2021

READING THE BONES: A TAPHONOMIC INVESTIGATION OF ARCHAEOFAUNAL REMAINS RECOVERED FROM SITE 48PA551, NORTHWEST WYOMING

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By

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Bachelor of Arts, The University of Montana, Missoula, Montana 2016

Thesis

presented in partial fulfillment of the requirements for the degree of

Master of Arts
In Anthropology, Archaeology

University of Montana
Missoula, MT

May, 2021

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Acknowledgments

I would like to first and foremost thank Dr. Anna Marie Prentiss for her constant support and guidance through both my undergraduate and graduate studies, and for allowing me to use her project for the basis of this research. This journey would not have been possible without her support and encouragement. No other professor has made me demand so much of myself. I would also like to thank my other committee members, Professor Dave Beck for his willingness to aid me in this process, and especially Dr. Kirsten Greene for her expertise and training in osteological identification, as well as her encouragement. I would also like to thank my family and friends for all the support they've given over the years that led to this moment.

Abstract

READING THE BONES: A TAPHONOMIC INVESTIGATION OF ARCHAEOFAUNAL REMAINS RECOVERED FROM SITE 48PA551, A SITE IN NORTHWEST WYOMING

Chairperson: Dr. Anna Marie Prentiss

This is a preliminary taphonomy study of archaeofaunal remains found at site 48PA551, more commonly known as the Dead Indian Creek Site. 48PA551 is a well-known and commonly cited example of a McKean Complex occupation dating to between 3,800 and 4,800 B.P. The University of Montana held a field school at the site conducting small test excavations under the supervision of Dr. Anna Marie Prentiss in 2018. In the course of this testing a highly fragmentary bone bed consisting mostly of mammalian bone, cervids largely, was discovered eroding into the nearby creek. Ten 50 x 50 cm quadrants were excavated and a large number of faunal remains recovered. This study seeks to reconstruct taphonomic site history specifically focusing on what taphonomic agents and processes have created and impacted the data recovered from the Cut Bank. Using well established statistical methods, I test for both human and non-human processes that may have biasing effects on the data. In doing so patterns in the data emerge that build upon and reinforce interpretations from previous studies at this site. Implications for the importance of the contribution of this site to the greater understanding of the socio-economic changes that were taking place during the McKean complex are offered, as well as recommendations for future research and the need for further data recovery.

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Chapter 1 - Introduction

Since the 1960s, and growing in popularity since the 1970s and 1980s, studies of archaeofaunal remains have been essential to investigations into past human behavior, particularly in prehistory (Binford 1963, 1978, 1981; See Broughton and Cannon 2010; and Gifford-Gonzalez 2018 for further examples). Archaeofaunal studies offer the invaluable opportunity for archaeologists to investigate patterns of subsistence in the past that simply studying non-organic artifacts cannot offer. Understanding patterns of human predation and resource use has been especially important in the long endeavor of constructing the archaeological record of the Northern Plains (Frison 1991; Kornfeld et al. 2010). In a geographic and ecological area where long-term settlement was rare, often we are left with assemblages that were the result of relatively temporally short periods of activity, offering archaeologists today limited data to work with. The study of kill-sites and butchery sites has held a long and ongoing tradition amongst archaeologists of the Northern Rockies and Plains, as often these sites are the only source of meaningful data available to us (see Kornfeld et al. 2010 for summary).

Of integral importance to understanding archaeofaunal assemblages is "identifying the causes of the morphological, quantitative, and spatial variability exhibited by faunal assemblages," (Kreutzer 1996) which is the goal of taphonomic research. Put more simply, the study of taphonomy is the attempt to understand how a faunal assemblage came to be as it is found today. Most archaeological taphonomic research is specifically aimed at distinguishing the effects of human action from those of non-cultural processes (e.g., Bunn 1981, 1986; Butler 1987, 1990; Fisher 1992; Grayson 1988; Kreutzer 1988, 1996; Livingston 1988, 1989; Morey and Klippel 1991; Shipman and Rose 1983; Todd and Frison 1986). Often the relationships

between these variables are complex. However, an abundance of "natural" processes acting on an assemblage will often preclude the use of said assemblage for study of human behavior. Non-cultural processes often have the effect of obscuring the characteristics of an assemblage as it was originally deposited. As such, sites with good integrity and preservation are generally considered to be of greater potential value to researchers than those that have been overly affected by post-depositional attrition or biological and geological disturbances (Kreutzer 1996; Gifford-Gonzalez 2018). However, as Kreutzer (1996) points out, often an assemblage that has been heavily affected by non-cultural processes can still provide a wealth of environmental information that contributed to site history, even if the contributing cultural variables have been obscured.

The intent of this project is to apply this reasoning and investigate a bone bed found in 2018 at 48PA551, known in the literature as the Dead Indian Creek site in northwestern Wyoming (Figure 1). I acknowledge that the conventional literary name of the site is problematic and insensitive, and the name is only used here to refer to its identification in the literature or to refer to the creek when necessary. From this point on the site will be referred to by its Smithsonian identification number, 48PA551. A new excavation was conducted at the site in 2018 via a field school led by Dr. Anna Marie Prentiss of the University of Montana. In the process, Dr. Prentiss and her students uncovered a bone bed, titled "Cut Bank," largely consisting of cervid (mule deer) and other mammalian remains containing over 5,700 individual specimens. This bone bed provides an opportunity to apply taphonomic research to a data set taken from a relatively well-known, even famous, site that has seen very little rigorous statistical analysis, particularly in regard to archaeofaunal remains.
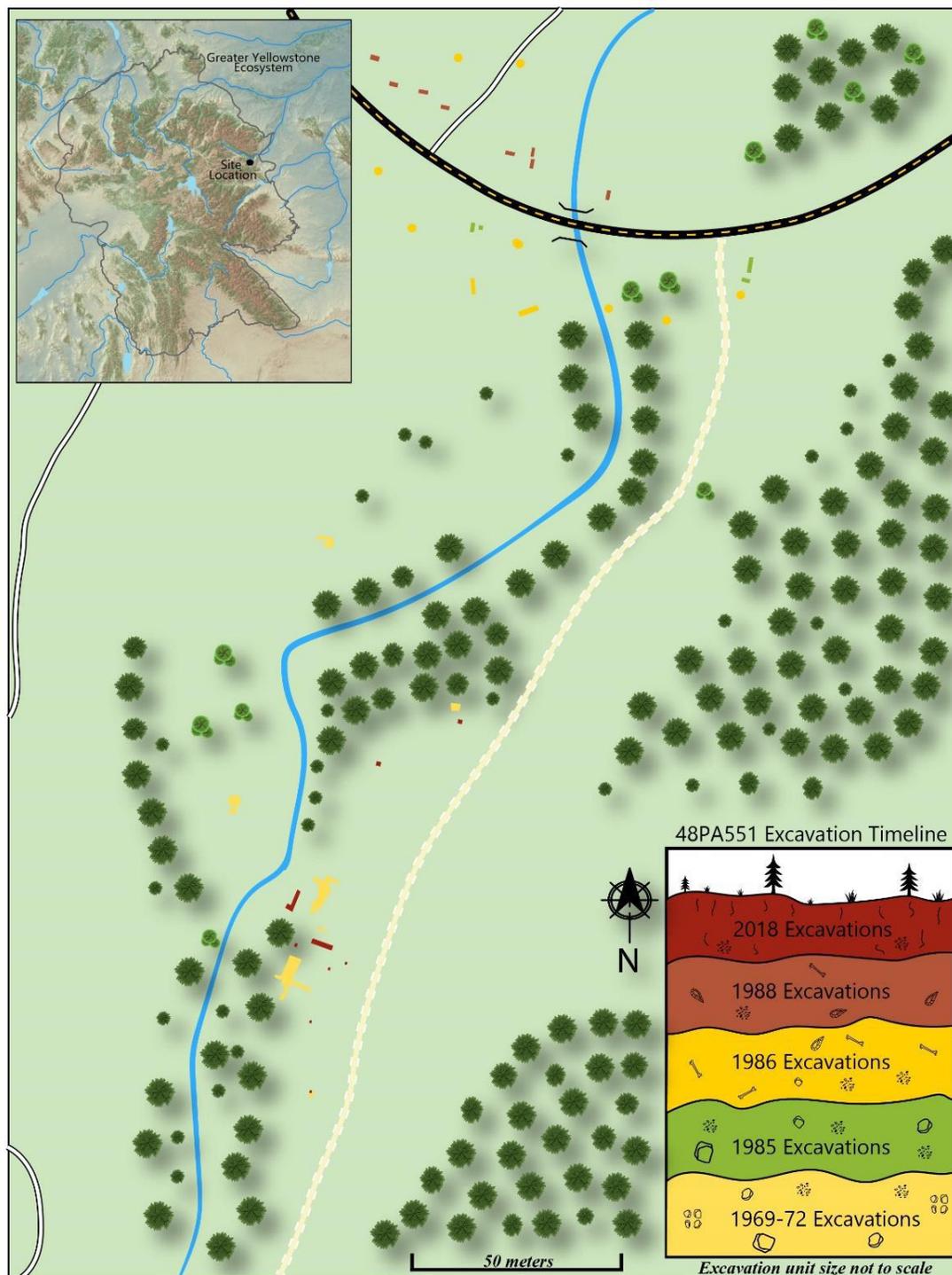
Figure 1- Region and Site map, from Prentiss (2019) final report. The Cut Bank block is located in the main site excavation areas, being the reverse "L-Shaped" block on the northwest corner of the area.

