	0	0	0	0
17185	*19*	4.6	*16*	0	0	0	0	0	0	0	0	0	0
17186	39.8	5	19.9	17.8	14.4	31.6	31.1	9.2	10.5	7	6.2	2	2.1
17187	*20*	4.7	*18*	0	0	0	0	0	0	0	0	0	0
17188	*16*	3.8	*14*	0	0	0	0	0	0	0	0	0	0
17189	*9.8*	2.8	*12*	0	0	0	0	0	0	0	0	0	0
17190	*39*	5.8	21.8	0	0	32.2	0	0	0	0	0	0	0
17191	*13*	3.4	*11*	0	0	0	0	0	0	0	0	0	0
17192	*47*	6.7	21	0	0	40.2	0	7	0	5	0	1	0
17193	*8.5*	3.4	0	*16.7*	0	0	0	0	0	0	0	0	0
17194	*37*	6	24.7	23.1	17.9	27.2	27.3	9.5	10.1	5.9	7.1	3	2.7
17195	*9.9*	4.8	0	23.2	17	0	0	0	0	0	0	0	0
17196	*10*	4.9	0	*24.2*	0	0	0	0	0	0	0	0	0

Appendix 3 (cont'd): Biface Projectile Points Quantitative Descriptions

CatNo	LGTH	THCK	SHLR	BASE	NECK	LBDY	RBDY	LBSL	RBSL	LNL	RNL	LND	RND
17051	*13*	4.3	17.2	16.2	12.5	0	0	11.9	10.7	7.7	6.9	2	1.9
17052	*16*	*3*	17.4	0	0	0	0	0	0	0	0	0	0
17053	*26*	3.1	19.1	12.8	12.3	*19*	*19*	7.7	6.1	5.1	4.5	1	1.1
17054	*40*	5.5	*19*	17.8	15.1	30	31.1	8.9	9	6.5	6.3	2.2	1
17055	40.8	7.3	*22*	21.9	19.2	31.1	29.2	10.8	12.5	7.8	8.1	1.5	0.9
17056	*11*	*2.3*	*13*	0	0	0	0	0	0	0	0	0	0
17057	*19*	4.1	20.6	0	0	0	0	0	0	0	0	0	0
17058	*32*	3.7	18.8	0	0	0	0	0	0	0	0	0	0
17059	*9.6*	4.2	0	18.8	14.9	0	0	0	0	0	0	0	0
17060	*17*	*2.7*	15.7	0	0	0	0	0	0	0	0	0	0
17061	15.6	2.8	9.6	11.1	7.8	9.9	7.7	6.5	5.6	4	6.2	*1*	1.5
17062	38.8	5.1	21.2	18.2	15.5	28.8	30	9.3	9.6	5.7	6.2	1.7	2
17063	*23*	3.2	16.1	13.9	12.3	16.5	*16*	*6.5*	7.4	5.2	3.5	1.2	1.1
17064	*9*	2.2	0	13.2	11	0	0	0	0	0	0	0	0
17065	*27*	*4*	14.5	0	0	0	0	0	0	0	0	0	0
17066	*41*	4.8	18	14.2	11.3	30.6	29.3	9.5	9.1	6.8	6	1.9	2.1
17067	*24*	4	18.9	12.1	12	*16*	*15*	8.8	8.8	5.8	7	1.2	0.8
17068	*25*	2.7	15.4	0	0	24.4	23	0	0	0	0	0	0
17069	*30*	3.8	19.8	0	*15.2*	28.1	25.8	0	0	0	0	0	0
17070	*20*	4.5	23.6	0	18.7	0	0	0	0	0	0	2.2	3
17071	13.3	2.3	10	11	8.9	7.9	7.1	6.6	7.1	4.2	3.4	0.9	0.5
17072	20.1	2.7	12.8	11.1	9.1	13.9	12.6	7.5	8.1	4.2	5.2	1.2	1.2

Appendix 4: Flake Projectile Points Quantitative Descriptions

Cat #	South	East	Bone	Age	AGE	M1 Height
21	86	73	Maxilla	Immature	1.5	
176	86	74	Maxilla	Fused	4.6	36.4
177	86	74	Maxilla	Fused		35.6
179	86	74	Maxilla	Immature	2.5	42.4
469	86.5	74.5	Maxilla	Immature	2.6	
694	86.5	75	Maxilla	Fused		27.7
695	86.5	75	Maxilla	Fused	3.6	38.4
696	86.5	75	Maxilla	Fused		28.4
697	86.5	75	Maxilla	Fused		25.1
1011	86	77	Maxilla	Immature	1.6	
1134	86.5	77	Maxilla	Immature	1.6	
1270	86	78	Maxilla	Fused		22.3
1303	86	78	Maxilla	Fused		13.5
1474	86.5	78.5	Maxilla	Immature	1.6	43.5
1898	86	80	Maxilla	Immature	3.6	
2049	86	80.5	Maxilla	Fused	1.6	44.8
2196	86.5	80.5	Maxilla	Fused	2.7	40.1
2602	87	83	Maxilla	Immature	2.6	40
3249	87.5	83	Maxilla	Immature	2.6	
4941	87.5	85.5	Maxilla	Immature	1.5	44.6
5919	87	84.5	Maxilla	Fused		32.8
7979	90	84.5	Maxilla	Immature		43.6
8479	90.5	85	Maxilla	Immature	2.6	41.4
8584	90.5	85.5	Maxilla	Fused	4.5	34.5
9608	90	88	Maxilla	Fused		33.1
9924	90.5	88	Maxilla	Fused		21
10021	90.5	88.5	Maxilla	Fused		32.9
10352	90.5	89	Maxilla	Immature	1.6	
10418	90.5	89.5	Maxilla	Fused		12.9
10511	91.5	81.5	Maxilla	Immature	0.7	54.2
10819	91	85	Maxilla	Fused	2.6	41
10820	91	85	Maxilla	Immature		
11439	91.5	87	Maxilla	Immature	1.6	45.1
13426	89.5	87.5	Maxilla	Fused		31.2
13925	64.5	59	Maxilla	Fused		32.9
13926	64.5	59	Maxilla	Fused		36

Appendix 5: Maxilla Age and Molar 1 Metrics

Cat #	South	East	Bone	Age	AGE	M1 Height
20	86	73	Mandible	Fused		29.3
189	86	74	Mandible	Fused		11.4
372	86.5	74.5	Mandible	Immature	2.6	
593	86	74.5	Mandible	Immature	2.5	43.2
2120	86.5	80	Mandible	Immature	1.7	
2683	87	82	Mandible	Fused		17.2
2843	87.5	82.5	Mandible	Fused		14.3
2981	87	83	Mandible	Immature	2.5	41.6
3251	87.5	83	Mandible	Immature	2.7	
3343	87.5	83.5	Mandible	Fused		7.9
3344	87.5	83.5	Mandible	Fused		23.6
3647	87	84	Mandible	Immature	1.5	51
3663	87	84	Mandible	Immature	2.6	42.7
3774	87	84.5	Mandible	Fused		2.5
3941	87.5	84	Mandible	Immature	1.5	51.8
4115	87.5	84.5	Mandible	Fused		2
5740	87	81.5	Mandible	Immature	2.6	
5741	87	81.5	Mandible	Fused		9.8
5898	87.5	81.5	Mandible	Fused		7.8
5963	88	80	Mandible	Fused		8.1
6209	88	81	Mandible	Fused		7.8
6547	88	82	Mandible	Immature	0.5	47.7
7130	89.5	82	Mandible	Fused		30.2
8380	90	85.5	Mandible	Fused		16.5
8760	90	86	Mandible	Fused		13.5
8761	90	86	Mandible	Fused		29.9
8859	90	86.5	Mandible	Fused		2.2
9035	90.5	86.5	Mandible	Fused		12
9273	90	87.5	Mandible	Fused		19.6
9327	90	87.5	Mandible	Immature	1.3	
9549	90.5	87.5	Mandible	Fused		14
10292	90.5	89	Mandible	Fused		8.4
10293	90.5	89	Mandible	Fused		5.6
10355	90.5	89	Mandible	Immature	2.5	
10740	91.5	84.5	Mandible	Immature	1.4	46.8
10853	91	85.5	Mandible	Fused		11.5
11131	91	86.5	Mandible	Fused		32
11410	91	87.5	Mandible	Fused		30.5
12027	91	89.5	Mandible	Fused		20.5
13267	89.5	87	Mandible	Immature		49
13268	89.5	87	Mandible	Immature	1.6	47.8
13689	63.5	59	Mandible	Fused		18.4
13846	64	59.5	Mandible	Fused		13
13894	64.5	59	Mandible	Fused		24.2
14023	64.5	59.5	Mandible	Fused		21.4
14591	104.5	129	Mandible	Fused		8.1
14592	104.5	129	Mandible	Fused		30.5

Appendix 6: Mandible Age and Molar 1 Metrics

Cat #	South	East	Bone	Age	AGE	M1 Height
14602	104.5	129	Mandible	Fused	3.5	37.7
14674	104	130	Mandible	Fused		24
14837	105.5	129	Mandible	Fused		24.1
14970	105	130.5	Mandible	Fused		28
15107	106	129	Mandible	Fused		11
15287	106.5	129.5	Mandible	Fused		24
15981	107	130.5	Mandible	Immature	3.6	38.7
16500	109.5	130	Mandible	Fused		23.6
16867	129	80.5	Mandible	Fused		24.4

