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Examining Large Game Utility and Transport Decisions by Fremont Hunters:

A Study of Faunal Bone from Wolf Village, Utah

Spencer Francis Xavier Lambert

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Arts

James R. Allison, Chair
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Department of Anthropology

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ABSTRACT

Examining Large Game Utility and Transport Decisions by Fremont Hunters: A Study of Faunal Bone from Wolf Village, Utah

Spencer Francis Xavier Lambert
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Master of Arts

This analysis of faunal bones from Wolf Village focuses on large game and its utility, as evidenced by what is known as the modified general utility index (MGUI). The MGUI proposes that bones at sites reflect transportation and butchering choices made by hunters at kill-butchering sites. According to the assumptions associated with the MGUI, hunters should select animal portions with high food value. The MGUI has been used in Fremont archaeology to provide a rough measure of site function. The expectation is that faunal bones would accompany the prized cuts of large game meat at habitation sites – and the animal parts with little food value would remain at kill-butchering sites because they are not worth the cost to carry them to the village. My analysis of large game animal bones found in excavations at Wolf Village counter these expectations. Fremont hunters at Wolf Village were returning to the site with low-caloric portions of large game, at least part of the time. Results from strontium isotope analysis suggest that many of the large game individuals hunted by the Fremont were not local to the immediate area. This suggests that hunters saw utility in low-caloric elements not related only to food value. Some low-caloric skeletal elements were used by the Fremont to construct bone tools and other objects, and as possible symbolic objects used in abandonment rituals. The results of this research suggests that the MGUI is not appropriate for measuring the utility of animal portions to the Fremont. Only when considering the social and non-caloric economic reasons for transporting low caloric elements, can archaeologists discover the true utility of large game animal parts to Fremont hunters.

Keywords: Fremont, Wolf Village, Lewis Binford, faunal bone, utility index, strontium isotopes, trade, ritual, worked bone

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1 Introduction

Lewis Binford (1978) created the “modified general utility index” (MGUI) as a measure of studying caloric utility and transport costs of big game hunting. He assigned numerical values to parts of animals based on weight proportions of meat, grease, and marrow. The MGUI is calculated archaeologically by identifying the bones pertaining to different parts of animals. This index is often used by archaeologists to identify site function, either as a habitation site or a kill-butcher site. The expectation is that kill-butcher sites are places where hunters killed and butchered large game before transporting body portions of the processed animals back to a habitation site. A further expectation is that the parts of processed animals taken from the kill site depended on transport costs to the site of final consumption. This is where the notion of “utility” comes in, meaning what was the most needful parts of the animals to carry away from the kill site? This, of course, was proposed by a rational calculation of the different utilities of different parts of the butchered animals (meat, hide, sinew, bones, etc.), the parts of the animal that were desired at the distant consumption site, and transport costs. A basic assumption of the MGUI is that meat was the most desired product, and meatless bones the least.

There are major complications and assumptions archaeologists should consider regarding the MGUI. The assumption behind the MGUI is that hunters want a large net gain in energy from hunting and not waste energy transporting body portions of animals that do not maximize caloric returns (i.e., low-caloric elements). These assumptions do not hold true for the Fremont of Wolf Village. Wolf Village is a Fremont site located south of Utah Lake in Utah Valley (Figure 1.1). In this thesis, I examine the utility of large game skeletal portions among the Fremont and the transport decisions associated with the usefulness of large game body parts. To do this, I calculate the MGUI at Wolf Village and evaluate the results. I argue that the MGUI fails to explain the utility of large game skeletal portions and transport decisions among the Fremont. The MGUI does not take into account non-caloric reasons for why animal parts with presumed low utilities were taken to some habitation sites. The Fremont made decisions about hunting and the transport of large game that counters Binford's expectations. Clearly the Fremont considered other factors beyond calories while making prey choices and judging transport costs.

In this thesis, I do not calculate the MGUI at Wolf Village to evaluate site function. Wolf Village was clearly a habitation site, as evidenced by the presence of permanent architecture. I evaluate the results of the MGUI at Wolf Village and other Fremont habitation sites to expose the weaknesses of the index, and the inappropriate assumptions associated with the MGUI. Wolf Village does have a higher ratio of low-caloric bones than high-caloric bones. It is possible that some deer individuals and other large game was captured close to Wolf Village and could be processed at the habitation site. Strontium isotope analysis on large game teeth can help determine if Fremont hunters were obtaining large game individuals local or non-local to Wolf Village.

The term "transport" in my thesis refers to the act of moving butchered large game animal portions from a kill site to a habitation site. The term "transport costs" refers to the caloric energy a hunter uses while transporting an animal or portions of an animal from a kill site to their home base. According to Binford (1978:72), the MGUI is based on the weighed proportions of meat, marrow, and grease. In other words, Binford only considers food value (i.e., calories) when measuring utility. So-called "low utility" elements provide very little food value and include foot bones, cranial elements, and mandibles. Therefore, Binford's (1978) definition of "utility"

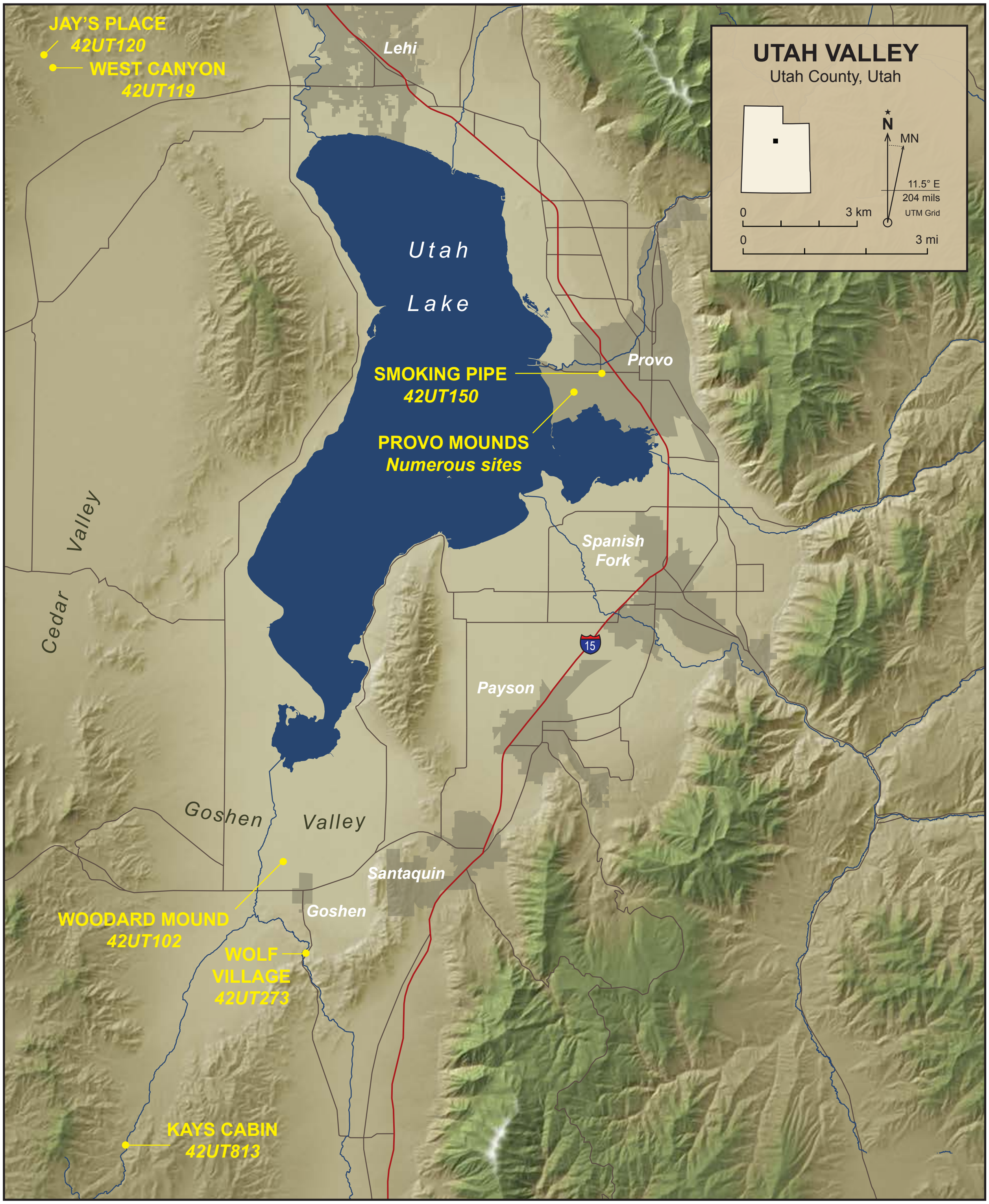

Figure 1.1. Map of Utah Valley showing the location of Wolf Village and selected Fremont sites. Map by Scott Ure.

refers to animal body parts that are of most interest to a butcher, since they provide the greatest amount of meat, marrow, and grease. In this thesis, the term “utility” refers to all possible values of animal body parts, including food value, social values, as raw materials for tools, and other potential uses. I argue that some elements identified as “low utility” by Binford, actually had high utility to the Fremont for reasons not related to food. Thus, I refer to skeletal elements with low food values as “low-caloric elements.” The term “caloric” refers to the food value (i.e., meat, marrow, and bone grease) associated with each skeletal element. In addition, Binford referred to animal elements with greater caloric returns (i.e., femora and axial portions) as “high utility” elements since they are encased in a lot of meat, bone grease, and marrow. In this research, I refer to Binford’s high utility elements as “high-caloric elements.” The term “element” refers to bone elements.

The MGUI has been used by archaeologists to determine site function for some Fremont sites. Reverse utility curves have been identified at some Fremont habitation sites (see Janetski 2000; Rood and Butler 1993; Sharp 1989, 1992; Stauffer 2012; Talbot et al. 2000; Todd 1993). Reverse utility curves are counter-intuitive patterns that suggest hunters transported mostly low-caloric bones and left high-caloric bones at kill sites. According to assumptions associated with the MGUI, sites with reverse utility curves should not be habitation sites. Thomas and Mayer (1983:368) explain that once a faunal bone assemblage from a kill site is tabulated, low-caloric elements should outnumber high-caloric elements, while high-caloric elements should outnumber low-caloric elements at residential sites (see also Binford 1978:80). This is based on the assumption that hunters only select high-caloric portions of animals to transport to distant habitation sites.

For this thesis, I studied the faunal bones recovered from Wolf Village (42UT273) to examine the utility of large game skeletal portions and transport decisions among the Fremont who lived there. The Fremont were a prehistoric group of farmers who inhabited much of modern Utah from approximately A.D. 500 to 1300 (Figure 1.2). The Fremont are often lumped with Great Basin groups despite being similar in many ways to Southwestern farmers. The Fremont, however, practiced agriculture by cultivating maize (Talbot 2000a), used ceramics similar to other groups in the Southwest (Janetski et al. 2000; Talbot et al. 2000; Watkins 2009), and aggregated into villages with buildings of several types, including surface and pit structures (Talbot 2000b).

My objectives for this research are the following: (1) to identify the relative abundance of taxa at Wolf Village and determine the importance of large game hunting at the site; (2) to compare large game skeletal frequencies to the MGUI to determine whether Wolf Village, like other Fremont habitation sites, had a high abundance of low-caloric elements compared to high-caloric elements; (3) to discuss possible reasons for why Fremont hunters from some habitation sites collected low-caloric bone elements from large game; and (4) to compare the skeletal frequencies of large game at Wolf Village to the results of strontium isotope analysis.

The results of my analysis indicate that Fremont hunters at Wolf Village and other Fremont villages transported low-caloric bone elements back to their villages more often than the MGUI model predicts. According to the assumption of the MGUI, the high frequency of low-caloric bone elements to high-caloric elements at Wolf Village suggests that the site served as a kill-butcher site, with high-caloric bone elements transported to a residential base somewhere else. This seems unlikely since Wolf Village was a Fremont habitation site, as evidenced by the quantity and variety of permanent architecture (Johansson et al. 2014). It is possible that some large game was captured near Wolf Village, and the site was both a habitation and a kill-butcher site, though strontium isotope analysis suggests otherwise. I argue, therefore, that the MGUI is a poor way to determine site function and hunting/recovery techniques among the Fremont and potentially other prehistoric groups. The MGUI only considers caloric motives (i.e., meat, grease, and marrow value) for why hunters selected certain portions of large game to take back