48PA551 Introduction and Investigative History

If one were to read any archaeological cultural resource management report concerned with any area in the Northern Rockies or Plains of the U.S., one would find mention of 48PA551. For decades now the site has been the poster-child for the McKean Complex (5000 to 3000 BP) of the Northern Plains, perhaps 2nd in importance only to the McKean site itself (Frison 1991; Kornfeld et al. 2010). The site has been cited as a quintessential example of a high-mountain basin McKean occupation, exhibiting all of the hallmark artifacts of the McKean complex. And yet, perhaps in mirror image to archaeologist's current understanding of the McKean complex as a whole, the site is poorly understood.

48PA551 was originally excavated in three separate sessions ranging from a few days to two weeks in the summers of 1969, 1971, and 1972, most of which was supervised by George C. Frison. The site was investigated after its initial discovery as the result of erosion by the stream, Dead Indian Creek, revealing bone and artifact deposits eroding out of the stream bank. After the initial discovery excavations were conducted in 5 separate "Areas" along the creek. Areas 1, 2, and 3 were investigated in the summer of 1969, which is when the famous "deer skull feature" was discovered in Area 1. It was determined that further data recovery was warranted after a few days were spent testing in Areas 1 and 2 in the summer of 1971. As such, in 1972 a team spent 2 weeks at the site in which the bulk of the excavations were conducted.

Through the course of the work done at the site it was apparent that 48PA551 represented a unique collection of lithic projectile points, totaling 565 complete and fragmentary points, reminiscent of the McKean site in northeastern Wyoming (Mulloy 1954). Every projectile point type (McKean, Duncan, Hanna) associated with the McKean complex, the hallmark of the Middle Plains Archaic period (5500-3000 BP), were found at the site in the initial investigations.

Simpson et al. (in Frison and Walker 1984) described 3 basic projectile point variations, lanceolate, stemmed, and side-notched with a myriad of "intergrades" between these 3 types. Simpson argued that these types represented a range of variation around a single norm, rather than three distinct styles. This variation was part of what motivated the later excavations at the site, as the investigators were curious as to why these apparently "distinct" projectile point types were found co-occurrent with no evidence of mixed components.

The source of the lion's share of the site's fame, one might argue, is likely the well-known "Deer Antler Feature", more vernacularly and facetiously referred to as the "Deer Skull Alter" by archaeologists of the region. This feature consisted of a basin shaped pit approximately 0.8 meters in diameter and 0.4 meters deep in which was found the skull cap and antlers of a mature mule deer. Five other skull caps and antlers, four intact and one broken with the two parts 1 meter apart, were found in the area adjacent to the pit resting at the occupation level rather than in a pit. Several large cobbles were covering the skull cap in the pit. Frison (1978) interpreted the feature as one of ceremonial or ritual purposes, which was still regarded as highly probable when the information from the site was finally published in 1984 (Frison and Walker). Nonetheless, the authors in 1984 did offer a "food cache" hypothesis as an alternative.

The other find of particular note was the discovery of the remains of an 8 or 9-year-old human child. The remains were found in association with the Middle Archaic component. The age estimate was based on the developmental level of "the 2nd molar tooth" which was said to be consistent with the stages of epiphyseal development and length of long bone diaphysis. It was assumed based on dating and artifact associations that the remains originated from the Middle Archaic component, and the author's argued that the "racial affinities" of the molar eruption were consistent with Native American ancestry.

Unfortunately, the data from these early excavations that are of most interest to this project are the least well defined. Counts of identifiable faunal remains were recorded as well as MNIs (Minimum Number of Individuals) for each species present. The data that was published in the report dealt only with those elements that were identifiable at both the element and species level, which excluded a large portion of the remains. The remains of around 50 mule deer (*Odocoileus hemionus*) were identifiable by analysis of mandibles, the largest number of any single element in the assemblage. An MNI of 16 *Ovis canadensis* (mountain sheep) was also recorded based on the number of distal ends of the left humeri. A variety of other fauna, including a number of local rodent species, canine, bird, bison, and pronghorn remains were also recorded, though in far lesser frequency than the mule deer and mountain sheep remains.

Dating done by Irving Friedman of the USGS supported the Middle Plains Archaic time period, rendering radiocarbon dates of 4430 ± 250 BP and 4180 ± 250 BP from Area 1 of the site. A third date of 3800 ± 110 BP was rendered later on. Friedman also conducted hydration dating with obsidian samples from the site which "compared favorably" with the radiocarbon dates, according to Frison and Walker (1984). Both the dates and presence of every diagnostic projectile point type associated with the McKean complex firmly placed the Area 1 component within the Middle Archaic period of the Northern Plains. This Middle Archaic occupation level ranged from as much as 90 cm. thick in some areas to as little as 31 cm thick in others.

In addition to the Middle Archaic levels, a stone ring with a Late Prehistoric side-notched point sat on the surface to the east of Area 1. Testing at Area 4 turned up more evidence for a single Late Prehistoric component. Further downstream, at Area 5, tests were made along the edge of another terrace which found a Late Plains Archaic component approximately 0.5 meters below the surface. (Frison and Walker 1984). All together the testing and excavation showed this

site to be incredibly complex and rich in data and cultural materials. With components dating

from the Middle Plains Archaic, on through the Late Archaic (3000-1500 BP) and Late

Prehistoric (1500-500 BP) periods, and a complex and expansive stratigraphy, the importance of

this site was recognized early on and was nominated for listing on the National Register of

Historic Places (Junge 1973) and thereby enrolled (Ingbar et al. 1986).

The unfortunate truth of the main publication (Frison and Walker 1984) is that it was not

published until 12 years after the initial research was done. As such the reports are a

conglomeration of writing and data based on the analyses done by mostly undergraduate and

graduate students at the University of Wyoming in the early 1970s, shortly after the excavations

were conducted. Under these circumstances what data were published are somewhat suspect,

perhaps unreliable. However, some basic trends in the older data can be used for comparison

against the results of this project.

Later Investigations

In 1985, additional excavation work was conducted by the Office of the Wyoming State

Archaeologist, associated to road and bridge work being done nearby. These excavations were

located approximately 100 meters downstream from the earlier WAS excavations. The

investigators recorded a complex sequence of depositional strata, some of which contained

evidence of human occupation. They noted a significant amount of cultural material was exposed

on the surface. They also noted that materials were present for at least 30m on the surface in

various places around the Forest Service campground, though as one might expect, this area was

badly disturbed by the former bridge and the campground construction (Ingbar et al. 1986).

Nineteen separate subsurface tests were made, only one of which was sterile. The other eighteen units, all contained chipped stone and various quantities of bone with the exception of Unit 9 which contained only bone. They found that most of the site's stratigraphy was undisturbed by surface activities, and geomorphic history of the stream was well-recorded in the terraces. The investigators also found that the site is stratified both vertically and horizontally with terraces of different ages lying adjacent to one another along the entire drainage. Ingbar et al (1986) state:

"The site is a patchwork of different components lying of different terraces and terrace remnants, resulting in horizontally stratified deposits." This unusual geomorphology makes teasing out details of site history difficult to say the least.

A single radiocarbon date of 5570 ± 130 BP was acquired from Test Unit C3 below levels in which both Late Archaic and Middle Archaic projectile points were found. This unit alone contains an archaeological history spanning 5000 years, with the possibility of further deposits below (Ingbar et al 1986). This date, if reliable, raised the possibility of Early Archaic (7500-5000 BP) occupations being present at the site, widening the potential occupational history of the site considerably.

Lastly, on file with the Forest Service (FS) is a management plan report filed by Anthony A. Swenson and Robert York (n.d.). The report contains a History of Investigations for the site, and a management plan. Though it is unclear if any work was actually carried out as a result.

University of Montana Investigations

In 2017 Dr. Anna Marie Prentiss of the University of Montana partnered with the Shoshone National Forest to create a multi-year management and data recovery plan for 48PA551. The plan was deemed necessary due to the site's importance and the effects of animal burrowing, illicit artifact collecting, and severe erosion actively damaging the site (Prentiss 2019). The participants created a multi-year arrangement to engage in long-term research at the site, in order to recover what information the site has to offer before it is irrevocably lost. The 2018 field season included use of ground-penetrating radar (GPR), scattered test excavations, some limited data recovery in the areas most threatened, and stream bank stabilization to reduce hydraulic erosion impacts.