Appendix 6 (cont'd): Mandible Age and Molar 1 Metrics

Cat#	Bone	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	SEX
271	Humerus	0	0	0	0	0	0	0	0	9.59	6.03	10.05	6.25	8.55	5.15	4.38	F
360	Humerus	0	0	0	0	0	0	0	0	8.19	5.39	8.39	4.64	7.28	4.26	3.68	I
875	Humerus	0	0	0	0	0	0	0	0	9.2	5.93	9.18	5.61	8.63	4.84	3.83	M
1993	Humerus	0	0	0	0	0	0	0	0	9.63	5.77	9.56	0	8.71	4.59	3.87	M
2826	Humerus	0	0	0	0	0	0	0	0	7.89	5.21	7.84	0	7.09	4.01	3.62	F
2983	Humerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3505	Humerus	0	0	0	0	0	0	0	0	8.22	5.32	8.36	0	0	0	0	F
3690	Humerus	0	0	0	0	0	0	0	0	8.46	5.79	8.55	5.4	7.8	4.42	3.8	M
3758	Humerus	0	0	0	0	0	0	0	0	9.35	6.23	9.55	5.94	8.72	4.83	4.45	M
3759	Humerus	0	0	0	0	0	0	0	0	7.88	4.71	7.99	0	7.04	3.9	3.33	F
4118	Humerus	0	0	0	0	0	0	0	0	8.25	5.43	0	0	0	4.1	3.32	M
4668	Humerus	0	0	0	0	0	0	0	0	9.93	0	0	0	9.48	5.4	0	M
4742	Humerus	0	0	0	0	0	0	0	0	9.84	6.28	10.39	6.8	8.82	5.43	4.37	M
4893	Humerus	0	0	0	0	0	0	0	0	8.3	5.2	8.55	4.8	7.72	4.62	3.78	M
6076	Humerus	0	0	0	0	0	0	0	0	9.59	5.32	9.38	0	8.5	5.4	4.27	M
6714	Humerus	0	0	0	0	0	0	0	0	9.77	5.99	9.35	6.08	8.65	4.26	5.07	M
8246	Humerus	12.29	8.16	15.48	14.01	0.96	13.67	10.12	0	10.2	6.6	10.43	6.52	9.18	5.22	4.25	M
8512	Humerus	0	0	0	0	0	0	0	0	8.83	5.37	0	0	0	0	0	
8741	Humerus	0	0	0	0	0	0	0	0	9.93	6.5	10.14	6	8.56	5.29	4.39	M
9247	Humerus	0	0	0	0	0	0	0	0	8.43	5.17	7.96	0	0	0	0	F
9953	Humerus	0	0	0	0	0	0	0	0	0	5.24	0	0	0	0	0	F
10283	Humerus	0	0	0	0	0	0	0	0	0	6	9.56	0	0	0	0	M
11342	Humerus	0	0	0	0	0	0	0	0	8.57	5.08	8.59	0	7.74	0	0	F
11649	Humerus	0	0	0	0	0	0	0	0	7.17	4.35	0	0	0	3.81	3.24	F
11786	Humerus	0	0	0	0	0	0	0	0	9.48	5.98	9.85	5.79	8.49	4.83	4	M
11787	Humerus	0	0	0	0	0	0	0	0	8.2	5.19	0	0	7.57	0	0	F
13255	Humerus	0	0	0	0	0	0	0	0	0	4.25	0	0	0	0	0	F
13554	Humerus	0	0	0	0	0	0	0	0	9.51	5.84	9.82	5.35	8.66	4.36	5.55	M
14048	Humerus	0	0	0	0	0	0	0	0	8.24	0	0	5.24	8.13	4.92	4.21	M
14336	Humerus	0	0	0	0	0	0	0	0	9.23	5.57	7.35	0	8.14	0	0	M
14563	Humerus	0	0	0	0	0	0	0	0	8.25	5.33	7.72	5	0	3.62	3.16	F
14860	Humerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15961	Humerus	0	0	0	0	0	0	0	0	8.25	5.33	8	4.63	6.84	3.75	3.08	F
15962	Humerus	0	0	0	0	0	0	0	0	8.45	5.21	8.2	0	7.67	4.55	4.06	M

Appendix 7: Humerus Metrics

Cat#	South	East	Bone	a	b	c	d	e	f	g	h	i	j	k	SEX
362	86.5	74	Radius	8.73	4.77	2.86	5.31	0	5.41	0	0	0	0	0	F
459	86.5	74.5	Radius	11.02	5.36	3.6	5.42	4.81	6.9	0	0	0	0	0	M
1720	86	79.5	Radius	0	3.95	0	0	0	0	0	0	0	0	0	I
2172	86.5	80.5	Radius	9.88	5	3.2	5.71	4.1	5.4	9.35	0	3.79	1.64	4.91	M
2984	87	83	Radius	9.36	0	0	0	0	0	0	0	0	0	0	I
3692	87	84	Radius	9.1	4.95	2.82	4.95	3.95	5.85	0	0	0	0	0	F
3756	87	84.5	Radius	8.66	4.55	2.65	4.97	3.82	0	0	0	0	0	0	F
4085	87.5	84.5	Radius	0	4.39	0	0	0	0	0	0	0	0	0	I
4121	87.5	84.5	Radius	9.42	5.56	3.43	5.4	4.65	6.85	0	0	0	0	0	M
4588	87	85.5	Radius	0	0	0	0	0	0	7.17	4.22	4.23	1.94	3.32	F
4895	87.5	85.5	Radius	9.02	4.49	2.9	5.58	3.77	0	0	0	0	0	0	F
5082	87	86	Radius	10.16	5.08	3.43	5.07	4.31	5.85	0	0	0	0	0	M
5648	87	81	Radius	0	0	0	0	0	0	9.03	4.8	4.46	3.34	1.98	F
5722	87	81.5	Radius	9.75	4.92	3.03	0	4.09	6.26	0	0	0	0	0	F
5915	87	84.5	Radius	9.7	5.27	3.34	5.57	4.15	0	0	0	0	0	0	M
6077	88.5	80	Radius	10.29	5.2	3.61	6.07	4.36	5.94	8.63	0	3.82	1.92	5.02	M
6615	88	82.5	Radius	0	0	0	0	0	0	7.55	4.32	4.31	3.08	1.57	F
7623	90	83.5	Radius	10.16	5.39	3.07	5.68	4.3	5.95	0	0	0	0	0	M
8247	90	85	Radius	10.6	5.48	3.43	5.95	4.24	0	9.4	0	4.2	2.08	5.41	M
8255	90	85	Radius	8.37	4.52	2.71	5.1	3.42	5.24	7.29	0	2.79	1.58	4.04	F
8362	90	85.5	Radius	0	0	0	0	0	0	10.21	5.06	5.17	3.51	2.04	F
9159	90	87	Radius	9.74	5.21	3.33	5.7	4.48	0	0	0	0	0	0	M
9249	90	87.5	Radius	0	0	0	0	0	0	7.25	4.38	3.91	2.85	1.7	F
10750	91	85	Radius	0	0	0	0	0	0	7.27	4.67	4.14	3.18	1.58	F
11054	91	86	Radius	10.3	5.08	0	0	0	9.28	9.28	0	3.96	2.25	5.07	M
11277	91	87	Radius	10.36	5.34	3.45	5.55	4.45	6.45	0	0	0	0	0	M
11390	91	87.5	Radius	0	0	0	0	0	0	9.1	4.97	4.82	3.93	1.95	F
11596	91	88.5	Radius	9.57	5	3.14	5.21	4.11	0	0	0	0	0	0	M
11610	91	88.5	Radius	0	0	3.28	5.23	4.23	5.78	8.79	0	3.61	1.8	4.94	M
11650	91	88.5	Radius	7.32	3.82	2.64	4.3	3.51	0	0	0	0	0	0	F
11710	91.5	88	Radius	9.18	0	3.11	4.3	4.04	0	0	0	0	0	0	F
11789	91.5	88.5	Radius	10.3	5.32	3.45	5.72	4.36	6.4	9.56	0	3.86	1.91	4.83	M
11892	91	89	Radius	0	0	0	0	0	0	9.4	4.66	4.54	3.5	1.93	F

Appendix 8: Radius Metrics

Cat#	South	East	Bone	a	b	c	d	e	f	g	h	i	j	k	SEX
12085	91.5	89	Radius	0	0	0	0	0	0	9.15	5.1	4.27	3.52	1.94	F
12101	91.5	89.5	Radius	8.67	4.41	2.53	4.96	3.55	0	0	0	0	0	0	F
13593	63	59.5	Radius	10.46	5.32	3.56	5.47	4.31	6.32	0	0	0	0	0	M
13836	64	59.5	Radius	8.85	4.77	2.95	5.14	3.91	5.7	0	0	0	0	0	F
13914	64.5	59	Radius	8.23	4.43	0	0	0	0	0	0	0	0	0	F
14966	105	130.5	Radius	0	0	0	0	0	0	0	0	0	0	0	I
14775	105	129	Radius	8.77	4.77	2.52	5.02	3.74	0	0	0	0	0	0	F
14987	105.5	130	Radius	9.57	5.01	3.27	5.48	4.12	6.51	0	0	0	0	0	M
15965	107	130.5	Radius	8.91	4.51	2.82	4.88	3.68	5.91	0	0	0	0	0	F
16055	107.5	130.5	Radius	8.67	4.6	2.78	5.44	3.83	5.57	0	0	0	0	0	F
16591	110.5	129	Radius	10.05	5.42	3.26	5.92	3.97	0	0	0	0	0	0	M