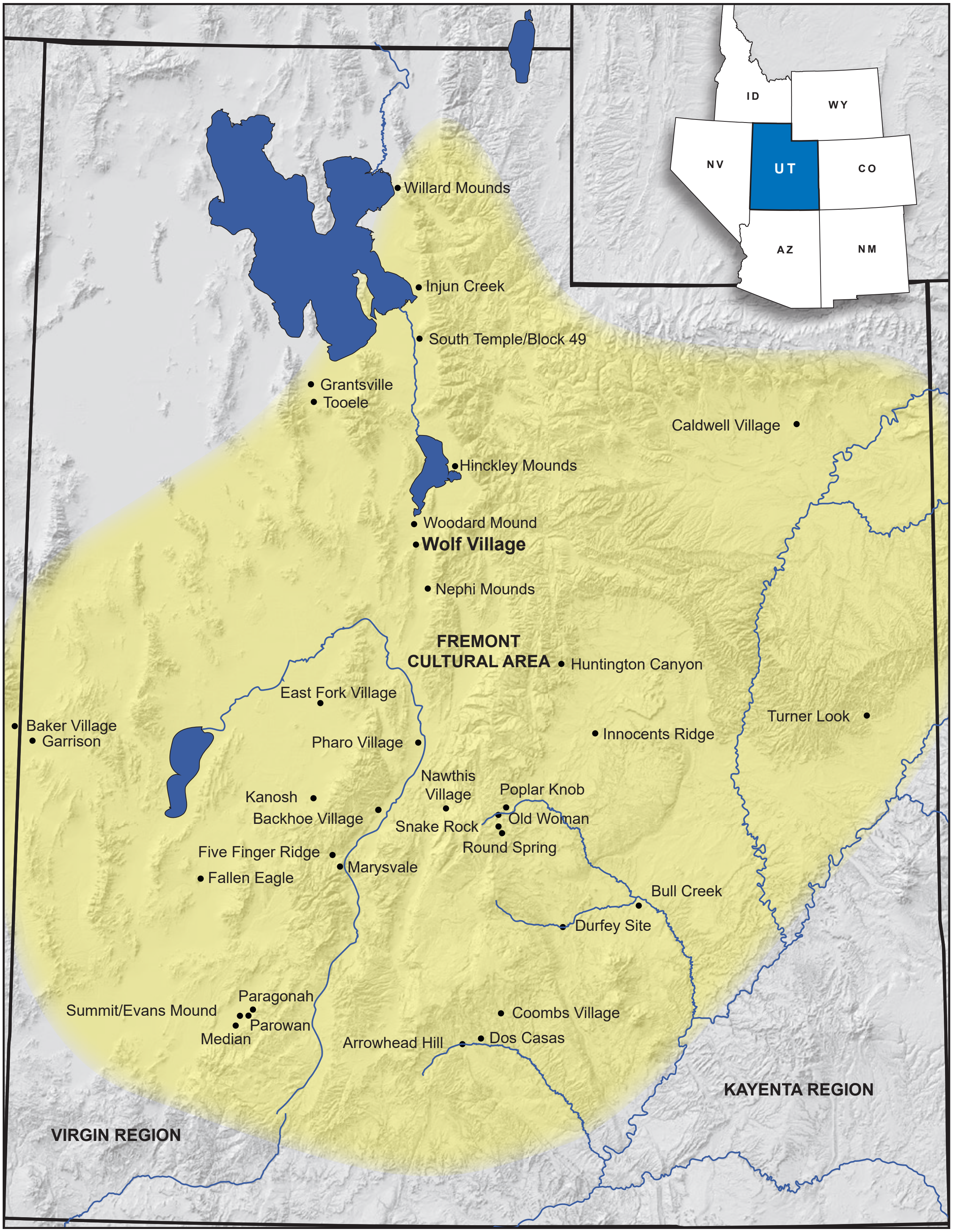

Figure 1.2. Map of the Fremont culture area with significant sites. Wolf Village is bolded. Adapted after Bryce (2016:Figure 3.1) and Ure (2013:Figure 12).

to their villages. The Fremont at Wolf Village obtained some large game animals from locations away from Wolf Village. They utilized small artiodactyl (i.e., mule deer, bighorn sheep, and pronghorn) bones as resources for tools and potentially as symbolic objects. I argue that some animal portions with low-caloric values had other values to the Fremont.

In this chapter, I describe my research objectives in detail. Next, I discuss the complications and assumptions associated with Binford's MGUI. I discuss previous research with the MGUI and explore some of its weaknesses. Next, I describe the benefits of strontium isotope analysis in archaeological research. Then I discuss my assumptions, followed by the scope and limitations of this thesis. The last section of this chapter provides an outline for the remaining chapters of this thesis.

RESEARCH OBJECTIVES

As stated, one of my research goals is to identify the relative abundance of taxa in the Wolf Village faunal bone assemblage. The term "faunal bones" in this study refers to all non-human animal bones recovered at Wolf Village and other Fremont sites. I specifically examine the importance of large game hunting. The term "large game" refers to mammals from the taxonomic order of Artiodactyla. In the Wolf Village assemblage, this includes mule deer, pronghorn, bighorn sheep, and bison. I specifically count the skeletal frequencies of small artiodactyls (i.e., mule deer, pronghorn, and bighorn sheep). Artiodactyl skeletal frequencies will help evaluate the utility of large game skeletal portions and transport decisions among the Fremont of Wolf Village. I adopt Binford's (1978) MGUI as a means for measuring the skeletal frequencies of artiodactyl bones. The MGUI was designed to predict which body parts should be expected to remain at kill-butcher sites and which should be transported to a habitation site to be consumed. Presumably, if there are significant difference in the ratio of low- to high-caloric elements at Wolf Village, then some large game were likely hunted in close proximity to the site, and whole carcasses were brought back to the site for processing.

Fremont hunters may have obtained some large game close to Wolf Village, which would explain why some low-caloric bone elements are at the site. To explore this possibility, I analyzed 25 large game animal teeth by strontium isotope analysis. I also identified the strontium baseline around Wolf Village by analyzing strontium ratios in ten muskrat teeth from the site. I compare the strontium ratios obtained from small artiodactyl teeth at Wolf Village to the site's strontium baseline. Strontium (Sr) occurs naturally in igneous bedrock and is passed on into the local ecosystem as herbivores eat plants and drink water. The ^{87}Sr and ^{86}Sr values depend on the geology of any particular area, and each area has a distinct geochemical signature. In theory, strontium isotope analysis should help identify which individual large game animals were local to the area around Wolf Village. In essence, the MGUI supplemented with strontium isotope analysis may help archaeologists understand Fremont large game hunting practices, while also considering possible social and economic factors involved in decisions to bring certain parts of animals back to villages.

DEFINING THE PROBLEM

Lewis Binford created many utility indices in order to measure the abundance of skeletal elements and the utility of those elements. The modified general utility index (MGUI) is the best-known utility index created by Binford (1978). The MGUI is based on Nunamiut hunting practices. Binford (1978:70) noted that Nunamiut hunters did not discriminate between left and right sides of large mammal carcasses. Nunamiut hunters focused on processing carcasses in field, and left low-caloric portions in favor of high-caloric portions. They fractured caribou long bones to extract marrow (Binford 1978; see also Lyman 1994:274). Archaeologists have long used the Nunamiut as an analogy for Great Basin and Southwest people's hunting practices, although Metcalfe and Jones (1988:501–502) explain that Nunamiut hunters transported certain animal body parts using dog sleds and snowmobiles, which may make the analogy inappropriate.

The MGUI combines numeric values for meat, marrow, and grease utility, while modifying those values for contingencies of transport (Marean and Frey 1997). The MGUI was based on the anatomy of the modern Nunamiut caribou (*Rangifer tarandus*) and domestic sheep (*Ovis aries*). Since the caribou and sheep indices are highly correlated (Binford 1978:21–28), many archaeologists, including Binford (1978:475–476; 1981:270–275), have used these indices for other artiodactyls to analyze prehistoric faunal bones (see Chase 1985:287). Binford (1978) created the MGUI as a means to determine site function and to study the utility and transport costs of large game body parts by hunters. The MGUI can only predict hunting behavior based on which portions of animals provide the most caloric value. The assumption behind the MGUI is that hunters want to net a large gain in energy and not waste energy transporting animal portions that do not maximize caloric returns (i.e., low-caloric elements). This assumption has often been promoted in Great Basin archaeology (see Bettinger 1993; Grayson and Cannon 1999; O'Connell et al. 1982). To be fair, the MGUI seems an attractive model for archaeologists to investigate butchering and transport decisions, as well as examine the function of a site. Unfortunately, the MGUI is a poor way to evaluate site function or transport decisions from kill-butchering sites to habitation sites for the weaknesses previously mentioned.

For this research, I created bivariate scatterplots that show the relationship between the utility of animal parts (according to the MGUI) and the minimum number of animal units (MAU). According to the MGUI, these scatterplots should conform to the site function of Wolf Village and how Fremont hunters were deciding which animal parts to transport back to the site. Binford (1978:81) defined five possible transport strategies. A "bulk strategy" occurs when hunters select moderate- and high-caloric value parts, and the low-caloric pieces are abandoned. A "gourmet strategy" occurs when hunters only select the high-caloric portions of an animal, and moderate- and low-caloric parts are abandoned. An "unbiased strategy" occurs when high-, moderate-, and low-caloric elements are all selected. In addition to these three transport strategies, there are "reverse bulk" and "reverse gourmet" strategies. Reverse utility patterns occur when low-caloric portions are selected over high-caloric ones. Each of these transport strategies is represented on percent MAU/MGUI scatterplots (Figure 1.3). The scatterplots that graphically portray the proposed skeletal representations at habitation sites are shown in Figures 1.3b, 1.3c, and 1.3d. Scatterplots in Figures 1.3a and 1.3e portray reverse utility patterns (i.e., skeletal parts believed to be found at kill sites).

Analyses of faunal bones from some Fremont sites do not conform to the expectations of the MGUI. For example, Talbot et al. (2000:481) state that the analysis of large game skeletal frequencies at Five Finger Ridge (42SV1686) resulted in a reverse utility curve. Janetski (2000) argues that comparisons of skeletal elements at archaeological sites to the MGUI can lead to faulty conclusions. The faunal bone data from Five Finger Ridge, for example, according to the logic associated with the MGUI, suggests that the site functioned as a kill-butchering site, with prime cuts of meat being hauled away to other areas for consumption (Janetski 2000:68). This was unlikely to have been the case since Five Finger Ridge indisputably functioned as a residential base (Talbot et al. 2000).

Regression analysis of the Five Finger Ridge data using locally weighted scatterplot smoothing (LOWESS) suggests that the scatterplot is not a true reverse utility curve as described by Binford (1978). Visual information on a scatterplot is enhanced by plotting smoothed points (Cleveland 1979:829). LOWESS (or loess) is a regression technique that guards against outliers distorting the smoothed points by comparing the statistical relationship between a few data points at time, rather than all data points on a scatterplot (Cleveland 1981; Cleveland and Devlin 1988). The LOWESS curve for Five Finger Ridge does not portray a true reverse utility curve; since there are relatively high counts of mid-caloric elements such as distal ends of tibias. Instead of referring to scatterplots of this type as reverse utility curves, it would be more accurate to call

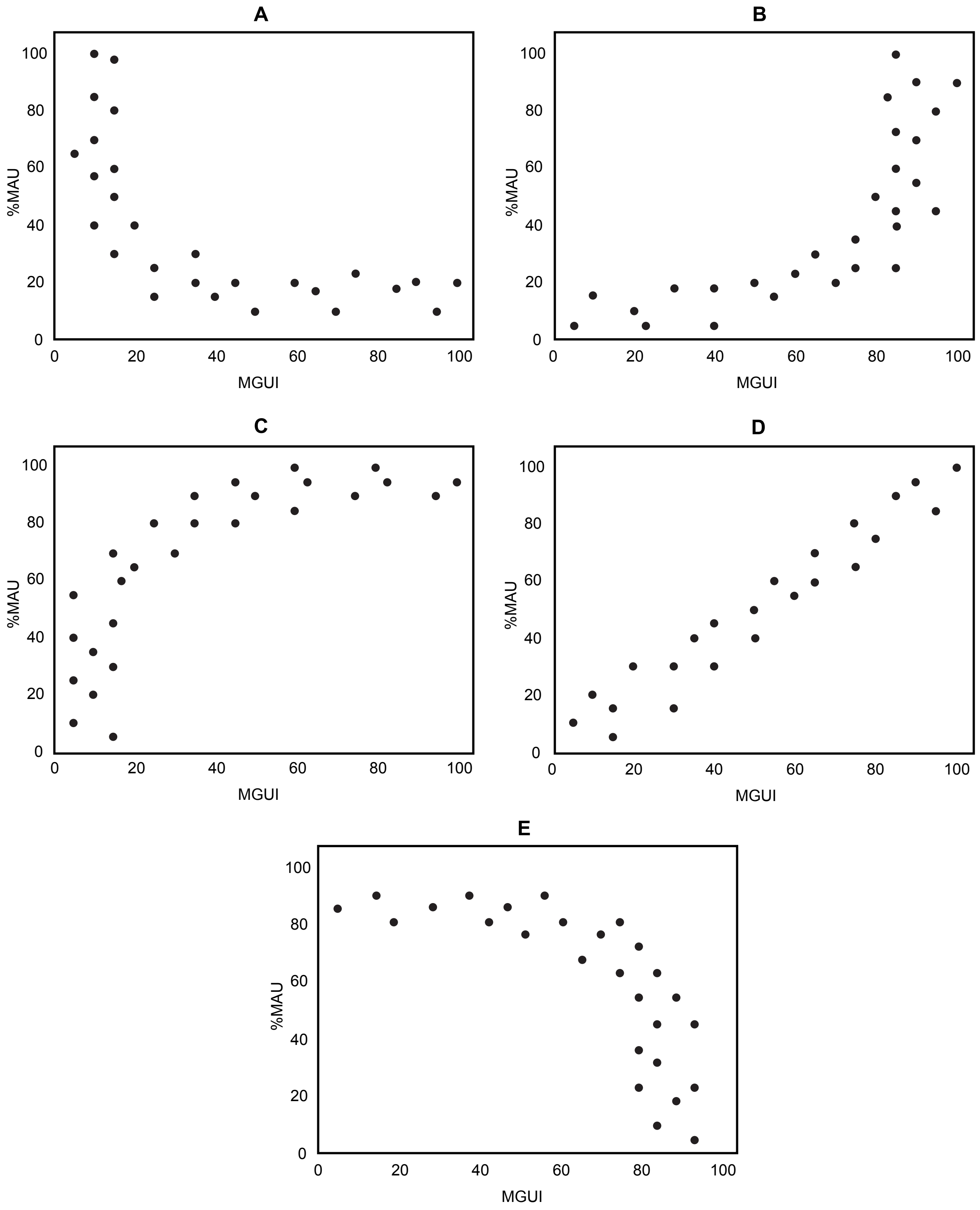

Figure 1.3. Scatterplots representing a series of different transporting and/or part utilization models based on %MGUI (after Binford 1978:81 and Lyman 1994:228–229). A. reverse (bulk) strategy; B. gourmet strategy; C. bulk strategy; D. unbiased strategy; E. reverse gourmet strategy.

them “reverse utility patterns.” Reverse utility patterns are scatterplots with high counts of low-caloric elements compared to high-caloric elements. They do not necessarily make the L-shaped curve as displayed in Figure 1.3a.