The purpose of this field season was twofold. First was to use GPR to identify geological anomalies beneath the surface of the site that could potentially represent past human occupations, features, etc. The second, once anomalies were identified, was to conduct limited test excavations in order to determine if the anomalies were in fact archaeological in nature, and thereby to try and use the collected data to answer research questions about the site history and the subsistence strategies and social structures that might be represented there. Of particular interest, was the question of whether 48PA551, and other associated McKean Complex sites, represent a newly innovated socio-cultural strategy "characterized by winter-sedentism and extensive use of logistical organization for acquiring particularly abundant local and more distant food resources." According to Prentiss (2019) such a strategy would potentially be marked by increased emphasis on food storage, which may have given rise to concepts of private goods and household resource-based inequality.

The reasoning behind asking such questions is that if the testing were to support such conclusions, then 48PA551 may help link the socio-economic systems of the McKean Complex to those of the later dating Pelican Lake Complex (3000-1500 BP). This could provide evidence for the early developments of strategies that played a "critical role in the evolution of later complex bison hunting cultures," (Prentiss 2019).

The 2018 investigations turned up interesting results. One of the GPR anomalies resulted in the discovery of the remains of another housepit feature described as Strata III and Ia/II in the report. These strata were marked by very dark soil and dense deposits of cultural material, both artifacts and faunal remains. Four other features interpreted as possible hearths and storage pits were also excavated.

One of the two larger excavation blocks was labeled as the "Cut Bank." This area was excavated because bones were observed eroding out of the bank along Dead Indian Creek and it was decided that the area at most risk of erosion should be excavated for data recovery, and structural stabilization of the bank to occur post-excavation. This excavation block turned up a thick bone bed (ranging from 5 to 65 cm in depth below surface) and the remains of another possible housepit feature. This bone bed contained over 5700 individual bone specimens, almost all mammalian in origin. The 10 quadrants excavated at the Cut Bank account for more than half of the faunal remains found during the excavation, while representing less than a third of the total area excavated.

The faunal remains recovered during UM's excavation present an opportunity to study subsistence patterns at 48PA551, and increase our understanding of Middle Archaic cultural patterns as a whole. Specifically, this project aims to focus on the remains recovered in the Cut Bank area, and attempt to reconstruct a portion of the site history. To do so, hypotheses and test

expectations have been developed that are pointed at teasing out the formation processes responsible for the deposition and subsequent alterations to the bed. Understanding both human and non-human processes at the site is paramount if the data of these excavations are ever to be used in future research.

The current chapter has introduced the purpose of this project, the basic theoretical approach, as well as given a background summary of archaeological investigations at the site. Chapter 2 will introduce in greater detail the research question that is the centerpiece for this project. Hypotheses and test expectations are formulated in order to guide research into answering this question. Also in Chapter 2, the methods and materials used are presented. Here is given a summary of the data, as well as the statistical methods used for each test. This chapter also goes into further detail on the literature establishment of taphonomic theory, and the thinking that produced the methods used in this project. Following this, Chapter 3 presents the results of each test conducted. Numeric results of each test are given, and in some cases charts are provided to illustrate the results. Chapter 4 offers discussion of the results presented in Chapter 3. Here the results are interpreted and what the implications of this project are for 48PA551. Finally, Chapter 5 provides a brief summary and conclusion of this project, as well as implications this project has for the McKean Complex on a grander scale, and recommendations for future research.

Chapter 2 – Research Goals and Methods

Research Question and Hypotheses

48PA551 provides a unique opportunity to further our understanding of Middle Holocene subsistence strategies and to test hypotheses concerned with the development of socio-economic systems that persisted into the time of Euro-American contact on the Northern Plains and Rockies. Specifically, for the purposes of this project, the "Cut Bank" bone bed provides an opportunity to use archaeofaunal data to understand depositional and post-depositional processes that created the assemblage excavated in 2018. To do so, this project is largely concerned with answering a single question:

- Were humans the primary taphonomic agents in the formation of the Cut Bank bone bed at 48PA551, and if so, what behaviors contributed to its formation?

To answer this, we must attempt to identify other taphonomic agents and processes that could have affected the assemblage. Using a similar research framework as was used at the Mill Iron Site by Kreutzer (1996) this research investigates potential biasing influences of human and non-human processes. The variables that are statistically tested are Carcass Utility and Density Mediated Attrition, with discussion of hydraulic action, carnivore/rodent actions, weathering, and burning and how they have affected the assemblage.

To answer these questions and direct the research, I tested the following hypotheses with the faunal data found in the Cut Bank excavation block.

Hypothesis 1: The Cut Bank bone bed of 48PA551 represents the remains of a primary butchering/kill area. Animals were killed on location and primary field processing

occurred. This may include the disarticulation of high-utility appendicular elements for transport to an unknown secondary location for further processing.

Hypothesis 2: The Cut Bank area of 48PA551 is the remains of a secondary butchering area where high-value parts were brought to for further processing. Once the parts had been processed, meat packages and high-value bones may have been taken elsewhere, perhaps even within the same vicinity, and anything not of value was disposed of and left behind.

Hypothesis 3: The Cut Bank bone bed of 48PA551 is a disposal site where fully processed animal parts were discarded. Once the animal parts had been fully processed, possibly including breaking and boiling for marrow and grease removal, they were dumped in a fairly consistent and concentrated area, which formed the bone bed excavated in 2017.

Null Hypothesis: Non-human taphonomic processes and variables, such as carnivore activity, hydraulic action, density mediated attrition through weathering, and/or burning from natural fires, have biased the data to the point that it is statistically unusable for research and investigation into human behavior at this site.

Test Expectations

The following are the expected resulting patterns from testing of the hypotheses laid out above (see also Table 1). These tests and expectations are designed with the intention of determining whether human action led to the deposition of the Cut Bank assemblage, and if so what behaviors created it, and what non-human agents have impacted it since.

H1 (Kill Site/Primary Butchering Area)

- Food Utility correlation tests result in a significant rank-ordinal negative correlation between element frequencies and element utility values (Binford 1978; Kreutzer 1996; Metcalf and Jones 1988), as low utility parts would be left behind after meat packages and high-utility elements are disarticulated and transported elsewhere.

- Representation of largely axial elements with minimal to no representation of appendicular parts. Possible exception would be foot bones, if primary processing was intensive enough to include removal of relatively low-utility carpals, tarsals, and phalanges.

H2 (Secondary Butchering Area)

- Utility correlation would result in a 'gourmet' or 'bulk' utility curve (Binford 1978; Kreutzer 1996) with a significant positive rank-ordinal correlation between element frequencies and element utility value.

- Identifiable elements should largely represent high-utility appendicular elements like femurs and humeri. Axial elements should bear minimal to no representation in the assemblage, as any important meat packages would likely have been removed and the bones left behind (for example, removing backstraps from vertebrae and ribs).

- Possible exception would be carpals, tarsals, and phalanges.

H3 (Disposal Area)

- Utility correlation may closely resemble that of a secondary butchering site, with a positive correlation between element utility and frequency. However, intensive processing can also lead to a negative correlation, as high-utility elements also contain

marrow and grease and may be destroyed or heavily fragmented in the extraction process (Binford 1978; Kreutzer 1996)

- May be signs of further processing, or "culinary processing" (Gifford-Gonzalez 2018), such as lower frequencies of complete bones, as bones may be broken for marrow processing once all meat has been removed.

- Possible deposition of large numbers of very small fragments if grease processing was taking place at the site.

Null (Natural Taphonomic Biases)

- The best indicator would be a significant and strong positive correlation between element frequency and Volume Density (Lyman 1984). Elements of relatively higher density will be more represented in the assemblage due to attrition.

- Frequent signs of carnivore and rodent action in the assemblage may indicated that scavengers impacted the assemblage between deposition and burial. Scavengers tend to differentially target elements based on calorie content and ease of fracture, which would lead to differential survivorship in the assemblage (Gifford-Gonzalez 2018).