Appendix 8 (cont'd): Radius Metrics

Cat Num	Bone	a	b	c	d	e	f	g	h	i	j	SEX
2547	Metacarpal	5.23	0	3.01	0	0	0	0	0	0	0	I
2649	Metacarpal	0	0	0	6.36	2.92	2.8	2.62	2.42	3.41	3.19	F
3069	Metacarpal	7.99	4.39	4.74	7.97	3.93	3.37	3.48	2.88	4.2	3.92	M
3336	Metacarpal	7.47	4.32	4.73	7.46	3.68	3.39	3.24	2.88	4.19	4	M
3403	Metacarpal	6.18	3.7	3.84	0	0	0	0	0	0	0	F
3427	Metacarpal	0	0	0	8.15	3.72	3.32	2.97	2.69	3.72	3.59	M
3658	Metacarpal	7.25	4.26	4.16	0	0	0	0	0	0	0	I
3957	Metacarpal	0	0	0	6.82	3.18	3.21	2.84	2.74	0.36	3.75	M
3958	Metacarpal	0	0	0	6.78	3.08	3.02	3.04	2.82	3.94	3.89	F
4179	Metacarpal	6.15	3.76	3.74	0	0	0	0	0	0	0	F
4743	Metacarpal	7.52	4.49	4.42	7.37	3.6	3.34	3.08	2.83	3.8	3.79	M
4943	Metacarpal	7.2	4.19	4.45	7.33	3.5	3.33	2.87	2.84	3.65	3.65	M
5362	Metacarpal	7.71	4.62	4.43	7.76	3.73	3.42	3.37	2.84	4.11	3.65	M
5769	Metacarpal	6.34	3.79	3.83	0	0	0	0	0	0	0	F
6085	Metacarpal	7.73	4.75	4.38	7.36	3.55	3.19	2.89	2.58	3.8	3.57	F
6526	Metacarpal	7.57	4.42	4.63	7.2	3.46	3.2	3.11	2.74	3.9	3.74	M
6527	Metacarpal	7.33	4.3	4.49	7.22	3.35	3.34	3	2.69	3.79	3.77	M
7012	Metacarpal	0	0	0	6.2	2.95	2.78	2.52	2.52	3.22	3.47	F
7729	Metacarpal	6.32	3.64	3.7	6.28	2.98	2.83	2.52	2.4	3.38	3.27	M
7847	Metacarpal	7.07	3.88	4.16	7.92	3.27	3.01	3.02	2.69	3.79	3.66	M
8253	Metacarpal	7.7	4.76	4.32	7.35	3.52	3.25	2.96	2.64	3.89	3.56	M
8365	Metacarpal	0	0	0	6.12	2.93	2.73	2.5	2.32	3.41	3.23	F
8772	Metacarpal	5.94	3.44	3.44	0	0	0	0	0	0	0	F
8913	Metacarpal	7.56	4.46	4.39	7.41	3.51	3.25	3.11	2.81	4.14	4.04	I
9017	Metacarpal	6.25	3.47	4.9	6.4	3.06	2.86	2.71	2.46	3.61	3.4	F
9162	Metacarpal	6.42	3.83	3.83	0	0	0	0	0	0	0	F
9792	Metacarpal	7.84	4.59	4.83	7.69	3.63	3.37	3.13	2.92	4.02	3.97	F
9879	Metacarpal	8.04	4.8	4.99	7.57	3.62	3.16	3.02	2.79	3.88	3.13	M
10237	Metacarpal	0	0	0	7.04	3.42	3.09	2.87	2.54	3.73	3.48	F
10398	Metacarpal	6	3.49	3.43	0	0	0	0	0	0	0	F
10535	Metacarpal	0	4.44	4.24	7.14	3.49	3.41	3.01	2.73	3.95	3.8	M
10726	Metacarpal	0	0	0	0	0	0	0	0	0	0	I
10941	Metacarpal	0	0	0	6.44	2.96	2.78	2.82	2.55	3.63	3.47	F

Appendix 9: Metacarpal Metrics

Cat Num	Bone	a	b	c	d	e	f	g	h	i	j	SEX
11119	Metacarpal	6.94	4.36	4.16	6.69	3.86	2.94	2.85	2.57	3.59	3.35	F
11166	Metacarpal	7.77	4.67	4.67	7.48	3.84	3.4	3.2	2.9	4.23	3.95	M
11167	Metacarpal	7.44	4.34	4.44	7.26	3.34	3.12	3.11	2.7	3.88	3.76	F
11345	Metacarpal	6.41	3.72	3.74	6.52	3.15	2.96	2.69	2.39	3.48	3.35	F
11893	Metacarpal	6.51	3.79	4.06	5.91	3.07	2.44	2.55	1.78	3.11	2.55	M
11937	Metacarpal	7.6	4.38	4.49	7.7	3.62	3.61	3.93	2.68	3.71	3.68	M
12051	Metacarpal	7.06	4.09	4.24	6.63	3.24	2.88	2.98	2.65	3.61	3.58	I
12102	Metacarpal	7.05	4.33	4.32	0	0	0	0	0	0	0	M
13866	Metacarpal	0	0	0	6.23	2.78	2.71	2.77	2.58	3.54	3.48	F
13936	Metacarpal	7.45	4.33	4.29	7.57	3.46	3.48	3.15	2.95	0	3.81	M
13937	Metacarpal	7.86	4.71	4.62	7.72	3.75	3.53	3.23	2.86	3.91	3.83	M
14340	Metacarpal	6.74	7.03	4.1	6.71	3.22	3.03	2.88	2.64	3.87	3.76	I
14403	Metacarpal	7.89	0	4.65	7.9	3.64	3.33	3.15	2.71	4.04	3.76	M
14811	Metacarpal	0	0	0	7.81	3.88	3.54	3.26	3	4.16	4	M
14404	Metacarpal	7.15	0	4.53	0	0	0	0	0	0	0	M
14834	Metacarpal	6.61	3.8	3.78	3.36	0	0	0	0	0	0	F
15273	Metacarpal	5.91	3.78	3.53	0	0	0	0	0	0	0	F
15595	Metacarpal	5.96	3.82	3.75	0	0	0	0	0	0	0	F

Appendix 9 (cont'd): Metacarpal Metrics

CAT	BONE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	SEX
272	Femur	14.36	7.05	5.61	0	3.17	4.91	0	0	0	0	0	0	0	0	0	M
364	Femur	0	0	0	0	0	0	0	0	10.94	6.94	0	6	5.52	0	0	I
430	Femur	0	6.79	6.39	0	3.35	5.99	9.07	0	0	0	0	0	0	0	0	I
1198	Femur	14.39	7.21	5.67	0	3.41	5.7	6.73	0	0	0	0	0	0	0	0	M
4083	Femur	0	0	5.63	0	3.24	5.63	8.18	0	0	0	0	0	0	0	0	I
4266	Femur	0	0	0	0	3.28	0	9.33	0	0	0	0	0	0	0	0	I
4669	Femur	0	0	0	0	0	0	0	5.5	11.67	6.38	14.2	5.6	5.26	5.39	9.86	M
5723	Femur	0	0	0	0	0	0	0	4.95	10.12	5.61	12.8	4.97	4.68	4.96	9.02	F
6294	Femur	0	0	0	0	0	0	0	0	0	7.16	0	0	4.67	0	0	I
6616	Femur	0	0	5.2	0	0	0	0	0	0	0	0	0	0	0	0	I
6657	Femur	12.16	6.1	5.13	0	2.63	4.62	6.71	0	0	0	0	0	0	0	0	F
7365	Femur	0	0	0	0	0	0	0	3.9	0	5.96	13.1	5	0	5.35	9.49	F
7451	Femur	12.93	6.15	5.38	0	2.94	5.17	7.76	0	0	0	0	0	0	0	0	I
7957	Femur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	I
8310	Femur	0	7.02	5.72	0	3.13	5.77	8.38	5.71	12.07	6.79	12.9	5.29	5.77	5.43	9.58	I
9594	Femur	0	6.66	5.25	0	2.85	0	0	0	0	0	0	0	0	0	0	I
9871	Femur	0	0	0	0	0	0	0	4.05	0	5.99	0	4.61	0	0	0	I
11344	Femur	0	7.16	5.61	0	2.85	5.91	9.17	0	0	0	0	0	0	0	0	I
11507	Femur	14.98	6.61	5.52	0	2.87	5.58	8.4	0	0	0	0	0	0	0	0	M
11657	Femur	0	0	0	0	0	0	0	4.5	11.43	6.84	0	6.15	6.1	0	0	I
11712	Femur	14.56	7.15	5.63	0	2.93	5.81	8.76	0	0	6.89	13.7	0	5.71	5.69	10.3	M
13935	Femur	0	0	0	0	0	0	0	4.98	10.68	6.49	0	5.75	4.13	0	0	I