In addition to Five Finger Ridge, reverse utility patterns have also been identified for faunal remains at other Fremont habitation sites, including Nawthis Village (42SV633/1291/1292) (Sharp 1989, 1992), Round Spring (42SV23) (Rood and Butler 1993; Todd 1993), and at sites in the Parowan Valley (42IN40, 42IN42, 42IN100) (Stauffer 2012) (Figure 1.4). While MGUI scatterplots representing skeletal frequencies from these sites do not display true reverse utility curves, the scatterplots show that low- to mid-caloric elements are more common than high-caloric bones (Figure 1.5). The exception is Nawthis Village where high-caloric elements such as the distal and proximal ends of femurs are more common than the other Fremont sites (although not as abundant as some low-caloric elements).

There are at least four possible reasons why low-caloric elements are more abundant than high-caloric elements at Fremont habitation sites. First, more dense faunal bones preserve better than less dense faunal bones. For example, thicker bones are more likely to survive natural processes that can damage or destroy other thinner bones, including some high-caloric ones (Lyman 1994). Second, the skill of the faunal analyst may affect which bones are identified during his or her analysis. For example, many low-caloric elements are easier to identify than long bone shafts, and only identifiable long bones are comparable to the MGUI values provided by Binford (1978:74). Third, some high-caloric elements may have been destroyed by past humans while processing for marrow or bone grease, or destroyed by carnivores such as canines. Fourth, low-caloric elements may have had value to the Fremont not measurable by the MGUI.

One reason that low-caloric elements are abundant at Fremont habitation sites may be due to preservation. Bone density could potentially impact the results of the MGUI analysis, since some portions of artiodactyls may survive site formation processes. In other words, if some

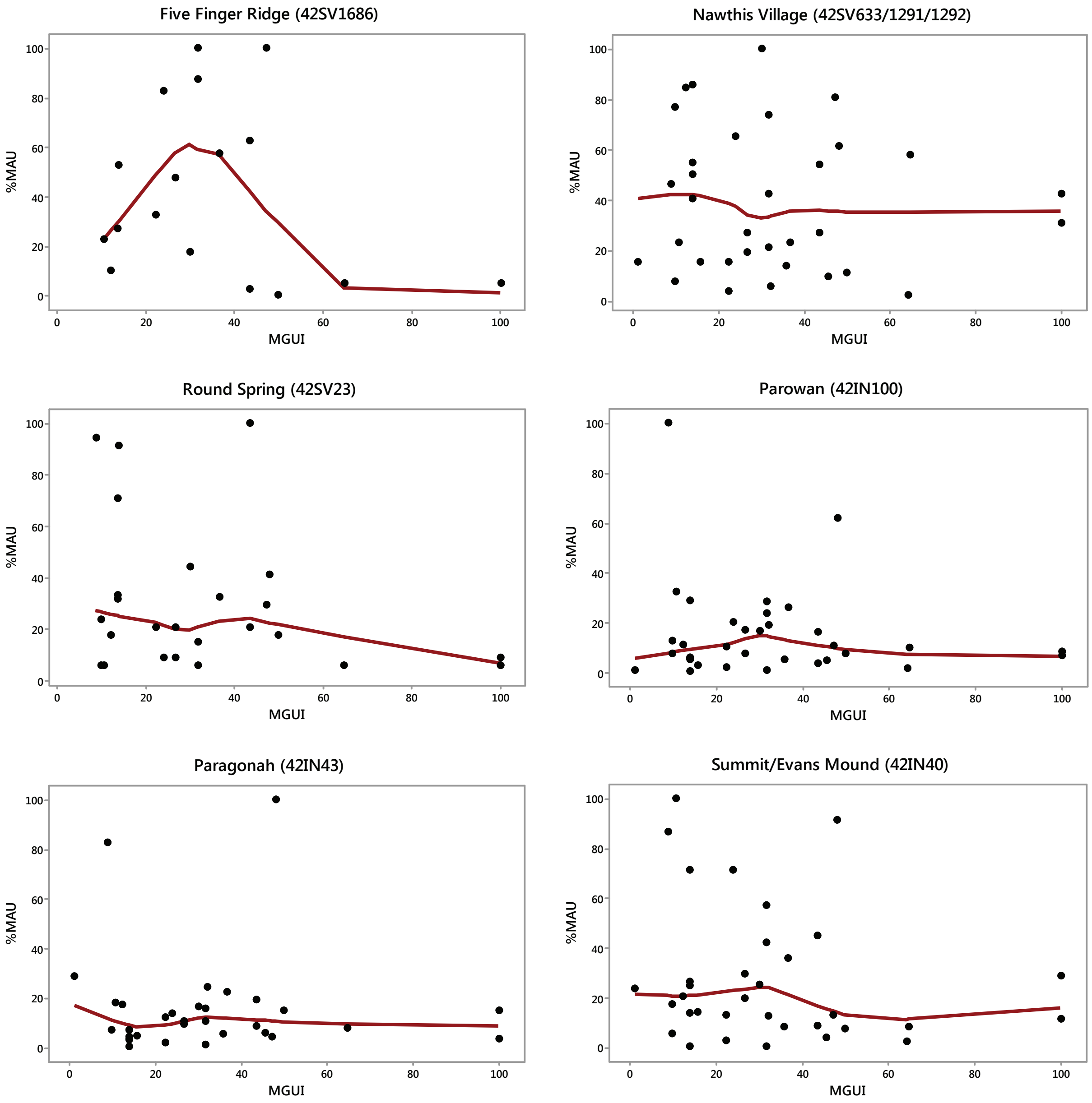

Figure 1.4. Reverse utility patterns from six Fremont habitation sites: Five Finger Ridge (r^2 = 0.051), Nawthis Village (r^2 = 0.006), Round Spring (r^2 = 0.076), Parowan (r^2 = 0.018), Paragonah (r^2 = 0.001), and Summit/Evans Mound (r^2 = 0.036).

bones do not survive natural processes, then the lack of those elements may create incorrect reflections of economic and transportation decisions. These potential problems with bone density could be the cause of some reverse utility curves (Grayson 1989).

The reverse utility pattern at Five Finger Ridge and other sites could possibly be

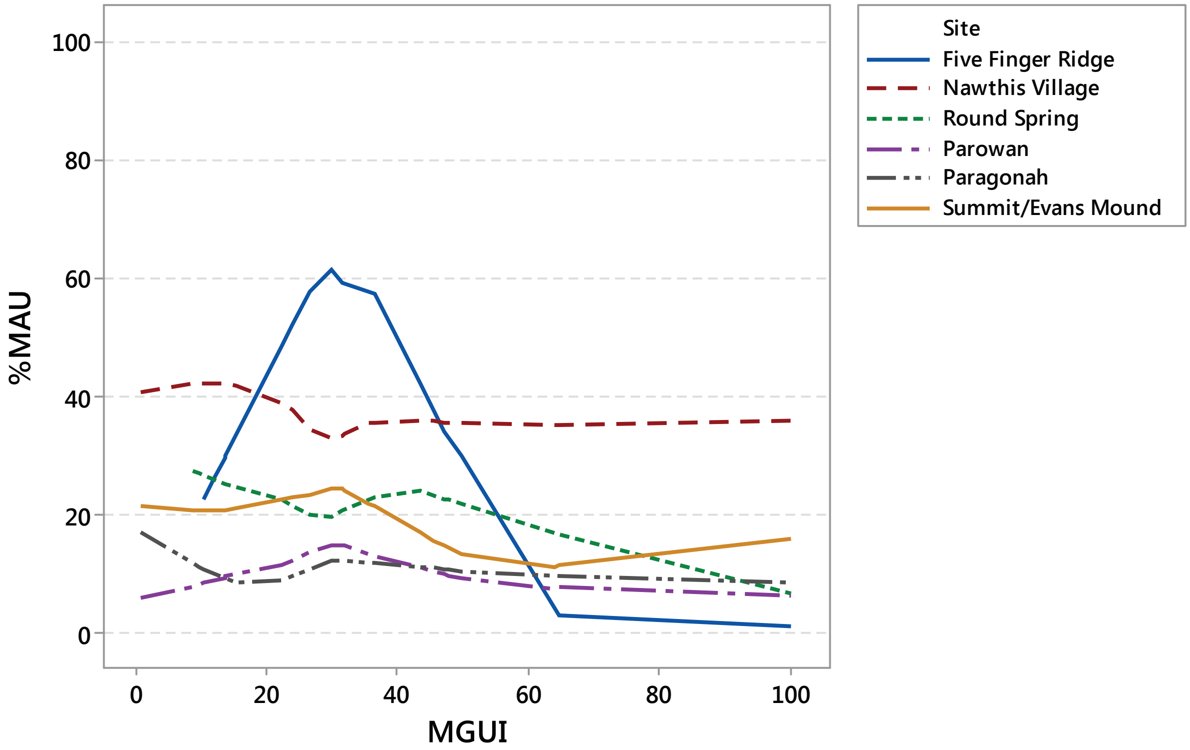

Figure 1.5. LOWESS regression of %MAU from six Fremont sites compared to the MGUI.

explained by the fact that many mid-caloric elements such as vertebrae, ribs, and innominate bones are not often identified during analysis. Therefore, low-caloric elements such as mandibles and metapodials (i.e., foot bones), appear more numerous than mid-caloric elements (see Talbot et al 2000; Sharp 1992; Stauffer 2012). Some animal elements are more easily identifiable. Sharp (1992) notes that elements from small artiodactyls at Nawthis Village were affected by differences in identifiability across elements. Sharp explains that the inability to assign some elements to the species level can skew the data to make it seem as though a residential site was used as a kill-butcher area. Only when all identified small artiodactyl assemblages are combined, including those not assigned to species, can the data reflect more accurate conclusions (Sharp 1992:154). To solve this problem, I combine all artiodactyl elements (including those not identified beyond the taxonomic level of order) into one assemblage to compare them to the MGUI.

It is also possible that the reverse utility patterns at Fremont habitation sites can be the result of differences in preservation rather than ancient transport behavior. In other words, high-caloric portions could have been brought back to habitation sites, and not preserved in the archaeological record for various reasons (Rood and Butler 1993; Sharp 1992; Talbot et al 2000). For example, the Hadza hunters of Africa intentionally crush vertebrae and other spongy bones in order to make bone grease soup, thereby removing evidence of transporting some high- and mid-caloric bones back to habitation sites (Bunn 1993:164; Talbot et al. 2000:483).

The Fremont viewed some low-caloric elements as vital for constructing bone objects. Some large game animals may have been brought back to habitation sites in their entirety, to be processed for food and non-food materials, such as dense bone for tools and worked bone gaming pieces. Binford (1978:72) acknowledged that hunters may be interested in animal parts that provide the greatest variety of potential uses. For the Fremont at Wolf Village, metapodials (low-caloric elements) were important for making bone tools and other objects (Bryce 2016; Robbins and Lambert 2016). Low-caloric elements are also abundant at Paragonah and Parowan. Stauffer (2012:58) notes that pelves and metapodials have the highest percentages represented in their assemblages. She theorizes that metapodials of artiodactyls may have been preferred skeletal elements for the Fremont for at least two reasons. First, metapodials were used in the construction of bone awls (Bryce 2016:56–58) and at least some bone gaming pieces (Robbins and Lambert 2016). Second, Fremont moccasins were constructed from the hide of the lower legs of mule deer (Stauffer 2012:59–60). Therefore, despite being labelled as “low utility” elements by Binford, metapodials had utility beyond caloric value. Similar findings were noted by Sharp (1989:27) for Nawthis Village and by Todd (1993:186–187) for Round Springs who concluded that the high counts of metapodials were likely due to their tool utility rather than food utility. This is the position that I take in this thesis.

STRONTIUM ISOTOPE ANALYSIS

As stated, a principle assumption of the MGUI is that prehistoric hunters discard low-caloric elements of killed game at kill-butcher sites and return to home bases with only high-caloric elements. If true, habitation sites would have few low-caloric elements. Alternatively, it may be likely that some large game was obtained near habitation sites, gutted and bled in at the kill sites, and brought back to the home base to be further butchered. If large game were obtained in the location around Wolf Village, then low-caloric elements may have been transported to the site out of convenience rather than for non-caloric uses. To address this issue, I rely on strontium isotope analysis to control for the results of the MGUI. Strontium isotope analysis can be useful for evaluating transportation practices. It allows analysts to determine which individual large game animals were local to a specific region. Fisher (2010) relied on this analysis for eight bighorn sheep and three deer mandibles from Five Finger Ridge to determine whether hunters traveled to different locations at different periods of time at the site (see also Fisher and Valentine 2013). In addition, strontium isotope analysis has helped to explore the trading of large mammals between ancient Maya communities (Thornton 2011). Data from strontium isotope analysis allows one to evaluate the results of the MGUI and to determine how much large game was obtained outside the local area surrounding the habitation site.