Table 1- Hypotheses and Test Expectations

Hypotheses	Test Expectations	Methods
Hypothesis 1: Kill Site/Primary Butchering	The results of the Utility correlations should show a reverse utility curve with a significant negative rank-ordinal correlation coefficient between frequencies and utility values	Correlating Metcalfe and Jones (1988) FUI values with part frequencies using Spearman's rho could potentially give an indication. Negative correlation would suggest a primary butchering site, a positive correlation a secondary butchering or disposal site. Signs of more intensive processing, such as intentional fracturing for marrow and grease extraction may result in a neutral or near neutral result, which may indicate a disposal site over a secondary butchering site.
Hypothesis 2: Secondary Butchering Site	The utility correlation would show a 'gourmet' or 'bulk' utility curve with a significant positive rank-ordinal correlation between the two variables	
Hypothesis 3: Disposal Site	A disposal site would likely resemble a secondary butchering site. A camp-side dump would contain an accumulation of fully processed high-utility parts that have been stripped of nutrients and disposed.	
Null Hypothesis: Non-Human Bias	Significant correlations between relative density and frequencies may suggest that attrition has significantly biased the data, which is no longer representative of the assemblage that was originally deposited. Differential proportions of parts targeted by carnivores and rodents may suggest scavenging has biased the data in favor of those parts unsuitable to carnivores, such as those with few nutrients or are particularly dense.	Using a Spearman's rho coefficient to correlate frequencies and Lyman's (1982) part density measurements should indicate whether density mediated attrition is a factor. Percentages of specimens impacted by carnivores relative to other element classes should indicate whether element classes are being differentially targeted by carnivores.

Methods and Materials

The primary variables of the Cut Bank assemblage that need to be understood are element frequency with relation to relative element density and food utility. It has been well understood that density mediated attrition of faunal elements can have significant impacts on archaeological and paleontological assemblages (Behrensmeyer, 1975; Binford and Bertram, 1977; Boaz and Behrensmeyer, 1976; Brain, 1967, 1969, 1976, 1981; Guthrie, 1967; Klein, 1989; Lyman, 1982, 1984, 1985; Shipman, 1977, 1981; Voorhies 1969). Degradation of faunal remains over time can lead to skewing in the assemblage in favor of those elements that have relatively higher density, which can preclude the use of faunal data for further investigation into human behavior (Kreutzer, 1996).

Utility curves can suggest to the analyst whether the assemblage represents a kill/primary butchering site, secondary butchering site, or disposal site, as well as other human decision-making patterns (Binford 1978; Kreutzer 1996). However, Lyman (1985, 1991, 1992) showed that skeletal-part densities are significantly and negatively correlated with Binford's (1978) MGUI (food utility) values. In most cases those elements that are of highest utility (ex. femurs, humeri) and are preferentially targeted for more intensive processing, are also generally less dense relative to lower utility parts (ex. skulls, carpals and tarsals). This means that the correlation between utility and element frequencies doesn't necessarily indicate human predation, just as correlation between density and element survival doesn't always mean that attrition produced the pattern. This leads to one of the more significant and consistent challenges to plague the efforts of the taphonomist, the problem of equifinality (Gifford-Gonzalez 2018; Lyman 1994). Understanding that both human and non-human action can lead to similar patterns of element representation means that the analyst must seek to understand the relationship between part-utility and density-mediated attrition within the context of the variation of the assemblage in question (Kreutzer 1996).

To address these concerns, I analyzed cervid (mule deer more specifically) remains, as these remains made up all of the identifiable elements in the cut bank area. Minimum Number of Elements (MNEs) counts of for each identifiable cervid part were derived following the conventions of Grayson (1988) and Lyman (1991, 1992): a particular portion or landmark is selected to represent each anatomical unit and only element portions that include that landmark are counted. This prevents multiple fragments of the same bone being counted separately. In the case of the density analysis, Lyman's (1984) "scan sites", taken from deer bones using a single-beam photon densitometer, were used as base frequency counts for the analysis. Following

Kreutzer's (1996) example, if any part of the scan site was identifiable on the specimen, it was included in the frequency count, (though it should be noted that the author was not part of the cataloging process for this assemblage and has to rely on the descriptions provided by the recorders of the data set). For the Food Utility analysis, Metcalfe and Jones' (1988) Food Utility Index for caribou elements was used. Not every individual element is assigned an FUI value in their research, rather some are grouped together and averaged, for instance "thoracic vertebrae" are given a single average value, rather than an individual value for all 13 elements. Any specimens from the Cut Bank that were identified as an element class assigned an FUI value were used for the MNE counts.

I understand that element utility values for caribou may differ somewhat from that of mule deer. Unfortunately, research has not turned up a more applicable or user-friendly utility indices thus far. Caribou and mule deer are a closely related species with very similar body and skeletal structure. Additionally, Metcalfe and Jones' FUI index is a re-scaled version based on the actual utility values. All parts were scaled according to the highest utility part (femur being 1.0) and assigned their scaled value in relation (see Table 3). It seems not unreasonable to assume that utility values in relation to other parts would fall into a similar range in mule deer as the averages assigned by Metcalfe and Jones from caribou, or near enough to not overly impact the outcome.

In both analyses, the respective counts were then converted into Minimum Animal Units (MAU) by dividing the MNE by the number of times that element occurs in a complete skeleton. This standardizes the element count which would otherwise be higher for those elements that occur more than twice in the skeleton (ex. ribs). The MAUs were further standardized by setting the highest MAU to 100% and scaling the other values accordingly (expresses as %MAU).

Again, following Kreutzer's (1996) example, Spearman' rho correlation analysis was used via

the SPSS (25) program to test for correlation between the respective variables. For the density

analysis, the MNE for each scan site was tested for correlation with their respective average

volume density. Lyman's (1984) research showed that "volume density", rather than "true

density" was a more strongly correlated with survivability. Spearman's rho will express the

proportion of the variability in element representation that can be accounted for by bone density

(Gifford-Gonzalez 2018). As a further test, volume density was correlated with the %MAU

values derived from the scan site frequencies, to provide a possibly more standardized outcome.

For the food utility analyses, Spearman's rho was used again to test for correlation between

Metcalfe and Jones (1988) part utility values and %MAU of the Cut Bank assemblage (see

Tables 2 and 3 below).

Table 2-Scan Site Volume Density and element frequency.

Element Class	Scan Site	Average Volume Density	MNE	MAU	%MAU
Acetabelum (Innominate)	AC1	0.27	0	0	0
Astragalus	AS1	0.47	1	0.5	0.2
	AS2	0.59	1	0.5	0.2
	AS3	0.61	1	0.5	0.2
Atlas	AT1	0.13	0	0	0
	AT2	0.15	0	0	0
	AT3	0.26	0	0	0
Axis	AX1	0.16	0	0	0
	AX2	0.1	0	0	0
	AX3	0.16	0	0	0
Calcaneus	CA1	0.41	0	0	0
	CA2	0.64	0	0	0
	CA3	0.57	0	0	0
	CA4	0.33	0	0	0
	CE1	0.19	1	0.14	0.06

Cervical Vertebrae	CE2	0.15	0	0	0
Metatarsal	MR1	0.55	1	0.5	0.2
	MR2	0.65	1	0.5	0.2
	MR3	0.74	5	2.5	1
	MR4	0.57	2	1	0.4
	MR5	0.46	2	1	0.4
	MR6	0.5	0	0	0
Naviculo-cuboid	NC1	0.39	0	0	0
	NC2	0.33	0	0	0
	NC3	0.62	0	0	0
Patella	P1	0.31	0	0	0
Pubis (Innominate	PU1	0.46	0	0	0
	PU2	0.24	0	0	0
1st Phalanx	P11	0.36	2	0.5	0.2
	P12	0.42	2	0.5	0.2
	P13	0.57	5	1.25	0.5
2nd Phalanx	P21	0.25	3	0.75	0.3
	P22	0.35	3	0.75	0.3
3rd Phalanx	P31	0.25	4	1	0.4
Mandible	DN1	0.55	0	0	0
	DN2	0.57	0	0	0
	DN3	0.55	0	0	0
	DN4	0.57	0	0	0
	DN5	0.36	0	0	0
	DN6	0.31	2	1	0.4
	DN7	0.43	2	1	0.4
	DN8	0.61	2	1	0.4
Femur	FE1	0.41	1	0.5	0.2
	FE2	0.36	0	0	0
	FE3	0.33	0	0	0
	FE4	0.57	2	1	0.4
	FE5	0.37	0	0	0
	FE6	0.28	1	0.5	0.2
Radius	RA1	0.42	4	2	0.8
	RA2	0.62	4	2	0.8
	RA3	0.68	1	0.5	0.2
	RA4	0.38	3	1.5	0.6
	Ra5	0.43	1	0.5	0.2
Rib	RI1	026	3	11	0.04
	RI2	0.25	0	0	0
	RI3	0.4	0	0	0
	RI4	0.24	14	0.53	0.21

	RI5	0.14	19	0.73	0.29
Sacrum	SC1	0.19	0	0	0
	SC2	0.16	0	0	0
Humerus	HU1	0.24	0	0	0
	HU2	0.25	2	1	0.4
	HU3	0.53	0	0	0
	HU4	0.64	2	1	0.4
	HU5	0.39	0	0	0
Illium	IL1	0.2	0	0	0
(Innominate)	IL2	0.49	0	0	0
Ischium	IS1	0.41	1	0.5	0.2
(Innominate)	IS2	0.16	1	0.5	0.2
Lumbar	LU1	0.29	6	1	0.4
Vertebrae	LU2	0.3	6	1	0.4
	LU3	0.29	0	0	0
Metacarpal	MC1	0.56	2	1	0.4
	MC2	0.69	2	1	0.4
	MC3	0.72	0	0	0
	MC4	0.58	1	0.5	0.2
	MC5	0.49	1	0.5	0.2
	MC6	0.51	2	1	0.4
Scapula	SP1	0.36	0	0	0
	SP2	0.49	0	0	0
	SP3	0.23	3	1.5	0.6
	SP4	0.34	0	0	0
	SP5	0.28	0	0	0
Sternal Element	ST1	0.22	1	1	0.4
Thoracic	TH1	0.24	1	0.08	0.03
Vertebrae	TH2	0.27	1	0.08	0.03
Tibia	TI1	0.3	1	0.5	0.2
	TI2	0.32	1	0.5	0.2
	TI3	0.74	1	0.5	0.2
	TI4	0.51	2	1	0.4
	TI5	0.5	2	1	0.4
Ulna	UL1	0.3	0	0	0
	UL2	0.45	1	0.5	0.2
	UL3	0.44	0	0	0

Table 3-Part Utility Values (Metcalfe and Jones 1988) and corresponding frequencies.