Appendix 10: Femur Metrics

CAT	BONE	A	B	C	D	E	F	G	H	I	J	SEX
1365	Tibia	0	0	0	0	0	0	0	7.51	5.35	5.36	M
2106	Tibia	11.8	11.1	8.02	11.5	5.12	5.81	8.92	0	0	0	M
2825	Tibia	12.05	10.9	8.52	10.7	5.01	6.02	8.68	0	0	0	M
2828	Tibia	0	0	0	0	0	0	0	7.17	5.6	5.04	I
4021	Tibia	11.93	0	8.65	0	5.46	6.58	0	0	0	0	M
4268	Tibia	0	0	0	0	0	0	0	6.18	4.7	4.54	F
4900	Tibia	0	11.7	8.54	0	5.97	0	9.37	0	5.57	0	M
6701	Tibia	0	0	0	0	0	0	8.16	0	0	0	I
8254	Tibia	11.79	11.7	8.16	12	5.04	6.09	9.66	7.41	5.24	5.17	M
8841	Tibia	11.87	0	0	0	5.99	5.62	0	7.92	5.96	5.41	M
8990	Tibia	0	0	0	0	0	0	0	6.65	5.21	4.71	F
9477	Tibia	0	0	0	0	0	0	0	7.12	5.46	4.99	I
10837	Tibia	0	0	0	0	4.12	0	0	0	0	0	F
11713	Tibia	0	0	0	0	0	0	0	6.57	5.15	4.91	F
12147	Tibia	12.05	0	8.24	11.1	5.92	6.1	9.14	7.64	5.88	5.42	M
13694	Tibia	0	0	0	0	0	0	0	7.16	5.22	5.16	M
14862	Tibia	0	0	0	0	0	0	0	7.81	5.72	5.46	M
15967	Tibia	0	0	0	0	0	0	0	7.01	5.14	5.09	I
15973	Tibia	0	0	0	0	0	0	0	6.74	5.3	4.9	F
16489	Tibia	0	0	0	0	0	0	0	6.36	4.57	4.7	F
16751	Tibia	0	0	0	0	0	0	0	6.46	5.52	5.1	F

Appendix 11: Tibia Metrics

CAT	BONE	A	B	C	D	E	F	G	H	I	J	SEX
757	Metatarsal	5.95	5.77	2.92	5.74	2.68	2.58	2.52	2.25	3.29	3.26	F
1666	Metatarsal	4.86	5.02	2.54	5.64	2.71	2.56	2.52	2.39	3.46	3.31	F
1994	Metatarsal	0	0	0	5.82	2.73	2.56	2.52	2.23	3.36	3.23	F
2173	Metatarsal	5.69	5.29	2.64	6.55	3.14	2.99	2.85	2.64	3.87	3.79	M
2477	Metatarsal	4.98	4.98	2.47	5.79	2.77	2.59	2.42	2.23	3.47	3.37	F
2547	Metatarsal	5.23	0	3.01	0	0	0	0	0	0	0	I
2600	Metatarsal	0	0	0	6.71	3.07	3.13	2.83	2.77	3.84	3.79	M
2646	Metatarsal	5.29	5.14	2.88	6.29	3.11	2.72	2.83	2.48	3.55	3.45	F
2647	Metatarsal	4.78	4.79	2.52	5.83	2.72	2.61	2.41	2.26	3.4	3.29	F
2648	Metatarsal	5.91	5.68	3	0	0	0	0	0	0	0	M
2823	Metatarsal	6.03	5.54	2.85	6.44	3.01	2.88	2.83	2.56	3.67	3.48	M
3689	Metatarsal	4.72	4.54	2.35	0	0	0	0	0	0	0	F
3762	Metatarsal	5.72	5.57	2.96	6.52	2.95	2.91	2.94	2.6	3.7	3.64	M
4564	Metatarsal	5.78	5.37	3.02	0	0	0	0	0	0	0	M
4796	Metatarsal	5.13	5.06	2.56	5.97	2.96	2.82	2.81	2.61	3.67	3.56	F
5727	Metatarsal	5.36	5.41	2.95	6.12	3.03	2.7	2.88	2.57	3.62	3.51	F
6617	Metatarsal	4.73	4.79	2.37	5.95	2.63	2.62	2.45	2.22	3.29	3.2	F
7298	Metatarsal	5.07	5.27	2.69	5.89	2.91	2.69	2.78	2.66	3.8	3.61	F
7368	Metatarsal	4.67	4.7	2.57	5.82	2.59	2.43	2.58	2.4	3.35	3.27	F
7696	Metatarsal	4.76	4.88	2.56	5.44	2.48	2.43	2.51	2.48	3.22	3.33	F
7697	Metatarsal	5.46	5.31	2.8	6.51	3.15	2.91	2.74	2.39	3.42	3.35	M
7790	Metatarsal	4.89	4.74	2.39	0	0	0	0	0	0	0	F
7883	Metatarsal	0	0	0	6.04	0	0	0	0	0	0	I
7962	Metatarsal	0	0	0	6.49	2.95	2.89	2.92	2.68	3.75	3.54	M
8017	Metatarsal	0	0	0	5.89	2.74	2.62	2.75	2.39	3.57	3.33	F
8018	Metatarsal	0	0	0	5.78	2.7	2.48	2.64	2.42	3.41	3.3	F
8165	Metatarsal	4.68	4.56	2.83	0	0	0	0	0	0	0	F
8412	Metatarsal	0	0	0	5.73	2.71	2.4	2.48	2.23	3.33	3.3	F
8843	Metatarsal	0	0	0	6.48	0	0	0	0	0	0	I
8883	Metatarsal	0	0	0	6.39	0	0	0	0	0	0	I
9018	Metatarsal	6.17	5.59	2.77	6.91	3.25	2.99	2.9	2.64	3.94	3.74	M
9020	Metatarsal	5.69	5.46	3.01	0	0	0	0	0	0	0	M
9161	Metatarsal	5.06	5	2.91	0	0	0	0	0	0	0	F

Appendix 12: Metatarsal Metrics

CAT	BONE	A	B	C	D	E	F	G	H	I	J	SEX
9372	Metatarsal	5.79	5.07	2.81	6.68	3.09	2.9	2.94	2.57	3.82	3.42	M
9478	Metatarsal	5.96	5.46	2.19	0	0	0	0	0	0	0	M
10751	Metatarsal	4.93	5.07	2.61	0	0	0	0	0	0	0	F
10910	Metatarsal	4.55	4.79	2.44	5.77	2.73	2.63	2.61	2.41	3.48	3.34	F
11057	Metatarsal	4.67	5.55	3.08	0	3.13	0	2.92	0	3.79	3.61	F
11058	Metatarsal	4.95	4.91	2.57	0	0	0	0	0	0	0	F
11102	Metatarsal	5.75	5.68	2.96	0	0	0	0	0	0	0	M
11281	Metatarsal	5.12	5.26	2.71	0	0	0	0	0	0	0	F
11508	Metatarsal	4.94	5.03	2.83	0	0	0	0	0	0	0	F
11509	Metatarsal	0	0	0	5.65	2.61	2.55	2.49	2.29	3.36	3.28	F
12011	Metatarsal	0	0	0	6.77	3.31	2.96	2.89	2.48	3.75	3.58	M
12103	Metatarsal	5.65	5.4	2.83	6.69	2.98	2.95	2.87	2.74	3.83	3.67	M
12148	Metatarsal	4.32	4.21	2.06	0	0	0	0	0	0	0	F
13883	Metatarsal	4.88	4.76	2.5	5.84	2.71	2.37	2.35	2.12	3.1	2.95	F
13938	Metatarsal	5.98	5.88	2.75	6.92	3.21	3.12	3.24	2.9	4.24	4.04	M
13939	Metatarsal	5.96	5.71	2.7	6.9	3.25	3.11	2.8	2.57	3.89	3.73	M
14036	Metatarsal	4.88	4.95	2.67	5.98	2.72	2.65	2.42	2.36	3.41	3.36	F
14913	Metatarsal	0	0	0	7.08	3.04	3.03	3.01	2.82	4.15	4	M
15690	Metatarsal	5.22	5.34	2.87	0	0	0	0	0	0	0	I
16690	Metatarsal	4.84	4.97	2.49	0	0	0	0	0	0	0	F
16808	Metatarsal	4.71	5.05	2.49	0	0	0	0	0	0	0	F
16839	Metatarsal	5.46	5.64	3.04	0	0	0	0	0	0	0	M
16883	Metatarsal	0	0	0	0	0	0	0	0	0	0	I