Strontium isotope analysis is important for understanding past human behaviors of prehistoric people at Wolf Village. There is no published research on the utility of large game skeletal portions and transport decisions among the Fremont at Wolf Village. Such information would shed light onto Fremont behavior. By comparing large game strontium ratios to the Wolf Village strontium baseline, I will determine whether mule deer, pronghorn, and bighorn sheep were obtained near or far from Wolf Village. The individual large game animals tested in this study undoubtedly moved throughout the course of their lives, so each individual was exposed to multiple strontium signatures. Therefore, I make the assumption that individual large game animals with similar strontium signatures as the Wolf Village baseline, at least were local to the area during their youths. If strontium ratios obtained from small artiodactyls from Wolf Village differ significantly from the site baseline, then it is likely that Fremont hunters obtained them from locations away from the site. I take a conservative approach to identifying individuals as non-local to Wolf Village by requiring them to be two standard deviations from the site's baseline mean. There are at least two reasons for why some large game might have been obtained at locations distant from Wolf Village.

1. Large game may have been hunted at areas away from Wolf Village due to resource depression in the immediate area, meaning that some animal species were scarce close to the site.
2. Wolf Village served, in part, as a trade center for the Fremont in the area, and portions of some large game may have been traded – including meat for food and bones for tools.

CONDITIONS OF RECOVERY AND ASSUMPTIONS

The results of the MGUI analysis at Wolf Village are based on several assumptions about recovery techniques. Several factors can affect the composition of a faunal bone assemblage, including screening techniques and carnivore presence. My research assumptions include matters relating to my sampling methods, the accuracy of strontium isotope analysis, and Fremont agency while making hunting and processing decisions.

Screening Bias

The screening methods at archaeological sites can directly correlate to a faunal assemblage bias. Using an experiment conducted by Thomas (1969), Grayson (1984) notes that screen size correlates to the types of faunal remains that are recovered from an archaeological site. Thomas experimented with the number of faunal remains collected from three cave sites in northwest Nevada with the use of 1/4 inch, 1/8 inch, and 1/16 inch screens. Through the experiment, Thomas demonstrated that 100 percent of the large faunal bone fragments would be recovered with a 1/4 inch screen, but that fewer small remains (usually from rodents and fish) would be recovered. Small faunal bones would be recovered with either a 1/8 inch or 1/16 inch screen. Grayson (1984:171–172) notes that many Fremont sites (at least before 1984), were excavated using 1/4 inch screens, which he argues results in the overabundance of large mammals in the recovered assemblage.

Screening was used throughout all field seasons at Wolf Village. In most cases, all excavated deposits across the site were screened through 1/8 inch (0.31 cm) mesh screens. In some cases, though, such as when sediments were removed from above the midden-fill of Structure 2, screening was done with 1/4 inch (0.64 cm) mesh screens. In rare cases (also while removing sediments over Structure 2), the overburden over architectural structures was not screened at all. Nevertheless, the faunal bones analyzed in this study were screened through 1/8 in mesh screens. The faunal bones in this research came from the fills, floor zones (within 10 cm of the cultural floor), and subfloor features of all architectural features and activity areas at Wolf Village.

Wolf Village was excavated primarily using 1/8 inch screens, and the faunal bone assemblage primarily consists of bone specimens of artiodactyls and other large mammals. Nevertheless, excavators collected a large quantity of small bone fragments. While there may be preservation bias among the Wolf Village faunal bone assemblage, I am confident that the sample recovered was representative of the preserved faunal bone within the buildings and storage pits at Wolf Village.

Carnivore Disturbance

A faunal bone assemblage from an archaeological site can be affected by both cultural and natural processes (Schiffer 1987). Cultural processes include transport decisions and species selection. Natural processes include weathering, carnivore disturbance, and more. Non-human carnivores can scavenge bones that humans have discarded. Carnivore scavenging can result in a loss of bones that were present at a site, and this loss can affect the calculated relative abundance of taxa identified. Reitz and Wing (2008:134) explain that scavengers are attracted to the edible portions of animals, and that these types of animals can either destroy some faunal bones, move them to another location, and/or add additional faunal bones to a site. While it is impossible to account for the loss of faunal bones at a site, archaeologists can deduce whether portions of an assemblage are the result of non-human carnivores bringing faunal bones back to a site. Information about carnivore disturbance can be deduced by identifying cultural modifications, such as cut marks or burning, on a piece of faunal bone. If a high quantity of bones from an assemblage exhibit cultural modifications, then most of the assemblage was probably the result of human activities rather than non-human accumulation.

Density-Mediated Attrition

Faunal bone assemblages can be impacted by natural processes and result in damage or destruction of faunal bones. Cultural processes can affect which species are present within a faunal bone assemblage. In addition, cultural processes can affect the frequency of faunal skeletal elements, which may affect the results of analysis. Denser portions of skeletal elements are more likely to survive the taphonomic processes that can damage or destroy less-dense bones (Lyman 1994). Structural density values, like utility indices, can help analyze the effects of attrition on skeletal frequencies in an assemblage. A faunal analyst must observe the statistical relationships between the percentage of survivorship and bone density in order to determine whether density-mediated attrition, instead of transportation decisions, are responsible for frequencies of bones in a faunal bone assemblage. Grayson (1988) explains that if density-mediated attrition affects faunal bone assemblages, then the statistical relationship between the percent of survivorship and bone density will be positive and significant, while the relationship between the percent of survivorship and bone utility will be insignificant (see Lyman 1994).

Other Factors

I assume that my sampling methods (described in Chapter 3) gave me an accurate representation of the relative abundance of taxa identified (NISP) at Wolf Village. I analyzed faunal bones from different cultural contexts at Wolf Village, including all architectural features and activity areas. I assume that the bones recovered from those areas were related to activities that occurred at the site. I do not assume that faunal bones recovered from specific architectural features or areas were only associated with those areas, but instead aggregate all faunal bones into two groups according to time period. I do assume that all faunal bones recovered from storage pits and use surfaces of the activity areas were associated with activities occurring during Period I (A.D. 650 – 800) at Wolf Village. I further assume that all faunal bones recovered from the architectural features were associated with activities occurring during Period II (A.D. 1000 – 1150) at Wolf Village.

Lastly, I assume that the Fremont were capable of making hunting choices based on a wide variety of reasons and not just expected caloric returns. Human behavior and decisions are generally complex and variable. In this research, I consider social practices at Wolf Village, and how those practices may have affected the utility of large game skeletal portions and transport decisions. As previously explained, an example of low-caloric elements are metapodials, which were used by the Fremont to make tools and gaming pieces. Consequently, bringing these bones back to the village may have been worth the effort. Producing bone gaming pieces, bone awls, and other objects could have been important for several reasons, including to make tools for constructing basketry, moccasins, and other objects (Bryce 2016), and to engage in social activities such as trade and gambling (Janetski 2002). In addition, small artiodactyl mandibles may have been symbolically important to the Fremont. There have been several complete mandibles found in ventilation tunnels at Wolf Village (Abo 2016; see also Holm 2017). Although mandibles and metapodials are low-caloric elements, the Fremont may have viewed them as vital for tool production and social practices. In this thesis, I attempt to explore what the Fremont viewed as the true "utility" value of large game bone elements.

SCOPE AND LIMITATIONS

Along with presenting unpublished faunal bone and strontium isotope data for Wolf Village, the other goals of this thesis are to (1) gage the effectiveness of the MGUI for researching site function and transport practices and (2) to present strontium isotope analysis as a viable supplement to the MGUI for exploring prehistoric transport practices. The faunal bone assemblage from Wolf Village is ideal for testing the value of the MGUI and strontium isotope analysis since it includes a high quantity of small artiodactyl bones in a state of preservation that made it possible to identify specific skeletal elements.

A constraint of this research is that my focus is only on the utility of large game body parts and transport decisions by Fremont hunters. I do address the relative abundance of taxa at Wolf Village in Chapter 4 and briefly describe the importance of other non-artiodactyl animals; however, much of my analysis focused on identifying small artiodactyl remains. I do not explore the use of birds, fish, or small mammals at Wolf Village in depth. These topics are addressed elsewhere (see Lambert et al. 2017).

Another constraint of my research arises from limitations in funding. I only identified strontium baselines for six Fremont sites using teeth from ten small mammals per site. I assume that all small mammals were local to their specific areas (see Chapter 5), but it is possible that some were brought to their respective regions through trade. I was also limited on how many Fremont sites could be tested for their strontium baselines. Future research should include more Fremont sites and regions, especially sites including and around Five Finger Ridge, since that is where the only other strontium isotope research has been carried out in Fremont areas (see Fisher 2010; Fisher and Valentine 2013). Five Finger Ridge was excluded from this study since I was unable to obtain the permission for destructive analysis on rodent teeth within a reasonable timeline.

THESIS ORGANIZATION

In this thesis, I examine the utility of large game skeletal portions and attempt to reconstruct transport decisions by Fremont hunters based on data from Wolf Village. I argue that the MGUI conflates utility with values, and that some so-called low utility parts of animals had high value, such as dense bones for making tools. Results of strontium isotope analysis on small artiodactyl teeth from Wolf Village suggest that some large game was transported to Wolf Village as whole carcasses. The energy costs of carrying whole carcasses were apparently worth it since they were brought back to Wolf Village. Clearly, some low-caloric elements had significance to the Fremont beyond caloric value. This first chapter has focused on describing my research goals for this thesis, potential problems with Binford's MGUI in archaeological research, and the assumptions and limitations of this thesis research.

Background information is presented in Chapter 2 to provide context for Wolf Village and its place in the Fremont region. I briefly describe the history of Fremont archaeological research and define the Fremont and some of their cultural traits. I also describe previous archaeological research in Goshen Valley, especially at Wolf Village. I conclude Chapter 2 by describing Wolf Village in its environmental and historic setting.

In Chapter 3, I describe the methods used to identify the faunal bones recovered from Wolf Village. I describe my sampling strategy to select the faunal bones for my data set, discuss the process of recording taphonomic data, and describe the different ways in which I quantified the relative frequencies of taxa and skeletal frequencies.

Chapter 4 presents the results of my faunal bone analysis for Wolf Village. These include the relative frequencies of taxa and the proportions of artiodactyls, birds, and fish at the site. I also describe taphonomic modifications found on artiodactyl bones from Wolf Village caused by cultural and natural processes. Lastly, I attempt to gage the impact on my identifications, counts, and indexes of potential biases, specifically carnivore disturbance and density-mediated attrition on the faunal bones from Wolf Village.

In Chapter 5, I discuss Fremont hunters' large game transport practices at Wolf Village. I discuss taxonomic richness and diversity among the Wolf Village faunal bone assemblages. I also examine the possiblity of a resource depression of some artiodactyl species. I present the skeletal frequencies of artiodactyl bone elements from Wolf Village and compare them to expectations of optimal foraging models, including the MGUI. I also address my research objectives in relation to these findings.

In Chapter 6, I discuss the importance of strontium isotope analysis and I describe previous strontium isotope research in archaeology, specifically at Five Finger Ridge. I also explain the materials and methods used when performing strontium isotope analysis on artiodactyl teeth from Wolf Village. Finally, I present the results of the strontium isotope analysis and compare these findings to the results of the MGUI at Wolf Village.

In the concluding chapter, I discuss the results of both the MGUI and strontium isotope analysis. I also compare the result of the MGUI for Wolf Village and other Fremont habitation sites. I explore problems of relying on the MGUI alone to interpret hunting and transport strategies by the Fremont. I explore social uses of faunal bones, including as bone resources for tools and as elements of trade. I reconsider my research objectives and provide suggestions for future research.

2 | The Fremont

In this chapter, I focus on the Fremont. First, I briefly describe the current state of Fremont archaeology. The purpose of this discussion is to provide context for how the Fremont have been viewed, studied, and defined by past and current archaeologists. Next, I define and describe the Fremont, including a discussion on their subsistence, architecture, material culture, and social organization. After properly defining the Fremont, I narrow my discussion on the Fremont by describing previous research about Goshen Valley, specifically Wolf Village. Finally, I describe the Wolf Village setting and its architectural features.

A BRIEF HISTORY OF FREMONT RESEARCH

In-depth syntheses of Fremont research have been offered by others (see D. Fowler 1986; Janetski 1997a; Madsen and Simms 1998; Ure 2013). Therefore, I only offer a brief synthesis of Fremont research. Since the Fremont bordered both the Great Basin and Southwest culture areas, Fremont archaeology has had a complicated relationship with both regions. Early Fremont interpretations described the Fremont as a periphery of the Ancestral Puebloans (e.g., Gunnerson 1969; Morss 1931), while later researchers broke away from that tradition and portrayed the Fremont culture as one that stood apart from the rest of the Southwest (e.g., Jennings and Norbeck 1955; Marwitt 1970; Rudy 1953; and Wormington 1955;). Recent publications by some current Fremont archaeologists push for a Southwestern theoretical perspective (e.g., Allison

2008; Janetski 2008; Searcy and Talbot 2016; Talbot 2000b).

Noel Morss was the first to use the term “Fremont culture” to describe the prehistoric peoples of Utah. He also argued that the Fremont stayed at the Basketmaker III level of technology, as evidenced by their plain pottery, figurines, the absence of cotton and turkeys, and more (Morss 1931:76–77). Due to the similarities between the Fremont and Puebloan cultures, the Fremont region was referred to as the Northern Periphery of the Southwest by Alfred Kidder, Julian Steward, and others (Janetski 1997a:114; Janetski and Talbot 2000:2; Kidder 1962). Steward (1933) believed that the Northern Periphery was a result of various traits of the Southwest diffusing into the area, including pottery styles, and trapezoidal-bodied and anthropomorphic petroglyphs and figurines.

Although early archaeologists regarded the Fremont as peripheral to the Southwest, later researchers (see Jennings and Norbeck 1955) believed the Fremont to have derived from indigenous Great Basin hunter-gatherer cultures (Allison 2010:131). Some current archaeologists now suggest a theoretical perspective associated with archaeology in the American Southwest, in order to explore Fremont social behavior (Janetski 2008:105–106; see also Allison 2008, 2010; Janetski and Talbot 2014; Searcy and Talbot 2016; Talbot 2000b). At least one Southwest archaeologist has recently considered the Fremont as part of the history of the Southwest (Lekson 2014). Richard Talbot researched Fremont farming, trade, and community organization in relation to the Southwest and argued that “Fremont sociopolitical foundation and historical trajectory are distinctively southwestern, and Fremont people actively participated in interregional trade networks” (Talbot 2000b:288).