Part	SFUI Value	MNE	MAU	%MAU
Antler	1	0	0	0
Skull	18.20	2	2	1
Mandible	31.10	2	2	1
Atlas	10.20	0	0	0
Axis	10.2	0	0	0
Cervical Vertebra	37.1	1	0.14	0.14
Thoracic Vertebra	47.3	1	0.08	0.4
Lumbar Vertebra	33.2	5	0.83	0.42
Pelvis	49.3	1	1	0.5
Rib	51.6	3	0.12	0.06
Sternum	66.60	1	1	0.5
Scapula	44.7	1	0.5	0.25
Proximal Humerus	44.7	1	0.5	0.25
Distal Humerus	36.8	2	1	0.5
Proximal Radio-cubitus	25.8	4	2	1
Distal Radio-cubitus	20.2	2	1	0.5
Carpals	12.7	6	1	0.5
Proximal Metacarpal	9	3	1.5	0.75
Distal Metacarpal	7.1	2	1	0.5
Proximal Femur	100	1.0	0.5	0.25
Distal Femur	100	1.0	0.5	0.25
Proximal Tibia	62.8	1.0	0.5	0.25
Distal Tibia	44.1	3	1.5	0.75
Tarsals	27.7	0	0	0
Astragalus	27.7	1	0.5	0.25
Calcaneous	27.7	0	0	0
Proximal Metatarsal	19.5	2	1	0.5
Distal Metatarsal	15.4	0	0	0
1st Phalanx	8.6	5	1.25	0.63
2nd Phalanx	8.6	3	0.75	0.38
3rd Phalanx	8.6	4	1	0.5

It has been established that hydraulic processes are capable of producing sorted patterns of accumulation that can mimic those of a butchery or kill site (Behrensmeyer 1975, 1978; Boaz and Behrensmyer 1976; Hanson 1980; Kreutzer 1996; Todd 1987; Todd and Frisson 1986;

Voorhies, 1969). The possibility of hydraulic processes influencing the assemblage is particularly relevant at this site, as the Cut Bank lies adjacent to an active stream that is eroding the assemblage and the surrounding soil (Prentiss 2019). It is beyond doubt that the archaeological remains of 48PA551 have been impacted by hydraulic processes, after all the site was initially discovered when bones and artifacts were observed eroding from the streambank in the 1960s (Frison and Walker 1984).

Unfortunately, because of the limited spatial distribution that the sample for this project is drawn from ten (50x50 cm) quadrants, investigating hydraulic processes with statistical tests is not possible. However, the stratigraphy suggests a pretty stable podzolic soil forming on a higher energy stream bed sediment containing gravel bars. This suggests that the stream had moved west before the forest soil began to accumulate and it was at or just after that point that human groups began to occupy the site. While the stream erosion of the Cut Bank has impacted the data, the stream in unlikely to have played a major role in the structure of the bone bed (Prentiss 2019; 2021, personal communication).

As for carnivore and human modification, the analysis is fairly simple. Looking at the distribution of carnivore modifications to specimens of the assemblage, we can attempt to determine if element classes were differentially targeted by such agents. This may give some indication as to what elements could have suffered higher levels of attrition post-deposition. This was done by simply looking at the percentage of the assemblage that has visible non-human carnivore modifications, and if those modifications target element classes differentially to an observable degree. Carnivore modification was found to be so rare, with only 25 specimens showing signs, that it was clear no statistical test was necessary. However, 93 specimens showed evidence of human modification, either through percussion marks or cut marks. Of these, 43

were identified as originating from axial or appendicular portions of the skeleton. A chi-squared test was run on a simple 2-variable contingency table testing independence between axial vs appendicular specimens and presence/absence of human modification (Table 4). Such a test might suggest whether different portions of the skeleton were differentially targeted by inhabitants of the site for butchery.

Table 4-Human Modification vs Skeletal Portion Contingency Table.

Labels	Human Modification	No Human Modification	Totals
Axial	6	400	406
Appendicular	37	493	530
Totals	43	893	936

I also examined burning with the purpose of determining whether burned specimens could be the result of a natural fire event or of human action. Kreutzer (1996) was able to use chi-squared analysis to test for randomness of burning across element classes. She was then able to compare this result to spatial distributions of the burned specimens across the site to determine whether the burning was the result of cooking, or of natural wildfires burning elements exposed on the surface. While in this case the sample size and lack of data resolution preclude such a detailed analysis, this project made a similar attempt. Rather than looking at spatial distributions, a simple two-variable contingency table was created with frequencies of burned and unburned axial and appendicular specimens. In order to boost the sample size, fragments that were identified as rib fragments and skull fragments were included for the axial data, and the same was done with long bone fragments for the appendicular data. Using the contingency table below (Table 5), expected values were calculated and a Chi-squared Test of Independence was run using Microsoft Excel.

Table 5. Burned Specimens contingency table.

Row Labels	Burned	Not Burned	Totals
Axial	13	393	**406**
Appendicular	80	450	**530**
Totals	**93**	**843**	**936**

Another approach that has been used by researchers investigating heat treatments is color analysis. Bone will change colors in a fairly predictable pattern when subjected to differing levels of heat (Kreutzer 1996). The challenge of any color-based analysis with this assemblage is the problem of possible soil chemistry influence. It was mentioned by O'Brien (2019) in the UM field report, that nearly all of the specimens exhibited brown/blackish staining. This had a particular impact on the burning data, as only 10 specimens that were categorized as exhibiting heat treatment were classified as "brown" in color. All other signs of heat treatment were identifiable by more advanced color changes, while brown/tan color changes were obscured by soil staining. This makes any attempt at color analysis challenging and highly susceptible to taphonomic bias.

Chapter 3 – Test Results

This chapter will present the numerical results of each test as well as offer descriptive statistics that will be relevant to the test results later on in Chapter 4. Preliminary interpretations are offered, which will be further fleshed out in Chapter 4.

For the Volume Density correlation test two separate Spearman's rho coefficient tests were conducted. Following Kreutzer (1996), one correlation test was run between Lyman's (1984) average volume density values, and the MNE count for each of Lyman's scan sites. The result was a correlation coefficient of 0.139 with a 2-tailed significance value of 0.179. This value is weak and statistically insignificant, showing that less than 14% of the variation in the assemblage can be explained by element density, with a relatively high chance that randomness has created the pattern. Figure 2 illustrates the relationship between the variables with a simple scatterplot with a linear regression score.
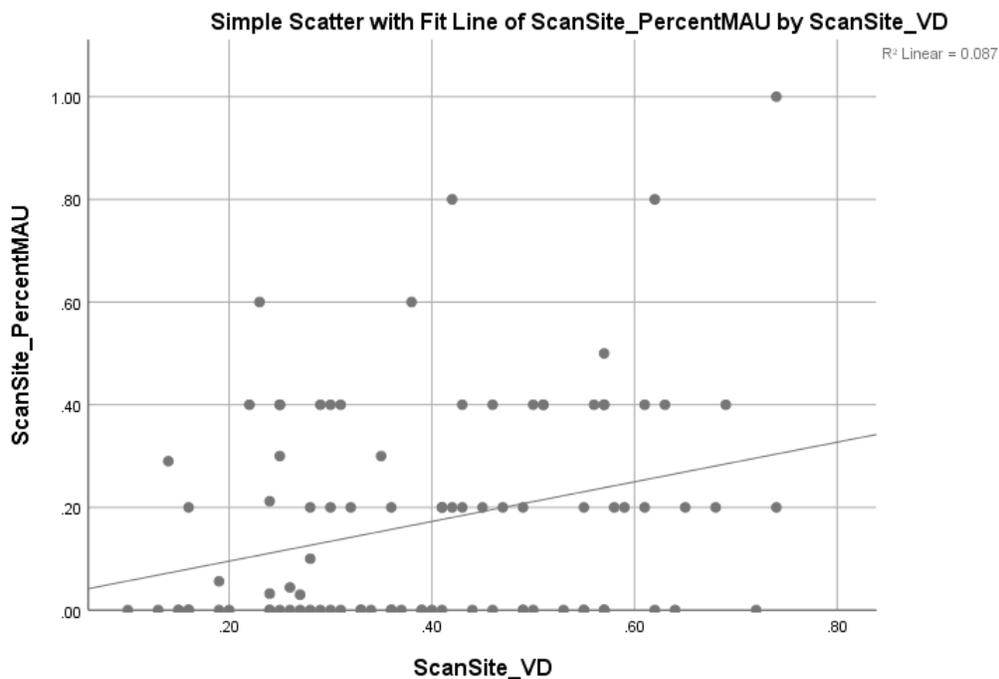

Figure 2 - Volume Density/%MAU Scatterplot.