Appendix 12 (cont'd): Metatarsal Metrics

CatNo	South	East	Element	L	Wp	Dp	Wd	Dd	Lc	Lt
1695	86	79.5	Calcaneus	146.8	35	41	42.5	57.9	37.8	32.2
1696	86	79.5	Calcaneus	142.2	36	38.2	39.1	54	38	33.7
2659	87	82	Calcaneus	155	41	42.3	45.7	58.2	41.4	33
2903	87.5	82.5	Calcaneus	153.5	45	46.4	49.8	65.1	38.4	34.1
3232	87.5	83	Calcaneus	144	35.7	41.7	42.7	56.9	38	34.2
3422	87.5	83.5	Calcaneus	157.5	42.5	42.8	48.5	63.2	46.5	0
4089	87.5	84.5	Calcaneus	142	33.4	38.3	39.7	55.8	36.6	33.7
4679	87.5	85	Calcaneus	157.7	33.4	42.4	45.3	59.5	44.3	38
4748	87.5	85	Calcaneus	0	25.6	34.9	45.2	59.1	42.9	34.9
5733	87	81.5	Calcaneus	136.4	30.8	35	40.3	44.6	0	30.8
5778	87	81.5	Calcaneus	139.5	34.3	34.2	40.7	53.4	0	0
6438	88.5	81.5	Calcaneus	158.4	42.3	47.3	51.5	63.1	37.6	34.2
6537	88	82	Calcaneus	145.5	36.8	40.5	44.3	56.1	0	0
6538	88	82	Calcaneus	149.1	34.6	0	40.9	57.8	35.8	0
6662	88	82.5	Calcaneus	139	31.5	35.3	39.5	54.8	37.7	31.6
7364	90	82.5	Calcaneus	139.5	32.9	36.7	37.5	52	35.1	27.8
8132	90.5	84	Calcaneus	157.7	36	44.6	48	61.7	43.6	36.5
8168	90.5	84.5	Calcaneus	153.8	40.7	0	44.6	60.1	41	30.5
8264	90	85	Calcaneus	144.8	34	35.7	41.9	58.8	39.5	31.7
8265	90	85	Calcaneus	155	37.9	45	49.7	61.3	46.3	35.7
8371	90	85.5	Calcaneus	145.9	34.3	40.7	41.4	60.4	40.5	33.4
8667	90	86	Calcaneus	133	33.9	36.7	41.4	55.1	0	40
8748	90	86	Calcaneus	143.7	31.9	36.8	41.8	56.7	38	32.5
8846	90	86.5	Calcaneus	157.7	42.8	41.9	47.5	62.1	42.1	34
9321	90	87.5	Calcaneus	151.6	41.7	44.9	0	0	0	35.3
9381	90.5	87	Calcaneus	0	31.1	45	43	59.2	40.6	34.4
9483	90.5	87.5	Calcaneus	149.1	39	42.8	43.2	58.7	38.5	34.4
9882	90.5	88	Calcaneus	157.7	43.7	49.2	49.7	66.3	44.1	36.2
9883	90.5	88	Calcaneus	153.5	37.6	44.1	48	0	31	30.9
10555	91	83	Calcaneus	154.4	38.3	40.5	44.5	58.3	41.2	33.3
11178	91.5	86	Calcaneus	139.6	33.9	37.5	0	56.6	36.8	32.3
11395	91	87.5	Calcaneus	145.7	34	37.5	42.8	57.8	38.8	35
11663	91	88.5	Calcaneus	158.1	41.8	51.5	47.5	62.3	45.5	34.9
11664	91	88.5	Calcaneus	157.7	43.7	50	54.7	65.1	44.4	37.3
11977	91	89.5	Calcaneus	158.2	35.7	45.2	44	0	0	0
13792	64	59	Calcaneus	141.5	32	35.2	41.5	56.2	38.5	34.4
14170	100	131	Calcaneus	0	35	40.9	41.5	0	0	32.3
14915	105	130	Calcaneus	157.7	42.8	45.4	50	64.5	47	37.6
16060	108	131	Calcaneus	144.7	36.4	40.3	40.3	54.4	39.2	31.5
16495	110	130	Calcaneus	0	0	0	0	56.9	38.4	0
16599	111	129	Calcaneus	142.8	34.2	38.5	42.3	57	40.9	35.1

Appendix 13: Calcaneus Metrics

CatNo	South	East	Element	Wp	Wd	Dm	Dl	Ll	Lm
1422	86.5	78	Astragalus	53.1	49	40.4	43.2	75	69.9
1668	86	79.5	Astragalus	49	46.8	37	41	74.5	70.5
1782	86.5	79	Astragalus	54.6	52.4	36.8	42.3	74.4	72.1
1997	86	80.5	Astragalus	39.6	39.6	0	34	64.7	61.9
2553	87	82	Astragalus	0	52.6	0	43.5	77.5	72.8
2795	87.5	82	Astragalus	47	48.2	35.7	40.9	72.8	66.3
2904	87.5	82.5	Astragalus	55.4	53	47.6	41.2	77.5	72.8
2989	87	83	Astragalus	47.6	47.8	35.1	42.7	75.9	71.2
3337	87.5	83.5	Astragalus	47.5	46.9	40	41.3	78.2	71.8
3424	87.5	83.5	Astragalus	47.7	46.5	37.3	43.3	76	71.3
3507	87	83	Astragalus	0	41.4	0	0	60.5	0
4130	87.5	84.5	Astragalus	42.2	43.2	31	37.6	68.3	66.2
4680	87.5	85	Astragalus	54.3	52.8	41.2	42.3	77.9	74.7
4681	87.5	85	Astragalus	48.3	47	36.2	37.7	70.7	66.4
4800	87.5	85	Astragalus	45.4	44.8	31	35.7	70	63.1
5394	87.5	86	Astragalus	0	51.8	37.1	41.2	0	73.3
5408	87.5	86	Astragalus	0	49.2	36.6	0	0	68.1
5540	87.5	86.5	Astragalus	48.9	45.9	0	38.9	69.7	65.6
5541	87.5	86.5	Astragalus	48.5	0	0	0	0	0
5775	87	81.5	Astragalus	42.4	43.8	0	35.3	66	66.3
5776	87	81.5	Astragalus	48.5	46.5	36.1	39.6	72.8	67.8
5883	87.5	81.5	Astragalus	58.3	55.4	42.5	45.7	79.5	71.7
5884	87.5	81.5	Astragalus	48.9	44	38.4	40.8	72.9	67.8
6355	88.5	81	Astragalus	58.3	56.4	42.3	44.9	77	71.1
6356	88.5	81	Astragalus	0	47.8	34.1	40.2	0	67.8
6386	88.5	81	Astragalus	48	47.9	0	41	72.3	66.6
6819	88.5	82.5	Astragalus	54.7	50.4	38.9	41.8	79.6	74
7363	90	82.5	Astragalus	46.2	42.4	34.5	38.2	70.8	64.8
8083	90.5	84	Astragalus	45	44.9	33.5	38	66.4	64.4
8084	90.5	84	Astragalus	43.7	45.9	34	39.9	68.5	65.9
8085	90.5	84	Astragalus	47.3	48	31.9	38.9	73.8	70.7
8259	90	85	Astragalus	52.9	52.6	39.3	41.4	74.5	72.3
8260	90	85	Astragalus	53.8	49.8	42.6	44.4	76.4	71.8
8416	90	85.5	Astragalus	52.2	52	40	43.3	79.9	75
8467	90.5	85	Astragalus	51.1	51.5	39.9	41.7	77.5	73.2
8468	90.5	85	Astragalus	50.8	50	40	40	74.3	70.7
8668	90	86	Astragalus	49.4	49.8	40.1	41.9	74.8	70.7
8885	90	86.5	Astragalus	49.5	48.2	39.2	40.8	74.6	71.6
8991	90.5	86	Astragalus	49.7	45.8	36.2	39.9	72.3	67.1
9027	90.5	86.5	Astragalus	49.3	48.7	38	40.5	75.6	70.4
9110	90	87	Astragalus	56.4	54.1	44	44.3	80.6	74.2
9165	90	87	Astragalus	46.4	52.1	44.8	46.7	83.6	79.7
9311	90	87.5	Astragalus	56	54.3	40.6	42.1	78.2	71.4
9884	90.5	88	Astragalus	54.2	54.7	39.7	42.1	77.1	73.5
9958	90.5	88.5	Astragalus	0	50.8	0	44.3	0	74.9
10644	91	84	Astragalus	53.5	51.8	39.7	44.9	81	75.2
10841	91	85.5	Astragalus	46.8	4.9	37.8	39	72.9	70.6

Appendix 14: Astralagus Metrics

CatNo	South	East	Element	Wp	Wd	Dm	Dl	Ll	Lm
11122	91	86.5	Astragalus	48.5	47.4	37.4	39.9	72.7	68.3
11235	91.5	86.5	Astragalus	50.8	49.3	38.2	40.7	74.6	71
11294	91	87	Astragalus	49.3	50.5	40.5	42.8	74.3	72.5
11349	91	87.5	Astragalus	0	53.9	0	0	0	0
11517	91	88	Astragalus	53.5	52.4	40.7	42	73.8	72
11604	91	88.5	Astragalus	50.9	49.8	40.2	41.1	74.4	69.9
11665	91	88.5	Astragalus	47.5	44.1	35.2	36.7	67.9	64.6
11941	91	89	Astragalus	46.5	46	0	40	76.1	69.6
12156	91.5	89.5	Astragalus	53.1	48.6	40.8	40.8	75.5	69.6
12862	89	87	Astragalus	56.4	0	0	0	0	0
13698	63.5	59.5	Astragalus	55.5	54.4	41.7	42.6	74.9	70.1
13945	64.5	59.5	Astragalus	47.3	48	39	40.4	74.8	71.8
14128	101	130	Astragalus	44.8	46.4	37.8	39.4	70.5	66
14292	102	130	Astragalus	53	0	0	0	0	0
15695	107	130	Astragalus	0	48	39.2	0	0	68.6
16497	110	130	Astragalus	47.4	44	37	38.3	69.1	66.7
16600	111	129	Astragalus	49.4	48.2	44.2	41.5	74.7	70.4