DEFINING THE FREMONT

As discussed above, defining the Fremont can be complex. For the purpose of this thesis, I define the Fremont for this research only and make no attempt at exploring the complexities of the Fremont as a group or groups. The term "Fremont" in this research, refers to diverse groups of people who practiced hunting and horticulture and who lived in much of Utah, as well as parts of Nevada and Colorado from approximately A.D. 500 to 1300 (see Figure 1.2). Fremont sites have been identified along the eastern edge of the Great Basin and the northern Colorado Plateau. Grayson (1984:143) notes that since the Fremont occupation interrupts an 11,000 year sequence of hunting and gathering, archaeologists have spent considerable time researching this cultural phenomenon, and Fremont subsistence practices have been particularly emphasized. As with Fremont research, in-depth syntheses of the Fremont people have been offered by others (Janetski 2008; Simms 2008; Ure 2013). In this thesis, I only provide a brief description of the Fremont, especially in relation to subsistence and hunting practices. For the purpose of this research, I briefly explore Fremont material culture, subsistence practices, architectural styles, and trade interactions.

Material Culture

As stated, Morss (1931) was the first to use the term "Fremont" to describe the prehistoric people of Utah. He described the Fremont as a distinct culture along the Fremont River near Torrey, Utah, due to a trait package of ceramic pottery types, rock art styles, figurines, moccasins, and more. Others (Maguire 1894; Palmer 1877) recognized these prehistoric farmers, but never referred to them formally as Fremont. Presently, the term "Fremont" has been expanded to include prehistoric farmers who occupied most of modern Utah. Fremont sites are usually identifiable due to their geographic location and distinctive material culture.

There are several cultural traits that are distinctively Fremont, including pottery types, rock art styles, and figurine styles. The Fremont are recognized, in part, by their distinctive pottery types. Fremont pottery consists of utilitarian grayware, as well as black-on-white and black-on-gray painted bowls. There are also corrugated pottery types and ones with "coffeebean” appliques (Richards 2014; Richens 2000; Ure 2013). Fremont rock art includes many trapezoidal-bodied anthropomorphic figures, some with elaborate regalia, including necklaces, ornaments, and headgear (Schaafsma 1971, 2014). Fremont figurines show similar shapes and designs as Fremont rock art (Yoder 2016).

Other material culture recognized by archaeologists as being Fremont are a single rod-and-bundle basketry technique (Adovasio 1975:68) and a distinct moccasin style made with a deer hock and the deer claw still attached on the sole of the moccasin (Aiken and Madsen 1986:159; Morss 1931:64). Material culture not distinctively Fremont, but recovered from some Fremont sites includes marine shell beads from shell found along the California coast (Castro and Dement 2013; Castro 2015; Janetski 2002), worked bone gaming pieces (Hall 2008, 2009; Janetski 2017; Robbins and Lambert 2016), turquoise ornaments, and lignite beads.

Subsistence

Fremont subsistence practices are particularly appropriate for my research. Fremont diet consisted of a mixture of wild resources (including plants and animals) and domesticated crops (maize, squash, and beans). Fremont diet has been debated by archaeologists for decades (see Madsen 1979; Madsen and Simms 1998; Marwitt 1970). Marwitt (1970) argued that the Fremont relied on mixed subsistence practices based on local environment. In essence, he argued that the environment determined how heavily the Fremont relied on agriculture or hunting and foraging. Madsen (1979) argued that data from Backhoe Village suggest the Fremont relied most heavily on wild resources, rather than on maize agriculture. Of 25,000 pollen grains collected from Backhoe Village, only eight were from domesticated corn. Therefore, he argues that since there was a “virtual lack of pollen from domesticated plant types” at Backhoe Village, the Fremont relied more on foraging than on farming (Madsen 1979:714). However, the high quantity of maize obtained from 1998 excavations at Backhoe Village suggest that domesticated maize was an important food resource and natural flora a secondary resource (Herrmann 2001:141).

Others have argued that Fremont subsistence differed depending on environmental conditions. Simms (1986) argued that Fremont diet was highly variable, depending on where people lived and the local environment. He proposes three Fremont subsistence practices based on diverse adaptations to the environment. These three strategies include: (1) full-time farmers who foraged locally to supplement their diet, (2) part-time famers and gathers who switched focus at different times of the year, and (3) both full-time farming groups and full-time hunter-gatherers who occupied the same region (Simms 1986:206). Later, Simms (2008:187) states that after A.D. 900, most of the Fremont people had aggregated into villages, hamlets, and farmsteads, to focus more on farming.

Recent isotope studies have explored aspects of Fremont diet. Coltrain and Leavitt (2002) describe research done on Fremont burials from wetlands around the Great Salt Lake to explore the relationship between Fremont reliance on maize, and gender and socioeconomic status. Isotope signatures of dated burials suggests that diets varied over time as well as by sex (Coltrain and Leavitt 2002:454). Male and female diets among the Great Salt Lake Fremont varied significantly. Isotope data from some male burials with grave goods had high C_4 diets, suggesting greater protein consumption. Coltrain and Leavitt (2002) argue that a social hierarchy may have been present among some Fremont males as evidenced by grave goods. Eventually, as economic diversity was replaced by a reliance on wild foods, the male-status distinctions were no longer present (Coltrain and Leavitt 2002:479). Likewise, Ure (2009) explored diet from a burial of a sub adult male excavated at Seamons Mound in 1968. Despite living during the height of Fremont maize cultivation in Utah Valley, stable isotope data from that burial suggests that his diet consisted of approximately 50 percent maize (Ure 2009:91–93).

In this research, I do not attempt to argue for or against Fremont reliance on either foraging or farming. I assume that both were important parts of the diet of the Fremont at Wolf

Village, as Dahle's (2011) research has suggested. I argue that hunting was also a major part of Fremont subsistence at the site.

Architecture

There was a variety of architectural styles identified at Wolf Village. Many of the faunal bones in this study were excavated from within the varying building types. Fremont architectural styles have been described in depth by Talbot (2000a). He notes that Fremont architecture was a less-studied topic in Fremont scholarship. He suggests that Fremont archaeologists should follow Southwestern archaeology, where architecture is an important part of Southwest archaeology research (Talbot 2000a:131). In his research Talbot (2000a) defines five major types of Fremont buildings: (1) pithouses, (2) surface houses, (3) central structures, (4) secondary pit structures, and (5) storage structures. In this thesis, I define buildings at Wolf Village according to the definitions provided by Talbot (2000a). I provide a brief description of each type.

The primary residences of the Fremont are called pithouses. Most pithouses contain common features, such as central hearths, small storage facilities, and internal structural supports such and postholes and post-sockets. Talbot (2000a:136) explains that most pithouses are circular or quadrilateral in shape, although some pithouses are also D-shaped. Pithouses are usually large enough for several people to occupy the structure, or at least to perform several activities at the same time.

Surface houses are found throughout the Fremont region, but they are less common than pithouses. They are constructed of freestanding walls of adobe, jacal, or masonry (Talbot 2000a:138). Surface houses draw their name from their similarities to pithouses. Surface houses likely functioned in the same manner as pithouses since they both display the same types of floor features. A central hearth, floor, and subfloor features are present in surface houses, and both pithouses and surface houses are often similar in size. Surface structures with multiple rooms usually have storage rooms attached to the main habitation room, as seen in Structure 1 at Wolf Village. Talbot (2000a:138–139) notes that ventilation tunnels are usually not present in surface houses since ventilation was probably attained through open doorways (although Structure 6 at Wolf Village seems to be an exception – see Johansson et al. 2014:44–46). The Wolf Village excavations discovered two surface houses, Structures 1 and 6.

Central structures are much larger in size than average-size pithouses. Since central structures are quite large, they require massive internal support, as evidenced by high counts of postholes and post-sockets. There is usually only one central structure at a Fremont site, and central structures are usually built on the surface of a site (Talbot 2000a:139). In his research on Fremont architecture, Talbot (2000a:139) states that central structures have been identified at several Fremont sites, including Baker Village, the Garrison site, Beaver Mounds, Paragonah Mound, Evans Mound, Five Finger Ridge, Poplar Knob, Huntington Canyon, and Turner-Look. Ure and Stauffer (2010:3) also listed the Blue Trail House and Structure 6 at Wolf Village as central structures. Johansson et al. (2014:49–50) disagreed with Ure and Stauffer's classification of Structure 6 at Wolf Village as a central structure, since its small size (22 m^2) was not large enough to be used communally. They argue that Structures 2 and 8, both oversized pit structures, were most likely communal places in the Wolf Village community (Johansson et al. 2014:50–51). Indeed, Richards et al. (2018) state that Structure 2 at Wolf Village may have been both residential and communal.

Secondary pit structures are defined by Talbot (2000a:136) as structures that served as temporary habitation areas. These structures had a specialized function such as sweat lodges, birthing or menstrual huts, or as places for visitors. A small central hearth is usually present, although other subfloor features are rare. Storage structures (also known as granary features) are separate from pithouses and are common at late Fremont sites (Talbot 2000a:137). Storage structures were likely used for storing excess food. Secondary pit structures and storage structures were not identified during the Wolf Village excavations.

Trade

The Fremont appear to have had trading relationships with other areas of the Southwest and at least as far as the California coast. Exotic items such as marine shell, turquoise, jet, and Ancestral Puebloan ceramics are common in Fremont archaeological assemblages, suggesting that trade was ongoing. Janetski (2002) views trade as a process in which regions can participate in social and economic interactions. He states that long distance exchange among the indigenous peoples of Australia, Alaska, California, and at the Big Camas Prairie on the Snake River usually were accompanied by trade festivals, which included feasting, gambling, and bartering. Gambling done at these types of festivals in upper Missouri was done with paraphernalia, which included gaming bones or dice. These items are also found at Fremont sites, including the Parowan Valley and Wolf Village (Janetski 2002:348; see also Hall 2008, 2009; Janetski 2017; and Robbins and Lambert 2016). Like in other cultures, festivals or trade fairs were also important in areas of the Southwest (Janetski 2002:347).

The presence of exotic goods among the Fremont (i.e., marine shell, turquoise, and Ancestral Puebloan ceramics) suggests the movement of goods within the Fremont area and between the Fremont and other peoples of the Southwest and the Great Basin (Janetski 2002:349–358; see also Bennyhoff and Hughes 1987, 2011; Castro and Dement 2013; Watkins 2006). Exotic materials were probably only a part of the larger volume of trade, which likely consisted of perishable goods such as food, hides, robes, slaves, and more (Janetski 2002:359). Long distance trade occurred between the Fremont and other Southwestern groups. The mechanism of trade may have included trade festivals. Janetski et al. (2011:47) suggest that trade connections among the Fremont were reinforced by participating in regional festivals at central structures (similar to the Hohokam ball court network).

PREVIOUS RESEARCH IN GOSHEN VALLEY

Goshen Valley is located in Utah County, along the south end of Utah Lake (see Figure 1.1). Previous research in Goshen Valley has been done by numerous scholars (notably Baker and Janetski 2004; Cook 1980; Gilsen 1968; Jones 1961; among others). Much of the research in Goshen Valley has focused on Woodard Mound (see Richens 1983 for a summary of the excavations) and Spotten Cave (Mock 1971); however, survey work done by Leland Gilsen (1968) as part of his Master's thesis is most noteworthy for this research due to his descriptions of Wolf Village and the surrounding sites. He focused on surveying Currant and Kimball Creek drainages; however, limited excavations occurred as part of his thesis research (mainly at Woodard Mound) (Gilsen 1968:57–60). Janetski (2004:3) notes that Gilsen's survey was reconnaissance rather than systematic. Gilsen classified sites he found into three categories: village sites, house clusters, and campsites. These classifications were based on the size of the site, surface artifacts, architecture, and indications of potential sub-surface features (Gilsen 1968:21–24). His survey resulted in the identification of two villages, 10 house clusters, and 23 campsites along Currant Creek. Gilsen (1968:28) defined Wolf Village as a village site and dated it within the Fremont period as indicated by ceramic and projectile point types. Baker and Janetski (2004:50) note that Gilsen identified a Fremont campsite site (42UT277) approximately 150 meters northwest of Wolf Village, which they argue suggests that the ridges around Wolf Village may have contained a cluster of Fremont habitations (see also Gilsen 1968:30). They also note that Gilsen's survey is important for documenting many Goshen Valley sites that had been destroyed by development (Baker and Janetski 2004:39).

As a result of his surveys in Goshen Valley, Gilsen (1968) concluded that Fremont villages in that area (including Wolf Village) were closely associated with sources of running water. He attributed this to the Fremont practicing horticulture (Gilsen 1968:140). Gilsen (1968:141) claimed that many of the large Fremont sites on his survey contained Ancestral

Puebloan ceramics (although Wolf Village did not), which dated the sites to approximately A.D. 1050 – 1150. Modern radiocarbon dates from Wolf Village support the ceramic dates (see Table 2.1). The location of Wolf Village in relation to other Fremont sites suggests that Wolf Village was part of a greater Fremont community in Goshen Valley. However, Baker and Janetski (2004:39) note that Gilsen assumed all sites in his survey dated to the Fremont period, including sites without ceramics. At least some of these sites without ceramics could have been Archaic, rather than campsites associated with Fremont villages or house clusters.