Interestingly, when a further correlation test was done between the Scan Site Volume

Density values and the %MAU for the corresponding sites, a somewhat stronger and more

significant result came out. With a correlation coefficient of 0.237 and a significance value of

0.021 this result seems somewhat stronger and more stable than the previous. It seems that

standardizing the test by accounting for those elements that occur more frequently in the body

produced a stronger signal, with less of a chance of being produced by randomness. However, a

coefficient of 0.237 is still a fairly weak signal, indicating that with the given sample only 23.7%

of the variation in the assemblage can be accounted for by density mediated attrition.

The food utility correlation test had similarly weak results. Running Spearman's rho

between Metcalfe and Jones' (1988) part utility values and element frequencies resulted in a

correlation coefficient of -0.086 and a significance value of 0.647. While a negative utility signal

might be informative, as part utility and relative density are negatively correlated (Lyman 1985,

1991, 1992), such a weak signal with a high chance of being the result of random variation is less

useful. For consistency's sake, another correlation coefficient was created using the SFUI values

and the unstandardized MNE frequencies. Interestingly, the result was a somewhat stronger

negative correlation at -0.184, with a 2-tailed significance value of 0.323. While still not a

statistically significant relationship, it is interesting that the signal was stronger when

unstandardized, the opposite of what happened when the same was done with the density

coefficients. Figure 3 illustrates the relationship between the variables below, with the linear

regression showing a similarly weak negative signal. These results would indicate that while

density, and perhaps utility, are playing minor roles in the formation processes, neither are significant predictors for variation in the Cut Bank assemblage.
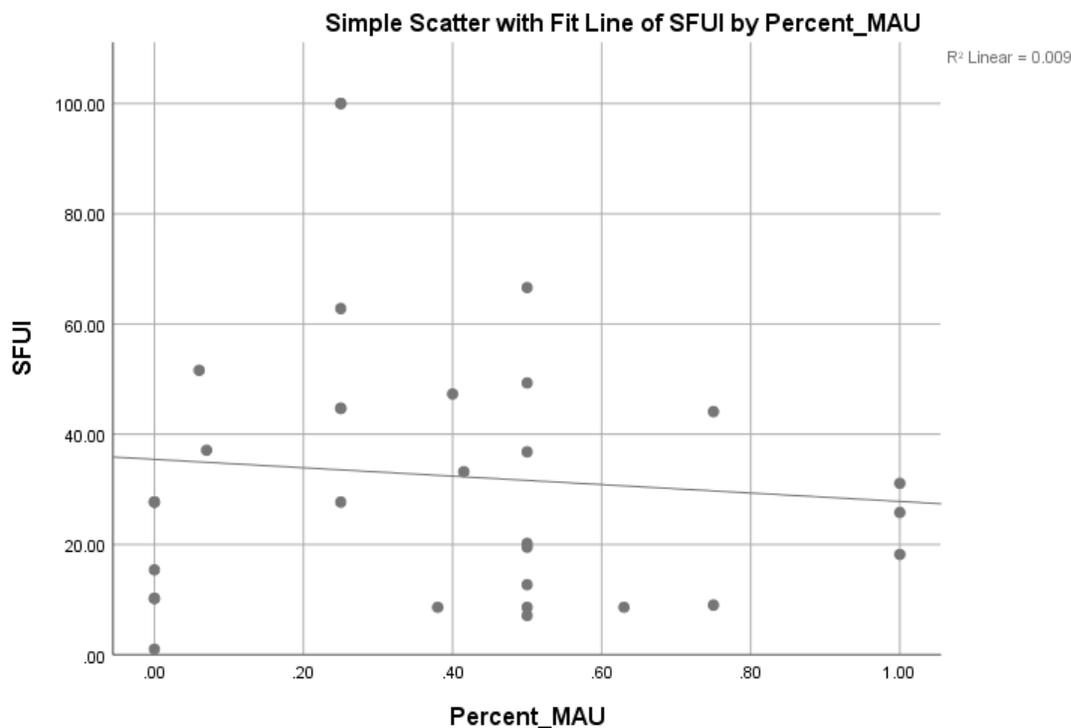

Figure 3 - SFUI/%MAU scatterplot.

Burning and Human Modification

The result of the chi-squared test for burned specimens across axial and appendicular elements was $X^2=1.66$. With one degree of freedom, this score earns a $0.1 < p < 0.25$ value. This indicates that burning patterns across the assemblage are independent of the axial vs. appendicular variable. As such formation processes that created the pattern did not differ significantly between axial and appendicular skeletal parts.

A similar test was conducted on human-modification data on the assemblage. 93 specimens showed evidence of human modifications, mostly in the form of shallow cut marks, as

well as several specimens that were broken in half. Of those 43 were able to be identified as originating from axial or appendicular skeletal portions. The chi-squared test resulted in $X^2 = 6.728$, or $p < 0.01$. This is a significant result that suggests that axial and appendicular parts were not subjected to the same behavior by human inhabitants of the site. This is in interesting contrast to the burning data, which may suggest that burning modification may not be a good predictor of human action on the data and that other variables may be in play.

Descriptive Statistics

Other statistics were acquired and looked at in the assemblage in order to give context to and support any conclusions that might be gathered from the above statistical tests. It should be noted that all of these statistics include the entire assemblage, not just those elements that could be identified as cervid remains. However, all are mammalian and are included to get a better understanding of the assemblage as a whole, not solely that portion constituted by cervids.

Appendicular vs Axial skeletal representation requires some discussion. It is generally true that appendicular parts are of higher utility in cervids than are axial parts, excluding the lowest appendicular elements (Metcalfe and Jones 1988). Using the previously mentioned counting conventions, the sum MNE for axial elements totaled 19, while the sum appendicular MNE totaled 38. Not an incredible difference considering the size of the assemblage. This of course excludes many hundreds of fragments, mostly from crania, ribs, and long bones, that can be identified to skeletal origin but not element class. If simple frequency counts are tallied, as they are in Tables 4 and 5 then total axial fragments amount to 406, or 7.1% of the total assemblage. Appendicular fragments total 530, or 9.2% of the total assemblage. Again, not an apparently large difference of representation. However, Outram (1998, 2001) has noted that there

is an argument to be made that when dealing with highly fragmentary bone assemblages, bone weight may be a more accurate measure than simple frequency counts or MNE counts. Such would seem to be the case in this instance. Total weight of all fragments originating from axial portions is 256.31 grams, while that of appendicular fragments is 953.8 grams or roughly 3.7 times the weight of axial bone. This difference seems to be more significant and illustrative than simple frequencies or MNEs for skeletal representation.

In discussing appendicular parts, it is important to note that there is not one complete long bone in the entire assemblage, and 5 long bones (tibias and radii) that were broken in half lengthwise either medio-laterally or antero-posteriorly (lengthwise). It should also be noted that all of the identifiable elements were identified as cervid remains. Additionally, there are 434 long bone fragments that could not be identified at the element class level. Five of these long bone fragments included portions of articular ends and/or epiphyses, the remainder were all diaphysis fragments. The breakage of long bones is highly consistent with ethnographic accounts of marrow extraction, an important and most reliable source of animal fat (Binford 1978; Gifford-Gonzalez 2018; Outram 1998). The fact that out of 40 elements that could be identified to a long bone element class, not one was complete would suggest that marrow extraction was taking place at the site, and the remains being disposed of in the Cut Bank.

Interestingly, there is one complete phalange, and 5 that are broken in half medially (lengthwise). This seems to me to be clearly intentional as I cannot imagine a natural process that would cleanly break a phalange, a very small and slender bone that is proximally/distally weak, in half in such a manner. This may suggest that even phalanges were undergoing some form of processing at the site. This is not unheard of in the ethnographic record; as Outram (1998, 2001)

cites several examples describing groups like the Nunamuit would sometimes preferentially target foot bones for grease processing because of flavor preferences.