Appendix 14 (Cont'd): Astralagus Metrics

CatNo	South	East	Element	L	D	W
756	86.5	73.5	Cen/4th	50.3	61.9	55.7
1421	86.5	78	Cen/4th	49.8	69.2	64.1
1467	86.5	78.5	Cen/4th	39.3	51	54.7
1579	86	79	Cen/4th	43.8	56.2	55.2
1667	86	79.5	Cen/4th	47.5	55.5	57
1781	86.5	79	Cen/4th	47	61.9	62.3
1941	86	80	Cen/4th	43.9	56.4	55.5
2184	86.5	80.5	Cen/4th	46	56.6	57.6
2185	86.5	80.5	Cen/4th	48.6	63	63.3
2660	87	82	Cen/4th	44.2	57.2	59.6
2661	87	82	Cen/4th	40.3	55.6	58.7
2902	87.5	82.5	Cen/4th	49	64.1	66
3425	87.5	83.5	Cen/4th	48.7	55.2	59.8
3508	87	83	Cen/4th	0	49.2	49.9
3509	87	83	Cen/4th	42.6	57.8	62.4
3764	87	84.5	Cen/4th	47.8	62.7	68.5
4276	87	85	Cen/4th	47.6	65	67.1
4682	87.5	85	Cen/4th	49.8	62.7	62.8
4801	87.5	85	Cen/4th	47.8	63.5	66.8
4882	87.5	85.5	Cen/4th	50.6	62.7	63.7
4883	87.5	85.5	Cen/4th	48.2	65.4	66.2
4950	87.5	85.5	Cen/4th	52	63.5	69.2
5777	87	81.5	Cen/4th	48.7	61.7	69.2
5821	87.5	81	Cen/4th	41.5	54.9	56.6
5880	87.5	81.5	Cen/4th	48.1	65.4	67.8
5881	87.5	81.5	Cen/4th	42.4	56	54.1
5882	87.5	81.5	Cen/4th	49.9	68.9	68
6387	88.5	81	Cen/4th	38.3	50.3	49.6
6539	88	82	Cen/4th	50.8	64.7	71.2
6818	88.5	82.5	Cen/4th	40.6	56.6	58.4
6929	89	82	Cen/4th	39.7	58.6	58.3
6987	89	82	Cen/4th	39.7	53	54.5
7120	89.5	82	Cen/4th	46.9	63.5	62.1
7182	89.5	82.5	Cen/4th	44.5	61.8	60.3
7303	90	82	Cen/4th	46.3	58.5	60
7304	90	82	Cen/4th	43.4	58	58.6
7344	90	82	Cen/4th	39.1	56	53.4
7454	90.5	82.5	Cen/4th	45.5	59.4	58.4
7504	90	83	Cen/4th	37.4	51.4	51.8
7807	90.5	83.5	Cen/4th	43.6	53.1	53.6
8026	90	84.5	Cen/4th	47.2	59.4	64.1
8081	90.5	84	Cen/4th	47.4	61.6	64.5
8082	90.5	84	Cen/4th	43.2	56.9	58
8169	90.5	84.5	Cen/4th	40.8	58.4	65.2
8261	90	85	Cen/4th	39.9	59.1	59.5
8262	90	85	Cen/4th	43.2	59.5	64.3
8263	90	85	Cen/4th	48.7	64.7	69.3

Appendix 15: Fused Central and Fourth Tarsal Metrics

CatNo	South	East	Element	L	D	W
8417	90	85.5	Cen/4th	48.2	59.6	61.5
8470	90.5	85	Cen/4th	45.9	59	57.3
8554	90.5	85.5	Cen/4th	50.1	63.8	67.1
9254	90	87.5	Cen/4th	45.6	57.4	60.8
9312	90	87.5	Cen/4th	46.5	60.4	62.8
9382	90.5	87	Cen/4th	52	66.3	70.6
9383	90.5	87	Cen/4th	47.4	61.6	59.9
9384	90.5	87	Cen/4th	39.6	56.9	56.6
9484	90.5	87.5	Cen/4th	47	59.4	63.7
9485	90.5	87.5	Cen/4th	47.8	60.7	67.8
9796	90	88.5	Cen/4th	45.7	57.6	63.1
10329	90.5	89	Cen/4th	38.3	55.4	60.7
10802	91	85	Cen/4th	45	57.4	60.5
11108	91	86	Cen/4th	40.7	56.8	54.7
11350	91	87.5	Cen/4th	47.4	61	68.5
11605	91	88.5	Cen/4th	36.9	52.5	52.7
11766	91.5	88	Cen/4th	48.8	58.8	0
12014	91	89.5	Cen/4th	44.8	57.5	57.6
12104	91.5	89.5	Cen/4th	48.1	63.9	66.7
12154	91.5	89.5	Cen/4th	48.5	59	66.4
12155	91.5	89.5	Cen/4th	43.6	52.5	56.8
13368	89.5	87.5	Cen/4th	54	70.9	71.2
13793	64	59	Cen/4th	43.5	58.8	58.2
14171	100	131	Cen/4th	46.7	59.8	61
14439	103	130	Cen/4th	0	65.8	68.7
14461	104	130	Cen/4th	42.3	52.6	55.8
14866	106	130	Cen/4th	49.7	64.8	66.5
15975	107	131	Cen/4th	44.7	55.5	57.4
16496	110	130	Cen/4th	40.2	52	56.2
16691	111	129	Cen/4th	43.2	56.4	57.8

Appendix 15 (Cont'd): Fused Central and Fourth Tarsal Metrics

CatNo	South	East	Element	L	Wp	Dp
277	86	74.5	T 2/3	35.4	23.5	11.8
481	86.5	74.5	T 2/3	42.4	29.9	14.1
1008	86	77	T 2/3	37	22.5	10.9
1187	86.5	77.5	T 2/3	25.9	23	10.5
1583	86	79	T 2/3	38.2	21.9	10.2
1669	86	79.5	T 2/3	36.4	24	12.2
1998	86	80.5	T 2/3	33.5	22.4	10
2304	87	80	T 2/3	43	27.2	13.7
2367	87	80.5	T 2/3	42	28.7	14.3
2554	87	82	T 2/3	33.7	22	10.5
2749	87.5	82	T 2/3	40	27.1	12.9
2750	87.5	82	T 2/3	36	20.9	10.8
3153	87	83.5	T 2/3	40.1	25.7	13
3154	87	83.5	T 2/3	33.5	22	11
3622	87	84	T 2/3	36.8	23.2	10.6
3830	87	84.5	T 2/3	43.7	27.6	12.7
4025	87.5	84.5	T 2/3	34.5	21.1	11.7
4133	87.5	84.5	T 2/3	33.8	22.4	12.3
4138	87.5	84.5	T 2/3	29.3	18.9	10
4277	87	85	T 2/3	39.6	26.3	13.2
4348	87.3	85.3	T 2/3	35.8	33.7	11.6
4491	87	85.5	T 2/3	35	20	11
4749	87.5	85	T 2/3	31.9	18.3	10.5
5090	87	86	T 2/3	40	24.6	13.5
5657	87	81	T 2/3	42.7	28.5	13.8
5734	87	81.5	T 2/3	36.2	20.2	10.9
5860	87.5	81.5	T 2/3	34.5	24.6	10.3
5879	87.5	81.5	T 2/3	40	28.9	12.8
6061	88	80.5	T 2/3	38.7	24.4	12.4
6205	88	81	T 2/3	32.3	32	13.1
6212	88	81	T 2/3	35.5	24.6	11.4
6624	88	82.5	T 2/3	41.9	26	13.7
6687	88	82.5	T 2/3	38.3	24.8	11.8
6930	89	82	T 2/3	36.9	22	11.9
6931	89	82	T 2/3	21.8	19.5	10.5
7081	89	82.5	T 2/3	36.9	20.4	10.8
7302	90	82	T 2/3	38.8	26.7	11.9
7369	90	82.5	T 2/3	27.6	25.3	12
7455	90.5	82.5	T 2/3	35.9	20.4	11.2
7503	90	83	T 2/3	39	24.5	12
7550	90	83	T 2/3	34	24	10.6
7682	90	83.5	T 2/3	43.3	28.7	13.5
8027	90	84.5	T 2/3	25.4	25.7	12.1
8086	90.5	84	T 2/3	38.6	27.6	13.6
8133	90.5	84	T 2/3	37.2	26.5	11.7
8313	90	85	T 2/3	35.7	22.7	10.5
8556	90.5	85.5	T 2/3	40	26.8	13.1

Appendix 16: Fused 2nd and 3rd Tarsal Metrics

CatNo	South	East	Element	L	Wp	Dp
8669	90	86	T 2/3	31.9	22.5	11.4
9185	90	87	T 2/3	24.1	20.4	11.8
9542	90.5	87.5	T 2/3	36.7	20.4	12.6
10362	90.5	89	T 2/3	26.6	22.9	12.3
10484	91	81.5	T 2/3	42	28.9	11.6
10501	91.5	81	T 2/3	32.7	21.6	8.6
10803	91	85	T 2/3	36	23.7	12.9
11351	91	87.5	T 2/3	23.5	21.8	11
11666	91	88.5	T 2/3	35.5	22.5	11
11722	91.5	88	T 2/3	37.4	24.3	11.5
11794	91.5	88.5	T 2/3	24.7	19.7	9.8
11795	91.5	88.5	T 2/3	31	21.9	10.1
11976	91	89.5	T 2/3	35.6	22.9	11.5
12224	89	87	T 2/3	40.5	27.7	11.9
12584	89.5	87	T 2/3	45	28.9	13.5
12908	89	87	T 2/3	43	26	13.7
13370	89.5	87.5	T 2/3	42.3	26.7	12.5
13410	89.5	87.5	T 2/3	35.8	24.6	13.2
13411	89.5	87.5	T 2/3	39.8	24.3	12.4
13468	89.5	87.5	T 2/3	29.9	15.3	8.7
13469	89.5	87.5	T 2/3	41.5	23.5	12.3
13602	63	59.5	T 2/3	40.4	28	10.4
13654	63.5	59	T 2/3	43.7	28.2	10
14202	101	131	T 2/3	41	26.6	12.6
15279	107	130	T 2/3	36.4	24.7	10
15470	107	130	T 2/3	29.6	19.6	8.2
15533	107	131	T 2/3	39.7	25.3	13.2
15976	107	131	T 2/3	37.8	25	12.8
16494	110	130	T 2/3	34.8	25	11.8
16682	110	130	T 2/3	37.6	23.4	11.9