A more recent survey of Goshen Valley was conducted by Colleen Baker and Joel C. Janetski during the summer field seasons of 1990 – 1992. The Goshen Valley Survey Project was the first attempt to perform a systematic archaeological survey in the valley (Baker and Janetski 2004:67). During the project, only 10 percent of the valley was surveyed. This was done by crews walking 15 transects that were each 160 meters wide, from east to west across the valley. Archaeological sites were identified by surface artifacts, architectural features, and non-architectural features. The survey resulted in the identifying of 55 new sites and re-recording of seven of Gilsen's (1968) sites. Using diagnostic artifacts and features, Baker and Janetski (2004) identified 18 of the 62 sites to be from the Fremont period, seven from the Archaic, and six from the Late Prehistoric. The rest of the 62 sites could not be assigned a cultural affiliation (Baker and Janetski 2004:67). They note one pattern among the Fremont sites, specifically that of the four Fremont sites with structural evidence (two had previously been recorded by Gilsen), two were on Currant Creek. The other two were on a terrace overlooking Goshen Bay but did not contain structural adobe, so Baker and Janetski (2004:67–68) theorize that these other two sites may have been temporary structural sites since both are far from water sources. They suggest that Fremont structural sites in Goshen Valley were concentrated along drainages (Baker and Janetski 2004:67–68). This is also the case of Wolf Village, which suggests the site was a permanent village.

Wolf Village has been the topic of three Master's theses (Bryce 2016; Dahle 2011; Pyper 2011), two Brigham Young University (BYU) Honor's theses (Castro 2015; Wilson 2013), and two published articles (Castro and Dement 2013; Johansson et al. 2014). Previous and current research has been conducted on the architectural variation at Wolf Village, focusing on communal and residential architecture (Johansson et al 2014; Lambert and Bryce 2016). Johansson et al. (2014:47) define "communal structures" as facilities used by either entire communities or smaller portions of a community. They assume that communal buildings were built and used by groups larger than single households. These types of buildings would likely have required the cooperation of large portions of the community to build and maintain. Communal buildings are identified, in part, by being "much larger than the average-sized pit house" (Talbot 2000a:183). Talbot (2000a:139) explains that communal architecture requires a high amount of effort to build and maintain than for most other architectural forms, which he states implies communal use. Communal buildings include both pit and surface structures. Structures 1, 2, and 8 at Wolf Village seem to meet the criteria of communal architecture, due to their large size and unusual architectural styles compared to other buildings at the site. Ure and Stauffer (2010) argue that Structure 6 may also have been a central structure; a gathering place for community meetings and religious ceremonies. Johansson et al. (2014:50), however, are skeptical of this idea and argue that while Structure 6 "may have been a special building," it is not large enough to be built or used communally.

Other research includes plant-based subsistence practices and trade at Wolf Village. Dahle (2011) analyzed micro and macro botanical remains collected during the first three field seasons at Wolf Village (2009 – 2011). She argues that farming and foraging were both important parts of Fremont subsistence at Wolf Village. Structure 1 in particular, had a high amount of maize in the side-room east of the main habitation room (see Figure 2.12). There was an apparent abundance of maize, beans, and wild plants excavated at Wolf Village. Although wild plants, including dock, amaranth, beeplant, and goosefoot were present at Wolf Village, none would have provided as many calories as farming domesticated plants (i.e., maize and beans). Dahle (2011:73) concludes that farming was a strong economic basis of subsistence for the Fremont at Wolf Village in the latter period (i.e., Period II), but that foraging also played a role in the subsistence practices at the site.

Wolf Village appeared to have participated in a large trade network of marine shell between the California coast and the Great Basin. Castro and Dement (2013) analyzed 173 *Olivella* shell beads recovered from Wolf Village during the first four field seasons and determine that most of the shell originated from the California coast (see also Castro 2015). Janetski et al. (2011:42) state that a high number of shell artifacts suggests the importance of a site on the Fremont landscape. Locations with high frequencies of exotic artifacts (such as Structure 2 at Wolf Village) suggest that the location was a place where people may have traded with others (Janetski 2002:359; see also Renfrew 1977:85). Castro and Dement (2013:57–60) conclude from the shell data that Wolf Village was part of a large trade network between the California Coast and the Great Basin.

Former research relating to animal use at Wolf Village include several senior theses (notably Crandall 2017; Holm 2017; and Julian 2017) and one Master's thesis (Bryce 2016). Crandall (2017) analyzed faunal bones from Structure 1 in order to investigate whether faunal bone specimens excavated in the building were associated with activities undertaken at the building or were from secondary contexts. She concludes that most of the faunal bone specimens from secondary contexts, meaning they cannot suggest specific prehistoric activities done in any of the rooms. They can, however, provide information about overall diet at Wolf Village (Crandall 2017:16).

Julian (2017) investigated feasting activities that may have occurred at Structure 8, as evidenced by high quantities of small artiodactyl bone fragments. She compared faunal bones from Structures 1 and 4 to Structure 8 to identify differences between the buildings. She notes that “greater amounts of meat were consumed in [Structure 8] than in the other two structures” and argues that feasting activities occurred there (Julian 2017:2–3).

Abo (2016) examined evidence of ritual abandonment of some buildings at Wolf Village, a topic also explored by Holm (2017). Holm argued that Structure 9 at Wolf Village was ritually abandoned by the Fremont, as evidenced by “offerings” which included animal body parts and ceramic vessels. He further argued that the abandonment characteristics associated with Structure 9 (i.e., burning the building after its disuse, bone and ceramic deposits, etc.) were unique in the Fremont culture region (Holm 2017:2). I disagree with Holm (2017) since large game skulls, mandibles, and vertebrae were identified in supposed ritual contexts at other Wolf Village structures (Structures 2, 6, and 8 – see Abo 2016:8–17), and perhaps at Kay’s Cabin (Janetski 2016:49; see also Abo 2016:17–19). In fact, Abo (2016:17–19) reports that Ventilation Tunnel 1 in Structure 2 at Kay's Cabin contained one bighorn sheep mandible, one deer mandible, five deer scapulae, and one pronghorn scapula (see also Janetski 2016:40–42). She argues that concentrations of animal bones were likely intentionally placed in ventilation tunnels as part of rituals associated with the disuse of certain buildings (Abo 2016:22).

Bryce (2016) investigated the manufacture and use of bone awls at Wolf Village. He analyzed 135 bone awls and concluded that craftspeople at Wolf Village used these tools for basket making, leatherwork, and other activities. I assisted Bryce with identifying the taxon and element of all bone awls at Wolf Village, and determined that most awls were created from long bones (specifically metapodials) of small artiodactyls. Two awls were identified as bighorn sheep elements, two as pronghorn, and three as mule deer (Bryce 2016:56–58). It appears that animals were valued at Wolf Village beyond their meat. This thesis attempts to further add to the discussion on animal use at Wolf Village and to compare to other Fremont sites that have had their faunal bone assemblages compared to Binford’s MGUI.

Figure 2.1. Aerial view of Wolf Village facing south at the end of the 2012 field season. Photo by Michael Searcy. Courtesy of the Brigham Young University 2012 Field School.

WOLF VILLAGE

Wolf Village is located on private property owned by the Wolf family and used for grazing cattle (Figure 2.1). A reconnaissance survey of Goshen Valley was conducted by Leland Gilsen in 1966 as part of his master's thesis. He claimed to have identified thirteen buildings at Wolf Village, which were visible due to artifact concentrations and decaying adobe walls (Gilsen 1968:28). Archaeological excavations at Wolf Village focused on Fremont structures, and resulted in the excavation of nine, including six pithouses, two surface buildings, and one oversized pit structure (Figure 2.2) (Johansson et al. 2014). When referring to structure numbers of Wolf Village architectural features, I use the numbers designated by Johansson et al. (2014). Archaeological excavations began at Wolf Village in 2009 under the direction of Joel Janetski.

Figure 2.2. Aerial view of Wolf Village showing the location of nine structures outlined in white. The two activity areas are also marked. Map courtesy of Scott Ure after Johansson et al. (2014:Figure 3). Updated by the author.

James Allison directed the excavations from 2010 – 2016, with Michael Searcy co-directing in 2012 and David Yoder co-directing in 2016.

Setting

Wolf Village is located on a series of low hills and ridges, just north of the mouth of Goshen Canyon (see Figure 2.1). Vegetation at the site consists of juniper, sagebrush, greasewood, and rabbit brush. In addition, the fields surrounding the site, where the Fremont likely farmed, are now alfalfa fields. The closest water source is Currant Creek, which runs through modern nearby fields. Terrestrial fauna in Goshen Valley consists of cottontails (*Syvilagus* spp.), jackrabbits (*Lepus* spp.), various squirrels (*Spermophilius* spp.), coyote (*Canis latrans*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and several small rodents. Wetland animals include waterfowl and water-loving mammals such as muskrats (*Ondatra zibethicus*) (Baker and Janetski 2004; Prichett et al. 1981). Fish from Currant Creek and Utah Lake include suckers, chubs, and trout (Baker and Janetski 2004; Heckmann et al. 1981; Janetski 1990).

Dating

Eighteen radiocarbon dates from maize samples were processed from the nine excavated buildings. Some of these dates are presented in Johansson et al. (2014:35) and represented in Table 2.1. Newly obtained unpublished dates are also presented in Table 2.1 (James Allison, personal communication 2018). Johansson et al. (2014:33) point out that despite variability in architectural form at Wolf Village, radiocarbon dates from the buildings suggest that they were occupied within a few decades of each other in the A.D. 1000s or early 1100s. Recently obtained radiocarbon dates for Structures 8 and 9 suggest they too were contemporary with the other architectural features at Wolf Village (see Table 2.1).

Activity Areas 1 and 2 were located in the far north portion of the site. I define “activity area” as a location where prehistoric peoples performed daily activities, as evidenced by the remains of pits, postholes, or middens. Activity areas do not include clearly identified buildings.

Table 2.1. AMS Radiocarbon Dates from Wolf Village Structures and Activity Areas. Beta sample 432079 is from faunal bone, the rest are from maize samples.

Beta Number	Location	Measured Radiocarbon Age BP	$^{13}C/^{12}C$	Conventional Radiocarbon Age BP	Calibrated 95% Interval
287720	Structure 1	740 ± 40	-11.2	970 ± 40	998–1157 A.D.
287726	Structure 1	730 ± 40	-10.3	970 ± 40	998–1157 A.D.
261679	Structure 1	720 ± 40	-10.2	960 ± 40	1007–1164 A.D.
441614	Structure 1	710 ± 30	-11	940 ± 30	1020–1165 A.D.
287727	Structure 2	780 ± 40	-11	1010 ± 40	965–1154 A.D.
287723	Structure 2	750 ± 40	-10.7	980 ± 40	992–1154 A.D.
287725	Structure 2	740 ± 40	-10.5	980 ± 40	992–1154 A.D.
287724	Structure 2	730 ± 40	-10.9	960 ± 40	1007–1164 A.D.
287722	Structure 2	720 ± 40	-10.8	950 ± 40	1015–1172 A.D.
338654	Structure 2	640 ± 30	-8.7	910 ± 30	1032–1194 A.D.
338655	Structure 2	660 ± 30	-10.2	900 ± 30	1040–1207 A.D.
261680	Structure 3	780 ± 40	-10.3	1020 ± 40	900–1128 A.D.
287721	Structure 3	750 ± 40	-10.1	990 ± 40	987–1153 A.D.
312654	Structure 4	730 ± 30	-10.9	960 ± 30	1021–1152 A.D.
312653	Structure 5	680 ± 30	-11.8	900 ± 30	1040–1207 A.D.
287728	Structure 6	690 ± 40	-10.5	930 ± 40	1022–1189 A.D.
287730	Structure 6	690 ± 40	-10.9	920 ± 40	1026–1200 A.D.
287729	Structure 6	670 ± 40	-10.2	910 ± 40	1031–1208 A.D.
312655	Structure 7	750 ± 30	-9.8	1000 ± 30	989–1145 A.D.
440722	Structure 8	670 ± 30	-11.5	890 ± 30	1040–1220 A.D.
440723	Structure 8	740 ± 30	-10.6	980 ± 30	1015–1050 A.D.
441612	Structure 9	660 ± 30	-9.4	920 ± 30	1025–1190 A.D.
441613	Structure 9	700 ± 30	-10.6	940 ± 30	1020–1165 A.D.
441614	Structure 9	710 ± 30	-11	940 ± 30	1020–1165 A.D.
361249	Activity Area 1	670 ± 30	-10.8	900 ± 30	1030–1220 A.D.
361250	Activity Area 1	930 ± 30	-10.3	1170 ± 30	780–900 A.D. 920–970 A.D.
261681	Activity Area 1	1060 ± 40	-10.5	1300 ± 40	650–850 A.D.
361251	Activity Area 2	730 ± 30	-10.1	970 ± 30	1020–1160 A.D.
361252	Activity Area 2	1030 ± 30	-9.4	1290 ± 30	660–780 A.D.
312657	Activity Area 2	1120 ± 30	-11.4	1340 ± 30	640–770 A.D.
432079	Activity Area 2	1150 ± 30	-19.4	1240 ± 30	780–970 A.D.

Both activity areas provided radiocarbon dates from maize contemporary with the more recent buildings, but several pits contained maize samples that yielded dates much earlier than the buildings at Wolf Village (see Table 2.1). In addition, a mule deer tibia from a large pit in Activity Area 2 provided an early radiocarbon date. These dates range between A.D. 650 – 800.

For the purpose of this research, I divided the faunal bone assemblage into two groups according to time period: those from Period I and those from Period II. Period I at Wolf Village occurred from A.D. 650 – 800. The two activity areas date within Period I, and consist of several pits and postholes (Lambert et al. 2016). Period II at Wolf Village occurred from A.D. 1000 – 1150. All nine buildings at Wolf Village date within this time period (see Johansson et al. 2014). Both occupations are within the Fremont time period.