Another notable characteristic of the assemblage is the incredible levels of fragmentation. Out of 5,723 total individual specimens, 5,652 of them are 5cm or less in maximum dimension. Church and Lyman's (2003) summary of ethnographic records pertaining to "comminuting" bones for grease extraction indicates that ethnographic peoples would smash bone into "small" pieces, which could range from 1 cm to 7-8cm depending on the account (Chomko and Gilbert 1991; Leechman 1951; Smith and McNees 2000; Vehik 1977; Yellen 1977). The fact that 98.8% of the Cut Bank assemblage measure 5cm or less in maximum diameter demonstrates an extraordinary level of fragmentation. While non-human agents and processes have certainly had an impact on the data, the level of fragmentation seems a clear indication of intensive processing of bone for grease extraction. It has long been considered "conventional" archaeological wisdom that high levels of fragmentation in faunal remains is indicative of such behaviors (see Church and Lyman 2003 for summary and examples; Gifford-Gonzalez 2018), and 48PA551 seems to be no exception.

As for the impact of carnivores on the assemblage, a total of 25 bone specimens showed signs of carnivore modification. Of these, five were rib fragments, six were unidentifiable long bone shaft fragments, one phalanx fragment, and one cranium fragment. Observed data suggests that carnivores will preferentially target articular ends of long bones in order to access marrow cavities and grease within the articular ends themselves (see Gifford-Gonzalez 2018 for examples). As none of the specimens that showed carnivore modification consisted of articular ends, no useful comparative analyses could be done. Further signs of carnivore modification have likely been obscured by the intense fragmentation in the assemblage.

The results listed above give us an interesting picture of the Cut Bank bone bed assemblage. With neither utility nor bone density seeming to play a predictive role in the formation of this assemblage, and the unique levels of fragmentation and differential treatment of axial and appendicular parts by humans there is much to be understood and interpreted. These findings are discussed and interpreted in the following chapter.

Chapter 4 - Discussion

The above analyses were conducted with the purpose of suggesting a possible taphonomic site history for the Cut Bank bone bed assemblage at 48PA551. The goal of taphonomic research in archaeology is "to explain in the form of predictive models, the interface that existed between prehistoric human populations and the faunal section of the biotic community" (Smith 1976: 284). Lyman (1994) paraphrasing Gifford had another way of stating it, "Gifford(-Gonzalez) (1981) distinguishes two basic goals of taphonomic research: (1) 'stripping away' the taphonomic overprint from the fossil record to obtain accurate resolution of the prehistoric biotic community, and (2) determining the nature of the taphonomic overprint in order to be able to list the precise taphonomic mechanisms responsible for a given fossil assemblage, enabling the writing of taphonomic histories." The goal of this project has been congruent with Gifford and Lyman's second goal, in regard to understanding the taphonomic overprint and how it has affected the assemblage formed by human behavior at 48PA551.

In pursuit of that goal, hypotheses and test expectations (Table 1) were formulated to give direction to the testing conducted, to not only understand how taphonomic agents and processes have formed and impacted the site, but what possible behaviors lay behind its initial deposition.

Hypothesis 1 suggests that the assemblage represents a primary butchering site where animals were possibly killed and then field processed for further transport. Kreutzer's (1996) bison bed at Mill Iron is a quintessential example of this. In such a case it is expected that skeletal elements of low utility would be largely present, and higher utility parts, mostly appendicular, would be absent. While the utility correlation test did result in a negative signal, it was very weak and not statistically significant. This coupled with the clear representation of both axial and appendicular parts of various utility scores is contrary to the expectation for this

scenario. Additionally, the clear signs of bone processing for marrow and grease extraction go against an acceptance of H1 for this assemblage. This scenario also would make little intuitive sense, as it is expected that most primary butchering actions take place at or near the initial kill site. As 48PA551 is already established as a seasonal habitation site (Frison and Walker 1984; Prentiss 2019) it is unlikely that the assemblage would exclusively represent primary butchering actions.

Similarly, the test expectations for the Cut Bank representing a secondary butchering site are not well supported. In such a case it is expected that part representation would consist of high utility appendicular elements, while low utility axial and lower appendicular elements would comparatively lack in frequency. While it is the case that when long bone fragments are included, there are technically more specimens originating from appendicular elements, it is not possible to confirm exactly how many elements those fragments came from. The 'sum bone weight' argument would suggest that there is greater appendicular than axial representation in the assemblage. When taken as a whole though, it is clear that many low-utility parts are present in the Cut Bank, with a negative utility correlation coefficient (though a weak and insignificant one). However, strongest argument against a secondary butchering interpretation, is again evidence for culinary processing. Secondary butchery is generally associated with further dismemberment and de-fleshing, after primary butchery and before full culinary process (cooking and eating) takes place (Gifford-Gonzalez 2018). These results are not congruent with the expected results of a secondary butchering site which would lead me to reject Hypothesis 2 as a predictive statement for the Cut Bank assemblage.

This evidence is congruent with many of the findings of the previous excavations as well. The initial excavations found many axial elements in their assemblages. In fact, Frison and

Walker's (1984) Minimum Number of Individuals (MNI) for deer was based on 50 mandibles

found in their excavations. The results of UM's excavations seem to follow a similar pattern,

with a fair number of cranium and mandible fragments, as well as other axial elements, being

deposited in the Cut Bank as well as in other portions of the site (Prentiss 2019). This would

suggest that butchery patterns at this site may not have followed "conventional" patterns of

primary, secondary, and tertiary butchering. It seems to be the case that whole, or mostly whole,

animal butchery was taking place at this site.

This pattern intuitively makes sense for this situation. 48PA551 is located within a

narrow tributary canyon of Sunlight Basin and appears to have been strategically located to

intercept late autumn/early winter mule deer migrations as they move from high-alpine biomes to

lower elevations to find winter forage (Frison and Walker 1984; Prentiss 2019). Additionally,

when compared to many large-game species of North America, mule deer are relatively small

and easy to transport. With a strategically located logistical/seasonal hunting camp, and game

that is fairly easy to move once harvested, it is not outside the realm of expectation that it may

have been more convenient to transport a whole animal to the base camp where the group could

cooperatively engage in processing.

This leads us to the third hypothesis: Disposal Location. While the utility curve doesn't

match the model of a disposal site, which would look very much like a secondary butchering site

with mostly high-utility parts (Kreutzer 1996), other patterns in the assemblage support this. As

stated before in the "Descriptive Statistics" section, while frequencies of axial vs appendicular

fragments don't seem overly different, the comparison of sum bone weight would suggest that

appendicular parts are more represented in the assemblage, which makes the fact that there is not

one complete long bone (aside from two 1st phalanges and one lateral malleolus/fibula) in the

entire assemblage all the more informative. Several long bones (2 tibias and 1 radius and 5 phalanges), show evidence of clean intentional breaking lengthwise either medio-laterally or antero-posteriorly.

The lack of complete long bones and signs of possible human modification is interpreted as evidence for processing for marrow extraction. A number of different methods of bone fracturing for marrow extraction have been recorded in the ethnographic record and tested in actualistic research experiments (Gifford-Gonzalez 2018). While in this instance direct evidence for bone breakage in the form of percussion marks are largely absent (only 3 bones were recorded as showing such), this is likely more due to the intense fragmentation and weathering of the assemblage obscuring such marks rather than an absence of the behavior. Therefore, in this instance our conclusion must be informed by what is not there rather than what is. Outram (2001) points out that it would make very little economic sense for bones to be processed for grease (discussed further below) and not for marrow and there is no evidence of such in the ethnographic record.

As has been mentioned previously, perhaps the most unique and defining characteristic of the Cut Bank assemblage is the high levels of fragmentation. Researchers have noted in numerous ethnographic accounts that bones, mostly consisting of articular ends of long bones, would be fragmented into "small" fragments usually ranging from 1cm to 8cm depending on the account (Church and Lyman 2003; Gifford-Gonzalez 2018). The reason being that while smaller fragments don't necessarily speed up grease extraction (Church and Lyman 2003), smaller fragments require less water and therefore less fuel to get maximum grease output (Janzen et al 2014). In this case, with 98.7% of the assemblage being 5cm or less in maximum size, this pattern perfectly matches ethnographic descriptions of grease processing.

Outram (2001) states that grease extraction was prepared by storing up bone until a large enough quantity was available to make the labor-intensive process economically viable. Processing involved comminuting articular ends of long bones to get to the cancellous bone where grease is stored in the skeleton. This subsistence activity would likely have been of particular importance in late autumn and winter months as fat is most difficult to acquire during this time of the year. Plant sources are not available and animal sources of fat are difficult and labor intensive to acquire. Outram also points out (1998, 2001) that skeletal fat sources (marrow and grease) are the last fats in the body to be consumed during periods of stress. Often even a malnourished animal with little or no fat on the body would still contain reliable sources of fat in the skeleton. This resource would have been especially sought after during the winter, when mammals are actively burning through fat reserves and getting less access to forage.