Appendix 16 (Cont'd): Fused 2nd and 3rd Tarsal Metrics

CatNo	South	East	Element	La	Lp	D
27	86	73	Ulnar	30.1	38.5	38.4
825	86	76	Ulnar	26.7	30.4	37.8
1525	86	79	Ulnar	26	25.7	32.6
1784	86.5	79	Ulnar	26.4	33	33.8
1888	86	80	Ulnar	28.4	35.5	37.3
2042	86	80.5	Ulnar	31	32.3	40.5
2305	87	80	Ulnar	33.9	40.4	42.2
3234	87.5	83	Ulnar	34.9	42.6	43.3
3238	87.5	83	Ulnar	31.6	36.7	39.7
3283	87.5	83	Ulnar	33.1	40.5	40.9
3531	87	82.5	Ulnar	30	32.7	35.8
4617	87	85.5	Ulnar	28.2	33.7	33.6
4803	87.5	85	Ulnar	35.5	42.8	42.9
4804	87.5	85	Ulnar	27.5	31.9	35
5311	87.25	86.5	Ulnar	34.6	0	41.5
5363	87.5	86	Ulnar	33.2	42.4	40.6
5934	87.5	84	Ulnar	27.3	34.8	36.3
5935	87.5	84	Ulnar	32.6	39.6	40.7
6080	88.5	80	Ulnar	37.1	46.1	44.8
6150	88.5	80.5	Ulnar	35.3	46.7	43.4
6685	88	82.5	Ulnar	31.9	35.1	37.1
6743	88.5	82	Ulnar	31.9	40.6	37.1
7080	89	82.5	Ulnar	32.8	37.9	38
7501	90	83	Ulnar	27.7	35.5	36.3
7731	90.5	83	Ulnar	30	33.1	35
7795	90.5	83.5	Ulnar	26.5	29.7	32.4
8250	90	85	Ulnar	34.7	43.1	44.4
8369	90	85.5	Ulnar	27.5	34.4	33.6
8775	90	86	Ulnar	39.8	39.1	38.5
9024	90.5	86.5	Ulnar	36.5	41.7	42.5
10621	91.5	83.5	Ulnar	29.1	38.3	33.6
10801	91	85	Ulnar	34.5	39	38.4
10946	91.5	85	Ulnar	31.4	37.5	41
11174	91.5	86	Ulnar	33	39.9	42.1
11602	91	88.5	Ulnar	35.7	38.3	39.6
11765	91.5	88	Ulnar	32.5	41.8	40.4
11939	91	89	Ulnar	29.5	36.7	37.1
11940	91	89	Ulnar	32.3	40	41.3
12012	91	89.5	Ulnar	36.8	48.6	44.2
12151	91.5	89.5	Ulnar	34.5	38	44.2
12326	89	87	Ulnar	33.8	39.8	43.4
12968	89	87	Ulnar	26.6	32.1	30.7
13794	64	59	Ulnar	35.1	47.3	43.2
14012	64.5	59.5	Ulnar	39.1	46.1	42.6
14567	104	129.5	Ulnar	33.4	37.9	39.5
16059	107.5	130.5	Ulnar	35.4	39.7	39.2
16831	128.5	80.5	Ulnar	33.9	43	40.6

Appendix 17: Ulnar Metrics

CatNo	South	East	Element	L	W	D
1325	86	78.5	Internal	31.2	28.8	36.6
1465	86.5	78.5	Internal	29.8	36.1	55.9
1699	86	79.5	Internal	25.4	28.4	42.1
1744	86.5	79	Internal	24.5	28.2	43.1
1887	86	80	Internal	27.7	28.6	41.6
2186	86.5	80.5	Internal	34	34.3	48.8
2187	86.5	80.5	Internal	31.7	31.6	40.7
2341	87	80.5	Internal	30.5	35.6	49.1
2479	87.5	81.5	Internal	27.9	34.9	50.3
2557	87	82	Internal	27.3	27.1	0
3143	87	83.5	Internal	25.5	31.1	47.1
3695	87	84	Internal	25.3	28	40.6
4023	87.5	84.5	Internal	28.6	30.9	47.7
4024	87.5	84.5	Internal	25.7	29.1	40.5
4136	87.5	84.5	Internal	29.6	29.3	43.4
4180	87.5	84.5	Internal	31.4	32.5	0
4281	87	85	Internal	30.4	34.2	0
4545	87	85.5	Internal	31.5	34	52
5459	87.5	86.5	Internal	32.4	34.1	49.3
5655	87	81	Internal	30.2	35.1	48.8
5774	87	81.5	Internal	29.7	34.2	50
5822	87.5	81	Internal	20.5	20.6	29.8
5960	88	80	Internal	29.4	34.5	49.2
6037	88	80.5	Internal	25	27.9	44.9
6039	88	80.5	Internal	30.8	37	52.8
6040	88	80.5	Internal	29.4	32.2	46.8
6079	88.5	80	Internal	35.5	37.1	53.2
6471	88.5	81.5	Internal	25.2	24.4	38.4
6531	88	82	Internal	30.6	35.6	51.7
6532	88	82	Internal	30.2	33.6	51.4
6578	88	82	Internal	28	32.5	46.4
7079	89	82.5	Internal	29.4	32.2	44.9
7119	89.5	82	Internal	30.7	34.8	52
7178	89.5	82.5	Internal	26.6	29.4	40.7
7628	90	83.5	Internal	25.7	27.8	48
8023	90	84.5	Internal	31.1	35.5	47.5
8080	90.5	84	Internal	26.7	26.8	38.1
8170	90.5	84.5	Internal	33.9	33.4	45.2
8249	90	85	Internal	33.5	38.3	50.8
8368	90	85.5	Internal	28.7	32.2	49.9
8464	90.5	85	Internal	22.1	20.2	31.2
8465	90.5	85	Internal	35.3	31	44.9
8617	90.5	85.5	Internal	33.7	36.1	51.6
9025	90.5	86.5	Internal	34.9	34.1	48.8
9109	90	87	Internal	28.8	32.5	44.1
9310	90	87.5	Internal	29.4	33	47.2
9379	90.5	87	Internal	27.2	29.7	42.4

Appendix 18: Internal Metrics

CatNo	South	East	Element	L	W	D
9881	90.5	88	Internal	25.3	26.4	35
10010	90.5	88.5	Internal	20.7	21.9	32.3
10289	90.5	89	Internal	30.2	33.2	48.4
10325	90.5	89	Internal	31.6	33.6	43.7
10581	91	83.5	Internal	27	30.4	39.5
10753	91	85	Internal	29.9	34.4	49.2
10912	91	85.5	Internal	23.5	26.6	42.2
11003	91.5	85.5	Internal	28.6	34	48.5
11215	91.5	86	Internal	24.3	27.5	40.9
11233	91.5	86.5	Internal	32.4	32.4	45.5
11462	91.5	87.5	Internal	24.6	27	37
11513	91	88	Internal	30.8	30.4	42.3
11514	91	88	Internal	28.7	34.4	49.3
12091	91.5	89	Internal	29.9	33.5	50.1
12556	89.5	87	Internal	23.2	27.5	37.9
13409	89.5	87.5	Internal	23.6	28.1	36.4
13556	63	59	Internal	32.7	36.8	52.2
13600	63	59.5	Internal	30.3	32.3	43.1
14082	100	129.5	Internal	29.9	25.8	40.2
14462	103.5	129.5	Internal	31.6	33.2	49.7
15102	106	129	Internal	31.6	34.2	47.6
15183	106	129.5	Internal	31.6	33.5	51.7
15597	107	129	Internal	30.8	33.7	44.3
15694	107	129.5	Internal	28.6	32.2	45.9
16719	111.5	129	Internal	31.8	35.2	49.7

Appendix 18 (Cont'd): Internal Metrics

CatNo	South	East	Element	L	W	D
28	86	73	Radial	38	35.1	55.9
1886	86	80	Radial	30.8	24.2	43.3
2342	87	80.5	Radial	31.9	24.7	45.2
2365	87	80.5	Radial	33	31.1	50.1
2747	87.5	82	Radial	30.6	26.2	41.9
2873	87.5	82.5	Radial	31.1	24.7	48
3078	87	83.5	Radial	31.1	25.2	41.3
3237	87.5	83	Radial	36.7	32.8	53.3
3284	87.5	83	Radial	33.1	24.4	42.8
3960	87.5	84	Radial	36.3	35	54.9
4135	87.5	84.5	Radial	28.5	19.1	38.6
4350	87.25	85.25	Radial	37.4	0	49.5
5936	87.5	84	Radial	32.9	26.8	44
6036	88	80.5	Radial	29	26.8	44
6038	88	80.5	Radial	35.8	28.3	47.5
6078	88.5	80	Radial	35.2	31.1	53.8
6089	88.5	80	Radial	30.1	19.9	39.9
6186	88	81	Radial	32.9	29.1	46
6816	88.5	82.5	Radial	34.2	27.2	48.3
6926	89	82	Radial	32	22.8	40.4
6927	89	82	Radial	28.5	22.6	40.9
6988	89	82	Radial	32.7	26	48.2
7179	89.5	82.5	Radial	35.4	32.1	51.6
7502	90	83	Radial	32.2	34	53.5
7889	90	84	Radial	35	31	50.5
7921	90	84	Radial	33.8	27.9	43.5
8171	90.5	84.5	Radial	30.2	23.1	44.4
8248	90	85	Radial	40	33.5	52.2
8312	90	85	Radial	36.1	32	52.1
8367	90	85.5	Radial	35.9	28.4	50.4
8435	90	85.5	Radial	31.7	29.8	48.1
8466	90.5	85	Radial	32.4	20.7	37.4
8746	90	86	Radial	34.3	33	58.5
8971	90.5	86	Radial	30.5	23.7	43.6
9108	90	87	Radial	35.7	34.2	53.5
9376	90.5	87	Radial	33.1	25.9	48.3
9377	90.5	87	Radial	37.6	30.2	50.1
9482	90.5	87.5	Radial	30	25.1	0
9599	90	88	Radial	36.2	30.2	56.6
9739	90	88.5	Radial	31.7	29	48.3
10331	90.5	89	Radial	35.1	29.1	47.2
10402	90.5	89.5	Radial	34.5	33.1	53.7
10459	90.5	89.5	Radial	32.5	26.1	47.1
10944	91.5	85	Radial	28.5	22.7	46.5
10945	91.5	85	Radial	33.1	25.6	47.6
11106	91	86	Radial	35	29.5	48.7
11107	91	86	Radial	32.4	22.7	44.3