Period I (A.D. 650 – 800)

Two activity areas in the northern portion of Wolf Village dated to within Period I: one on the easternmost knoll and the other on the northernmost knoll of the site (see Figure 2.2). Both activity areas are seemingly unrelated to the nine excavated structures.

Activity Area 1

Activity Area 1 is on the easternmost knoll of Wolf Village. It has been dated with two early maize samples dating from 930 ± 30 and 1060 ± 40 B.P. A third radiocarbon date from upper sediments dated to 670 ± 30 B.P. (see Table 2.1). This area was identified by the presence of adobe and artifacts on the surface and was excavated during the 2009 field season. Since Activity Area 1 is located on top of a knoll, sediments and artifacts do not appear to have washed in from other areas.

There are no clear architectural features identified in Activity Area 1; however, there appear to have been at least two occupation periods. The early occupation period of Activity

Area 1 is evidenced by seven storage pits and ten postholes making a semi-circular shape, suggesting that a structure may have existed but has since eroded away or was unidentified during excavation (Figure 2.3). The presence of the artifact-rich fill, along with the postholes, suggests that cultural activities occurred at this area frequently during the earlier occupation of Wolf Village.

The seven subfloor pits were of varying size and depths. Pit 1 is a 2 x 0.8 meter depression, approximately 25 cm deep. Pit 1 contained lithic debitage, ceramic potsherds, faunal bones, corn, and a drill. In the center of the depression was a large posthole. Pit 2 is a large 1.6 x 0.9 meter depression that is approximately 15 cm deep and contained a high quantity of ceramic potsherds, lithic debitage, adobe, faunal bones, and four corner-notched or expanding stemmed projectile points. Two postholes were located along the eastern edge of Pit 2. Pit 3 is a partially excavated pit in the northwest corner of the excavation area. The depth of the partially excavated pit is 84 cm, but the unexcavated portion may be deeper. Pit 3 appears triangular in shape and contained faunal bones, lithic debitage, and ceramic potsherds. Pit 4 is a shallow 1.2 x 0.2 meter depression in the west portion of the excavation area and was approximately 9 cm deep. It was identified in profile and left mostly unexcavated, although a posthole was identified within Pit 4. Pits 5, 6, and 7 were irregular shaped pits that were heavily disturbed by rodents and contained no artifacts.

The later occupation period of Activity Area 1 was evidenced by a short-lived cultural surface. Although the sediment atop this short-lived cultural surface was heavily impacted by rodent activity, two postholes were identified within the sediment as well as two possible thermal features. The two postholes contained portions of burned posts. A Nawthis side-notched projectile point recovered from the area suggests a later occupation (Lambert et al. 2016).

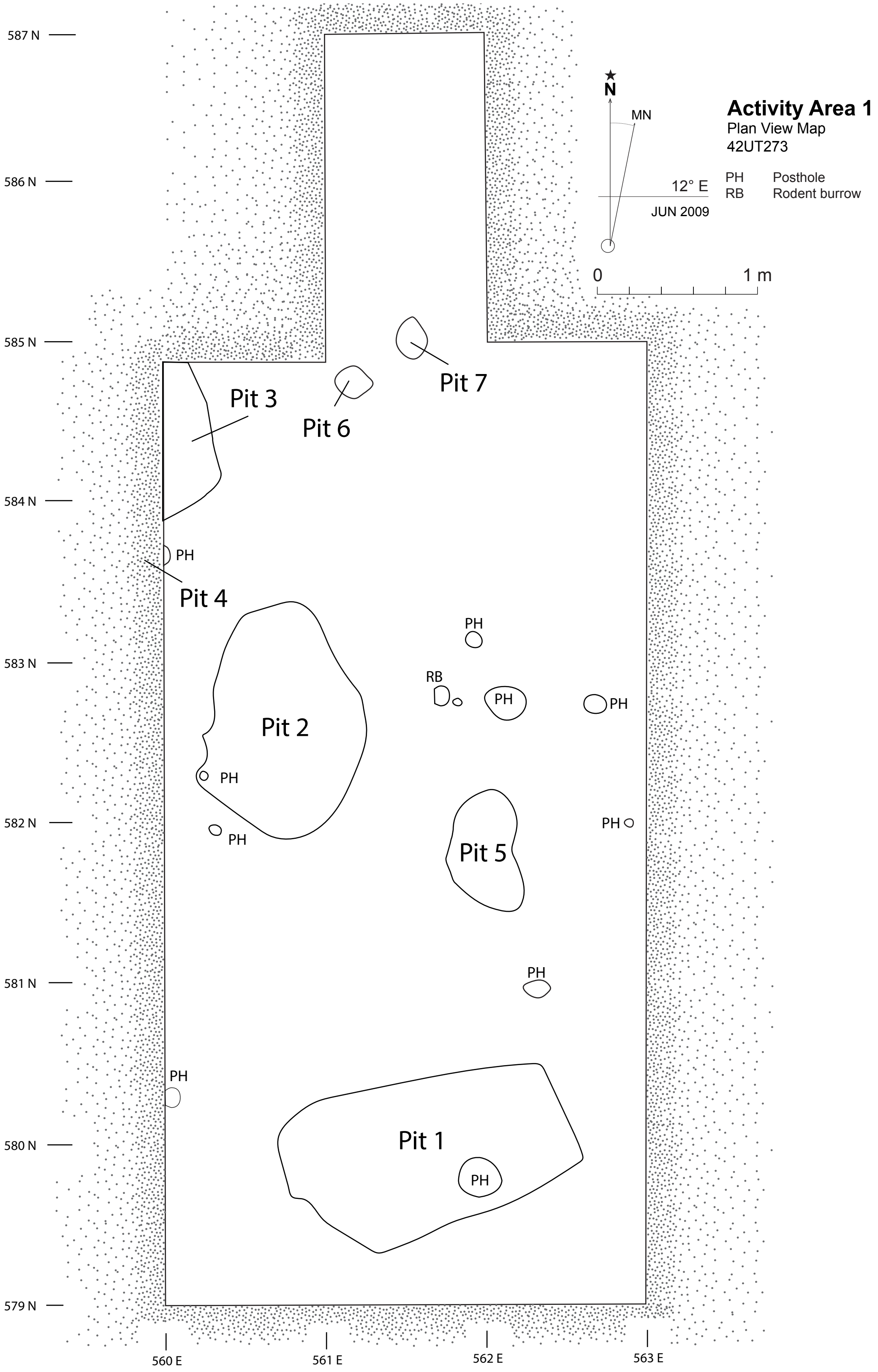

Figure 2.3. Plan map of Activity Area 1 at Wolf Village showing the location of seven pits.

Activity Area 2

Activity Area 2 is on the northernmost knoll of Wolf Village (Figure 2.4). Pit 8, a large, linear 2.9 x 1.1 meter storage pit was identified, containing numerous artifacts, including ceramic potsherds, faunal bones, lithic debitage, projectile points, corn, groundstone, and an ornamental pendant. The presence of a possible thermal feature, postholes, and midden strata suggest that this area may once have included an architectural feature that has since eroded away. The primary use of Pit 8 is unclear; although its linear shape suggest that it may have been either a ventilation tunnel for an eroded structure or a formal midden area. However, these hypotheses are largely speculative. In addition to Pit 8, there were three other smaller pits in Activity Area 2. Pit 9 was a shallow, slightly bell-shaped pit with ashy sediments containing over 1,200 fragments of faunal bones, and very few ceramics and lithic debitage (Lambert et al. 2016). The other two pits appeared to have been cleaned out after their use.

Functions of the Activity Areas

The presence of cores, drills, scrapers, and other stone tools in each activity area indicates that a variety of production activities occurred in each area. There were also 82 ceramic sherds recovered from Pit 8 in Activity Area 2. All sherds appear to have been from jars, except for five painted bowl sherds. Pit 9 only had 6 sherds, while no sherds were recovered from the other two smaller pits. Richens (2000:61–63) has suggested that vessel assemblages at site areas can help to interpret the function of complex sites and the activities which occurred in specific places. For example, the North Cedars Cave and Trail Mountain Shelter sites both contain only a moderate number of pottery sherds. Jars are the only vessel form represented at those two sites. Pottery related activities at the North Cedars Cave and Trail Mountain Shelter sites were probably limited to small scale cooking or temporary food storage (Richens 2000:63). The low number of ceramic sherds from Activity Area 2, suggests that the area may have been used primarily for

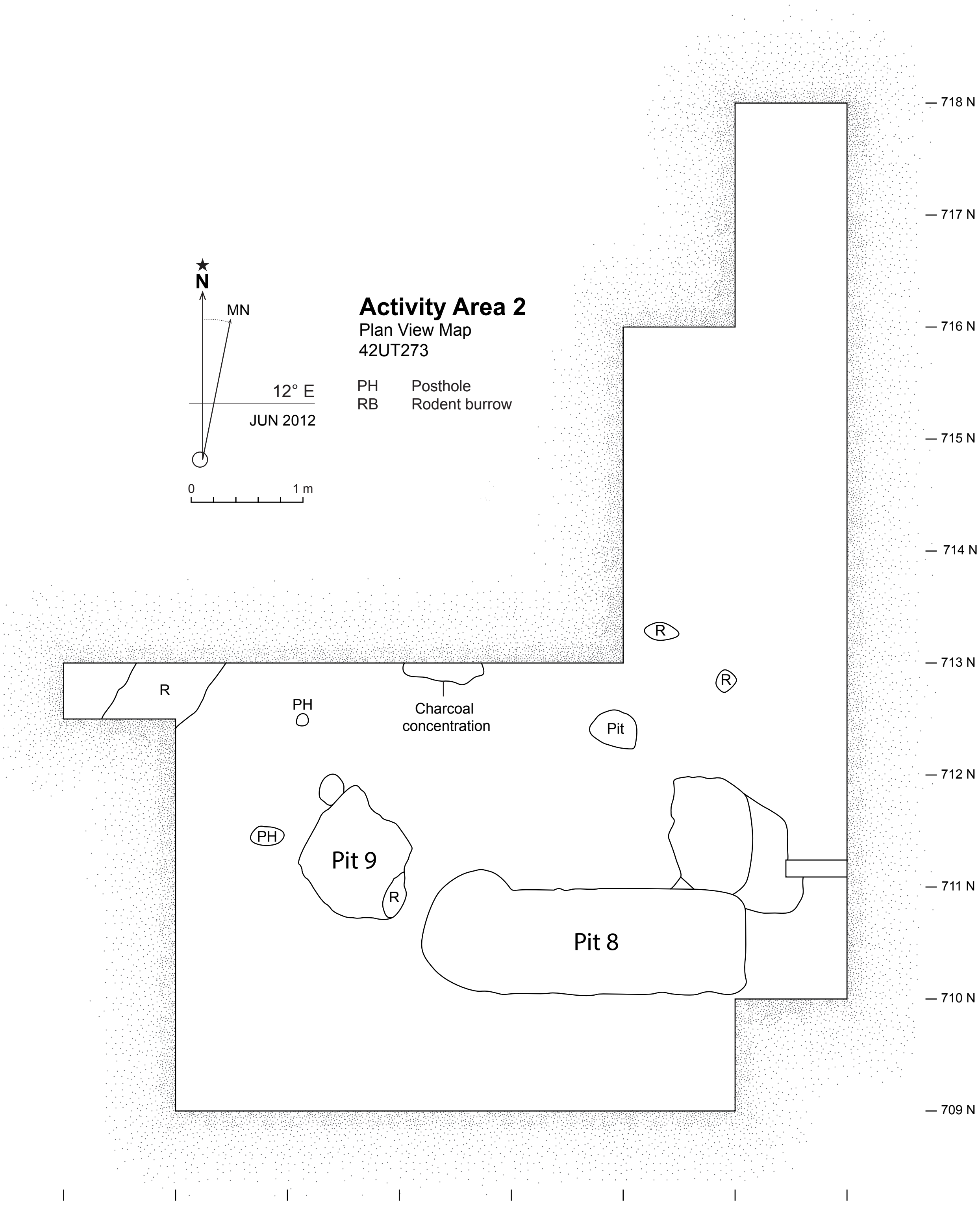

Figure 2.4. Plan map of Activity Area 2 at Wolf Village showing the location of two pits.

cooking and storage. The lack of sizable ceramic assemblages could also mean that the Fremont from Activity Area 2 may have been less sedentary than the Fremont who lived from A.D. 1000 – 1150 at Wolf Village. It could also mean that the Fremont at Wolf Village were not making or using ceramic vessels around A.D. 700 or 750 because the technology either was not available or did not catch on yet. It is also possible that the ceramic trash was deposited in currently unexcavated places.

Another possibility regarding the Period I activity areas is that they were not habitation sites. Gilsen (1968:21–24) notes that there were 23 campsites along Currant Creek which he identified in his survey of Goshen Valley. It is possible that Activity Areas 1 and 2 were noted by Gilsen and recorded as two of the supposed campsites. If Wolf Village during Period I was not a habitation site, then a reverse utility pattern in the artiodactyl faunal bone assemblage may be expected. Fremont hunters could have passed through the area while hunting large game and carried back high-caloric elements to their homes elsewhere.

Period II (A.D. 1000 – 1150)

Period II archaeological features consist of all the excavated buildings and associated middens at Wolf Village. All buildings date to within the same time period, approximately A.D. 1000 – 1150 (see Table 2.1). All faunal bone material from all nine buildings were aggregated together in one assemblage to simplify the comparative analysis. It is also theoretically possible that hunters were sharing their prey with other families and groups at the other dwellings at Wolf Village. There were two types of buildings excavated at Wolf Village, pit structures and surface structures. The architecture at Wolf Village is discussed in detail in Johansson et al. (2014), so I only briefly touch on it here.