This argument is especially relevant to 48PA551. It was interpreted from the beginning by Frison and Walker (1984) as a late autumn/early winter seasonal occupation site based on dental eruption from deer mandibles found in their excavations. Prentiss (2019) supported this initial interpretation in their report. Their findings suggested that the site represents a "collector" style model (Binford 1980) of subsistence behavior, with people coming to the location seasonally and living in semi-permanent house-pit structures. This base camp would have been the central place from which hunting parties would venture. The lithic assemblage found supports this, with an emphasis on hunting and butchery tools, with a secondary emphasis on plant processing tools. This interpretation is congruent with the patterns of the Cut Bank assemblage following Outram's reasoning on the importance of acquiring animal fats during the winter months. These fat sources would have been stored until sufficient amounts were available to make processing economic, and then processed and the remains disposed of. It is possible that

the grease and marrow acquired, along with surplus meat and hides, were taken elsewhere once the seasonal hunting period was complete. Prentiss (2019) suggested as much in their report, stating that the lack of hide processing tools would indicate that resources acquired were taken to a separate location, likely where the remainder of the winter months would be lived out.

The patterns of the Cut Bank data are most congruent with a waste disposal area, where fully processed bone, mostly cervid originating from mule deer, was disposed of once every available resource was stripped from it. While burning patterns didn't necessarily contribute to this conclusion, other human modifications did. The chi-squared results of human modifications on axial vs appendicular parts would suggest that different skeletal portions were targeted for butchery preferentially, lending further evidence to the Disposal Area interpretation. Additionally, the sum bone weight evidence would suggest that appendicular bone is more prevalent in the Cut Bank than axial bone. This supports patterns that would be expected from a disposal area for waste from grease and marrow extraction, as marrow is stored in diaphysis cavities of long bones, and grease is stored in cancellous bone found in the articular ends of such.

It should be noted that the presence of axial parts in the Cut Bank, as well as their majority presence in the other excavation areas, would still suggest whole animal butchery with a potential lack of field processing. I suspect that further investigation would reveal that the Cut Bank represents a particular activity area within the site. It is possible that other butchery stages, primary and secondary, were taking place in other areas of the site, which may account for the prevalence of axial skeletal parts in the other excavation blocks by comparison to the Cut Bank (Prentiss 2019).

As for non-human actors and processes, it cannot be denied that there have been impacts. While the sample area was not large enough to conduct a meaningful analysis of hydraulic

impacts, the fact that the Cut Bank was found because bones were seen eroding out of the bank into Dead Indian Creek is evidence enough. It is impossible to know without extensive excavations how much data has been lost to the stream. As noted above however, due to the fairly stable nature of the stratigraphy and the interpretations of the stream-path history, it is unlikely that the stream has had much of an impact on the bone bed beyond the removal of data through erosion. The stream is unlikely to have played a significant role in the deposition or structure of the bed itself. The stream had moved west before forest soils began to accumulate, which is when human occupations began there (Prentiss 2019; 2021 personal communication).

It is possible that the assemblage was impacted by natural fires while still exposed to or near the surface as well. The chi-squared analysis suggests that axial and appendicular skeletal parts were subjected to the same formation processes with reference to burning evidence. This may be evidence that non-human fires were responsible for the pattern, as axial skeletal parts tend to not hold meat packages that would be roasted with the bone still attached. This stood out in contrast to the same analysis applied to the variable of human modification, which suggested that axial and appendicular parts were subjected to very different processes with reference to butchery. I believe this provides further evidence that the burning pattern was created by non-human processes after the assemblage was deposited.

The most important metric for non-human taphonomic processes in this project was the correlation coefficient for Lyman's deer bone Volume Density scores with the %MAU derived from bone frequencies in the assemblage. This is the most rigorous test available to this project to understand non-human formation processes at work. The weak positive correlation suggested that density-mediated attrition could be playing a minor role in formation process. However, with the exceptionally weak and insignificant negative utility correlation coefficient, it seems

just as likely that the pattern resulted from human behaviors. As mentioned before, bone density is significantly and negatively correlated with part utility. If density were playing a significant role it would be expected that a stronger negative utility correlation would be present. As it stands, neither utility nor density can be considered accurate predictors of element representation in the cut bank. Rather, intensive and intentional fragmentation of the assemblage, and especially high-utility and relatively low-density appendicular parts, has obscured both signals significantly.

With the understanding that there are certainly impacts that cannot be fully accounted for, I believe that the evidence available is sufficient to reject the null hypothesis, which stated that non-human processes had biased the data beyond usability. This does not seem to be the case. While the data of the Cut Bank are certainly complex and requires some inference in interpretation, it is not without measurable patterns. The combination of small fragment data, axial vs appendicular representation, and differential treatment of axial and appendicular parts for butchery processes all point to the Cut Bank assemblage being a disposal area. This conclusion is congruent with and supports previous interpretations of 48PA551 as a winter base camp where specific resources were targeted and intensively processed, likely for acquisition of difficult to find fat resources. Therefore, I believe I may accept my third hypothesis.

Chapter 5 - Conclusions

Building on the previous work done at the site, this project's goal was to gain more detailed understanding of the formation processes, both human and non-human, that led to the assemblage found in the Cut Bank bone bed in 2018. Despite challenges of sample size, recognizable patterns did emerge. The findings of this project support and reinforce the conclusions drawn by previous researchers. The results suggest that the bone bed represents a human activity area, where fully processed mammal bone mostly consisting of cervid remains was disposed of once every possible calorie was retrieved. This is congruent with the expected patterns of a late autumn/early winter semi-permanent occupation site strategically located for the intensive acquisition and processing, possibly involving cooperative hunting strategies.

This interpretation has implications for the McKean Complex well beyond the limits of the site. Lanoe et al (2020) recently used summaries of findings at six sites located along the Northern Front of the Rockies, near the Blackfeet Indian Reservation in Montana, to make arguments for ethnogenesis occurring at the time of the McKean Complex that led to the development of the ethnic and social identities of modern indigenous groups of the regions. In this they point to a number of sites from the McKean period that show evidence for the beginnings of cooperative and targeted hunting of large game, with local idiosyncrasies between. Many well documented upland sites were clearly targeted at sheep hunting, while more lowland areas seem to have been targeted at elk and bison hunting (Reeves 2003; Kornfeld et al (2010).

The findings of this project, as well as previous research, suggest that 48PA551 contributes to this overall pattern while clearly possessing unique characteristics of its own. Most well-documented upland McKean sites are believed to be targeted towards sheep acquisition

(Kornfeld et al 2010). While sheep were certainly hunted at 48PA551, archaeofaunal evidence suggest that mule deer were the prey of choice, and likely the reason for the site location in the first place. Lanoe et al (2020) also state that the McKean complex is best documented in the Beartooth-Absaroka mountain areas of southwestern Montana and northwestern Wyoming, exactly where 48PA551 is located. Additionally, recent assessments of radiocarbon dates from McKean sites across Canada and the U.S. shows that sites in the Absaroka and Bighorn ranges generally predate those found on the plains to the east and north (Peck 2011; Webster 2004). Most archaeologists attribute this distribution to a perceived process of "recolonization" of the plains after they were nearly abandoned during the Altithermal period (8000-5700 cal B.P.) (Husted and Edgar 2002; Kornfeld et al. 2010).

The implication is that 48PA551 may be a contributing factor in a sort of McKean Complex "heartland" where unique subsistence strategies targeted at intensive acquisition of upland big-game resources possibly through group cooperative hunting developed. These strategies were then taken from this high mountain area out onto the plains once temperatures began to improve after 5700 B.P. (coincidently the earliest McKean components are dated to approx. 5600 B.P. (Lanoe et al. 2020)). Following the recolonization and spread out onto the Northern Plains, these strategies would have been applied and adapted to the unique environment, developing idiosyncrasies of their own while maintaining something of the overall strategic pattern and may have been directly ancestral to the Pelican Lake Complex and later complex hunter-gatherer societies of later periods.

If this interpretation is representative of reality, then 48PA551 and other sites like it may represent the very beginnings of important socio-economic and ethnic developments of the Northern Rockies and Plains societies. As such, the importance of furthering our understanding

of these sites, and especially 48PA551, cannot be overstated. Further investigation at PA551 will

be necessary to gather greater samples of data and to make for more solid and rigorous testing

and conclusions than is possible at this point. Data recovery is particularly crucial, as much of

that data is currently eroding into the stream, as well as other adverse impacts from weathering

and looting. I believe that archaeofaunal remains should be paid particular attention, as the

patterns unearthed would do much to clarify the picture of this site's past and how it contributed

to the growth and spread of the McKean Complex and the societies and groups that followed.

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