Appendix 19: Radial Metrics

CatNo	South	East	Element	L	W	D
11172	91.5	86	Radial	34	31.2	55
11283	91	87	Radial	37.2	35	54.9
11394	91	87.5	Radial	39.8	31.7	51.6
11601	91	88.5	Radial	26.2	26.1	41.9
12861	89	87	Radial	34.4	33.7	55.1
14081	100	129.5	Radial	34.5	27.2	50
14108	100.5	129	Radial	32.4	23.7	43
14639	104.5	129.5	Radial	29.5	22.8	43.8
15182	106	129.5	Radial	33.1	27	46.9
15852	107	129	Radial	39.1	32.6	54.8

Appendix 19 (Cont'd): Radial Metrics

CatNo	South	East	Element	L	W	D
1698	86	79.5	Unciform	25.5	29.7	33.7
2366	87	80.5	Unciform	27.5	32.7	36.1
2556	87	82	Unciform	23.9	27.5	30.9
2559	87	82	Unciform	24.9	32.4	37.8
2830	87.5	82.5	Unciform	27.7	28.2	34.8
3235	87.5	83	Unciform	28.3	32.9	38.1
3426	87.5	83.5	Unciform	28.8	32	36
4182	87.5	84.5	Unciform	27.1	33	37.8
4346	87.25	85.25	Unciform	24.4	33.2	35.6
4750	87.5	85	Unciform	27.1	30.7	37.7
4802	87.5	85	Unciform	27	35.6	38.7
6041	88	80.5	Unciform	27	32	34.8
6154	88.5	80.5	Unciform	20.2	22.1	28.6
6206	88	81	Unciform	26.3	32.6	36.4
6264	88	81.5	Unciform	27.9	28.5	35
6535	88	82	Unciform	25.6	30	36.8
6536	88	82	Unciform	27.8	32	36.8
6579	88	82	Unciform	24.8	26.2	32.3
6686	88	82.5	Unciform	27	33.9	37.4
6860	88.5	82.5	Unciform	23.1	27.2	33.6
7019	89	82.5	Unciform	24.7	25.7	31.3
7180	89.5	82	Unciform	24.9	31.6	35.5
7278	90	82	Unciform	22.3	26.1	32.3
7732	90.5	83	Unciform	24.9	26.3	30.1
7797	90.5	83.5	Unciform	25.2	32.1	36.2
7798	90.5	83.5	Unciform	28.6	32.2	37.5
7966	90	84.5	Unciform	27.9	32.1	36.8
8370	90	85.5	Unciform	28	34	38.7
8553	90.5	85.5	Unciform	23	29.1	32.4
8747	90	86	Unciform	25.1	29.3	34.7
9026	90.5	86.5	Unciform	22.1	26.2	28.7
9423	90.5	87	Unciform	25.7	33	36.7
9570	90.5	87.5	Unciform	26.2	30.4	31.3
9957	90.5	88.5	Unciform	24.6	30.2	33.2
10327	90.5	89	Unciform	26.2	34.4	32.2
10680	91	84	Unciform	22.7	26.1	29.9
10698	91.5	84	Unciform	26.7	31.8	38.5
10699	91.5	84	Unciform	26	30.2	36.1
10737	91.5	84.5	Unciform	26	28	30.8
11005	91.5	85.5	Unciform	26.8	31.7	36.8
11176	91.5	86	Unciform	27.1	35	40.6
11177	91.5	86	Unciform	28.7	34.2	38.2
11285	91	87	Unciform	25.9	23.4	28.9
11324	91	87	Unciform	23.5	26.2	29.2
11570	91	88	Unciform	27.8	30.5	37.9
11661	91	88.5	Unciform	25.7	32.2	35.8
11662	91	88.5	Unciform	28.5	26.3	33.5

Appendix 20: Unciform Metrics

CatNo	South	East	Element	L	W	D
11843	91.5	88.5	Unciform	25.3	30.9	36.7
12013	91	89.5	Unciform	28.7	35.2	40.9
12452	89	87.5	Unciform	23.9	27.2	29.2
12453	89	87.5	Unciform	28.1	0	0
12612	89.5	87	Unciform	28.8	27.4	38.9
13154	89	87.5	Unciform	27	30	36.8
14053	100	129	Unciform	25.3	30.8	32.6
14085	100	129.5	Unciform	25.3	29.6	31.9
15532	106.5	130.5	Unciform	28.4	34.3	37.3
15974	107	130.5	Unciform	28.7	34	42.1

Appendix 20 (Cont'd): Unciform Metrics

CatNo	South	East	Element	L	W	D
135	86.5	73	C 2/3	19.8	33.7	38.5
1580	86	79	C 2/3	19.6	35.7	36
1581	86	79	C 2/3	18.1	34.4	32.1
1783	86.5	79	C 2/3	23.5	45	43
1999	86	80.5	C 2/3	20.8	40.2	37.1
2306	87	80	C 2/3	22.6	42.1	40.7
2558	87	82	C 2/3	23	43.9	0
2662	87	82	C 2/3	23.1	38.1	37.5
2663	87	82	C 2/3	26.2	43	38.5
2801	87.5	82.5	C 2/3	22.1	41.3	39.3
3236	87.5	83	C 2/3	25	44.2	42.1
3899	87.5	84	C 2/3	24.8	47.2	44
4090	87.5	84.5	C 2/3	22.8	39	37
4134	87.5	84.5	C 2/3	26	41.3	39.2
4183	87.5	84.5	C 2/3	23.2	39.8	40.7
4718	87.5	85	C 2/3	18	33.2	31.3
5089	87	86	C 2/3	20.9	37	33
5462	87.5	86.5	C 2/3	21.2	38.2	36.1
5878	87.5	81.5	C 2/3	23.5	44.8	42.8
6082	88.5	80	C 2/3	24.9	45	43.8
6090	88.5	80	C 2/3	21.3	37.3	36.1
6151	88.5	80.5	C 2/3	25.2	45.7	41.5
6419	88.5	81.5	C 2/3	18.3	39.5	38.6
6533	88	82	C 2/3	22.4	39.7	37.2
6534	88	82	C 2/3	23.3	48.2	43.5
6861	88.5	82.5	C 2/3	19	38.2	34.5
7018	89	82.5	C 2/3	22.2	38.1	34.7
7425	90.5	82	C 2/3	0	0	32
7629	90	83.5	C 2/3	19.8	34.2	32.1
7733	90.5	83	C 2/3	20.3	36.7	33.4
7734	90.5	83	C 2/3	22.1	35.8	33.1
7796	90.5	83.5	C 2/3	26.8	47.5	45.3
7965	90	84.5	C 2/3	22.1	37.7	36.1
8025	90	84.5	C 2/3	25.3	47.8	42
8251	90	85	C 2/3	25.8	45.5	44.1
8257	90	85	C 2/3	18	34.5	32.1
8434	90	85.5	C 2/3	20	36	34.1
9163	90	87	C 2/3	22	37.1	35.2
9184	90	87	C 2/3	13	26.3	25.7
9380	90.5	87	C 2/3	24	45.8	40.2
10098	90	89	C 2/3	18.1	34.4	32.1
10326	90.5	89	C 2/3	23.6	38.9	35.9
10404	90.5	89.5	C 2/3	27.1	47	44.5
10405	90.5	89.5	C 2/3	23	40.7	38.8
10537	91.5	82.5	C 2/3	26.1	41.5	41.9
10679	91	84	C 2/3	17.8	36.2	33
10697	91.5	84	C 2/3	19.8	38.1	34.1

Appendix 21: 2nd and 3rd Carpal Metrics

CatNo	South	East	Element	L	W	D
10754	91	85	C 2/3	20.3	37	34.7
10947	91.5	85	C 2/3	22.2	37.8	35.8
10988	91.5	85	C 2/3	24.2	47.4	41.5
11175	91.5	86	C 2/3	19.2	34.1	33.1
11284	91	87	C 2/3	21.1	41.2	40
11516	91	88	C 2/3	24	44.1	41
11603	91	88.5	C 2/3	24.3	47	42.9
11721	91.5	88	C 2/3	20.8	39.7	37.1
12451	89	87.5	C 2/3	24.1	0	0
12826	89.5	87.5	C 2/3	0	45.9	41.3
12907	89	87	C 2/3	22	36.1	36.3
13557	63	59	C 2/3	24.2	46	44
13601	63	59.5	C 2/3	25.6	46.2	42.1
14052	100	129	C 2/3	23.2	38	37.7
14084	100	129.5	C 2/3	23.3	40.1	40.8
14341	102.5	129	C 2/3	0	0	38
14359	102	130	C 2/3	22.1	39.1	37.1
15184	106	129.5	C 2/3	23	40	39.1
16250	108	130	C 2/3	24.7	42.2	40.2
16718	111.5	129	C 2/3	27.4	45.2	42.2

Appendix 21 (Cont'd): 2nd and 3rd Carpal Metrics