Pit Structures

Structures 2, 3, 4, 5, 7, 8, and 9 are pit structures. Structure 2 is an unusually large sub-rectangular pit structure with roofed tunnels on the east and west and a small antechamber to the south (Figure 2.5). It is the largest known Fremont pit structure with a total floor area of 80.5 m^2 (Johansson et al. 2014:37). The building contained a large central hearth measuring 1.1 m in diameter. The building contained over 200 postholes and post sockets, including four main posts that supported the roof of the building. Many of the smaller postholes probably supported internal features that were frequently changed or remodeled. The building was burned and collapsed after its use by the Fremont. After Structure 2 was burned, a rich 65 centimeter thick midden layer was deposited over the collapsed roof. The midden of Structure 2 contained an abundance of artifacts, including figurines, pipes, shell and lignite beads, gaming pieces, ceramic sherds, and a large quantity of unworked faunal bones (Johansson et al. 2014). Johansson et al. (2014:39) state that the midden appeared to have no break in the cultural layer. This suggests that the midden likely accumulated over a long period of time, but was redeposited over the building in one episode of backfilling after it burned.

Structure 3 at Wolf Village is a shallow pithouse with a well-preserved floor (Figure 2.6). The floor of Structure 3 is only a few centimeters below modern ground surface, so much of southern edge of structure has eroded over time. Johansson et al. (2014:39–40) estimate that Structure 3 was originally 5.3 x 4.4 m in length and width and 21.8 m^2. A hearth was present in the central portion of the building. Structure 3 was significantly eroded, and only 39 bone fragments were recovered.

Structure 4 is a sub-rectangular pithouse with a ventilation tunnel (see Figure 2.6). This structure is located only 9 meters west of Structure 3. The building is 3.8 x 3.5 m, and the area of the floor is approximately 13.3 m^2 (Johansson et al. 2014:40). Johansson et al. (2014:40–41) explain that there is remodeling on the ventilation tunnel and a high number of postholes and

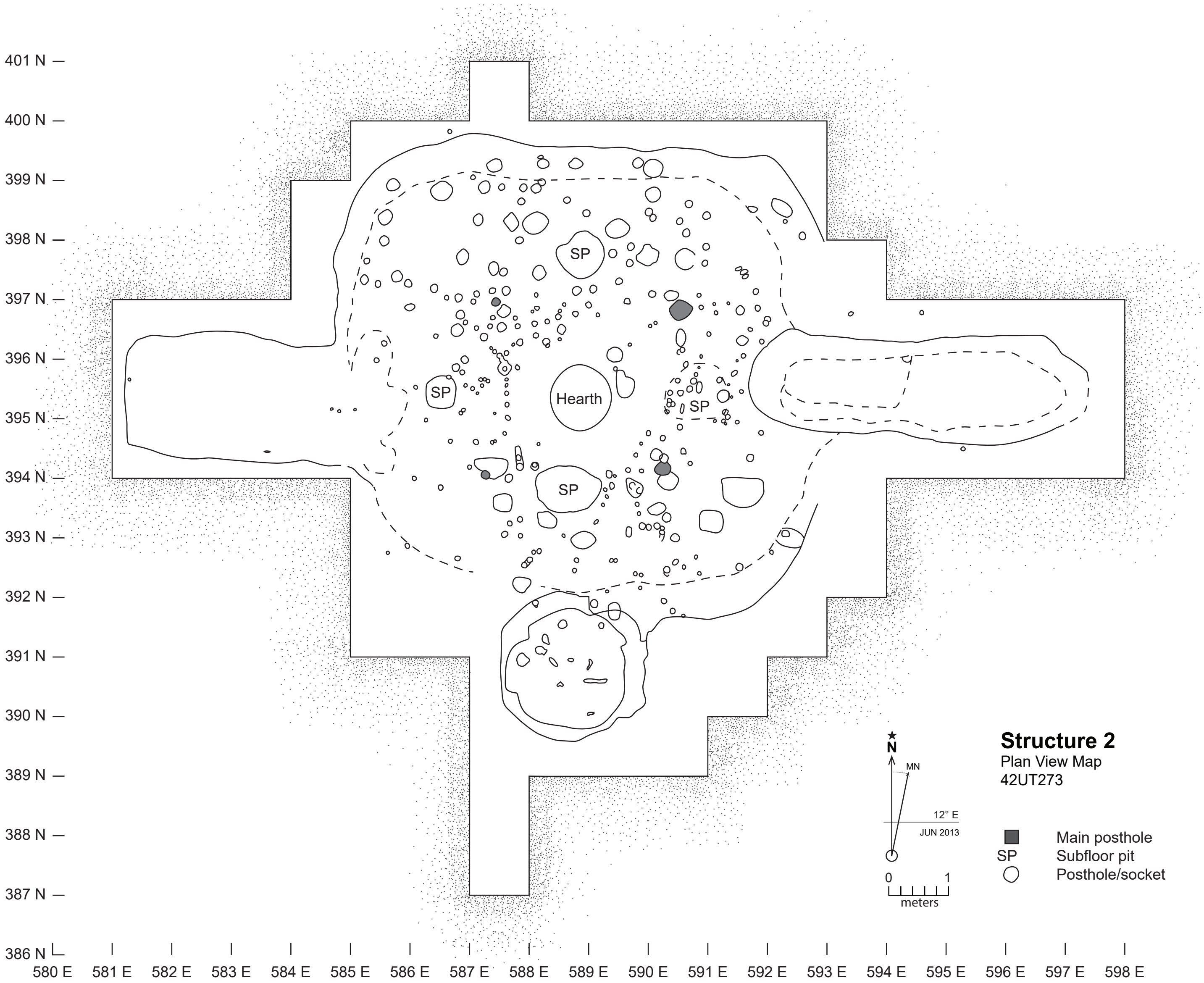

Figure 2.5. Plan map of Structure 2 at Wolf Village (Johansson et al. 2014:Figure 4).

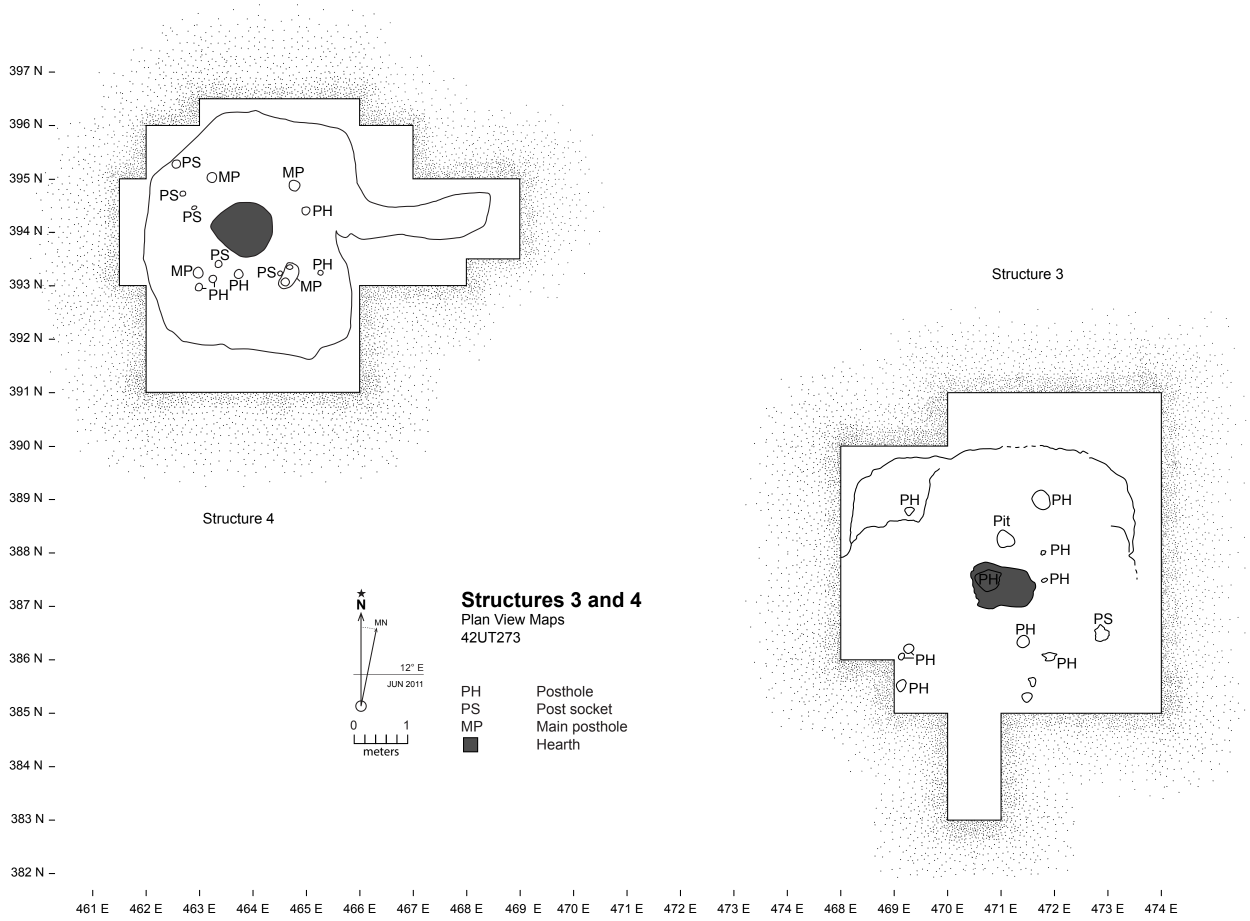

Figure 2.6. Pithouses at Wolf Village: Structures 3 and 4. Figures after Johansson et al. (2014:Figures 6 and 7).

post sockets indicating frequent repair or remodeling. This suggests that Structure 4 was used for a relatively long period of time.

Structure 5 is a sub-rectangular pithouse, and like Structures 3 and 4, is only a few centimeters below the modern ground surface (Figure 2.7). Therefore, much of the southern edge of the structure has eroded away. Structure 5 measures 3.08 x 4.14 m with a floor area of 12.1 m^2. However, if the hearth were centrally located, then the estimate of the area could be as great as 17 m^2. Johansson et al. (2014:41) state that Structure 5 was likely used for domestic activities such as food preparation, cooking, and storing items. Structure 5 contained 24 faunal bone fragments.

Structure 7 is a semi-subterranean pit structure that is sub-rectangular in shape (Figure

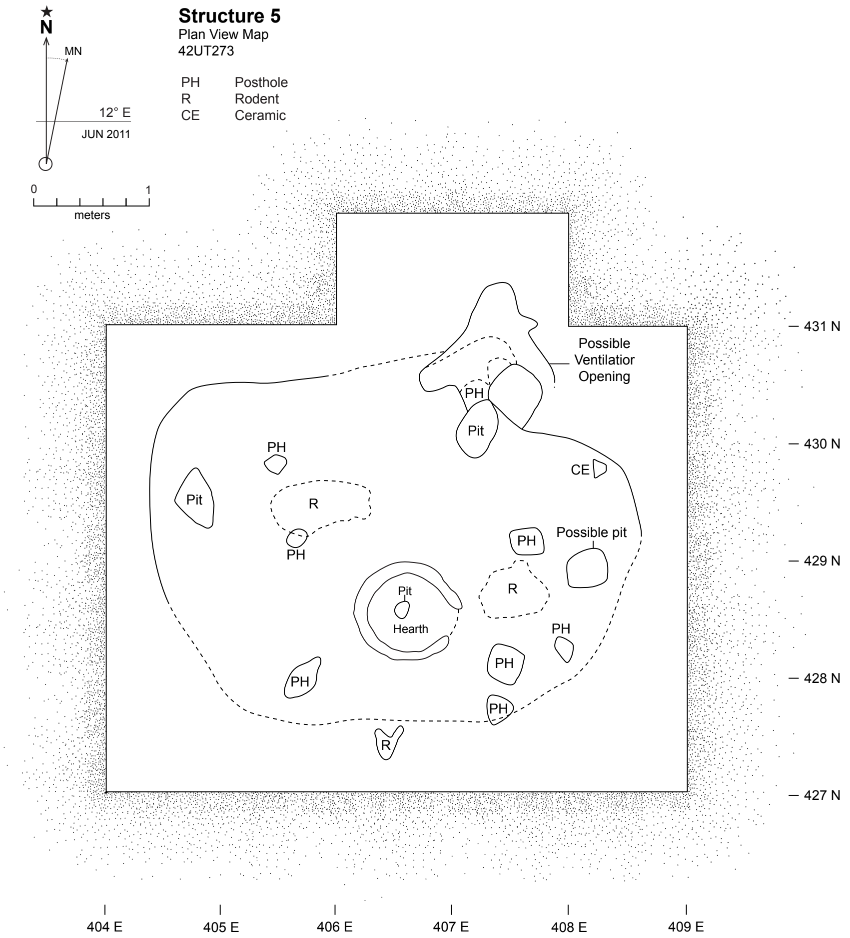

Figure 2.7. Plan map of Structure 5 at Wolf Village. Figure after Johansson et al. (2014:Figure 8).

2.8). It rests on a south facing slope; therefore, the eastern and southern edges of the structure have eroded away. Estimated measurements for the building come from the placement of postholes, and the building may have been as large as 5 x 3 m and 15 m^2 (Johansson et al. 2014:42). Johansson et al. (2014) argue that Structure 7 is different from the other building for having been occupied only a short period of time. There was a central hearth in the structure, but it was on top of a filled in storage pit. Johansson et al. (2014:41–42) believe that most of Structure 7's use was as a storage structure, and that the central pit was turned into a hearth late in the structure's life. Although Structure 7 may not have been constructed as a residential pithouse, it was included in this research since it was modified to be one later in its use and contained faunal bone fragments.

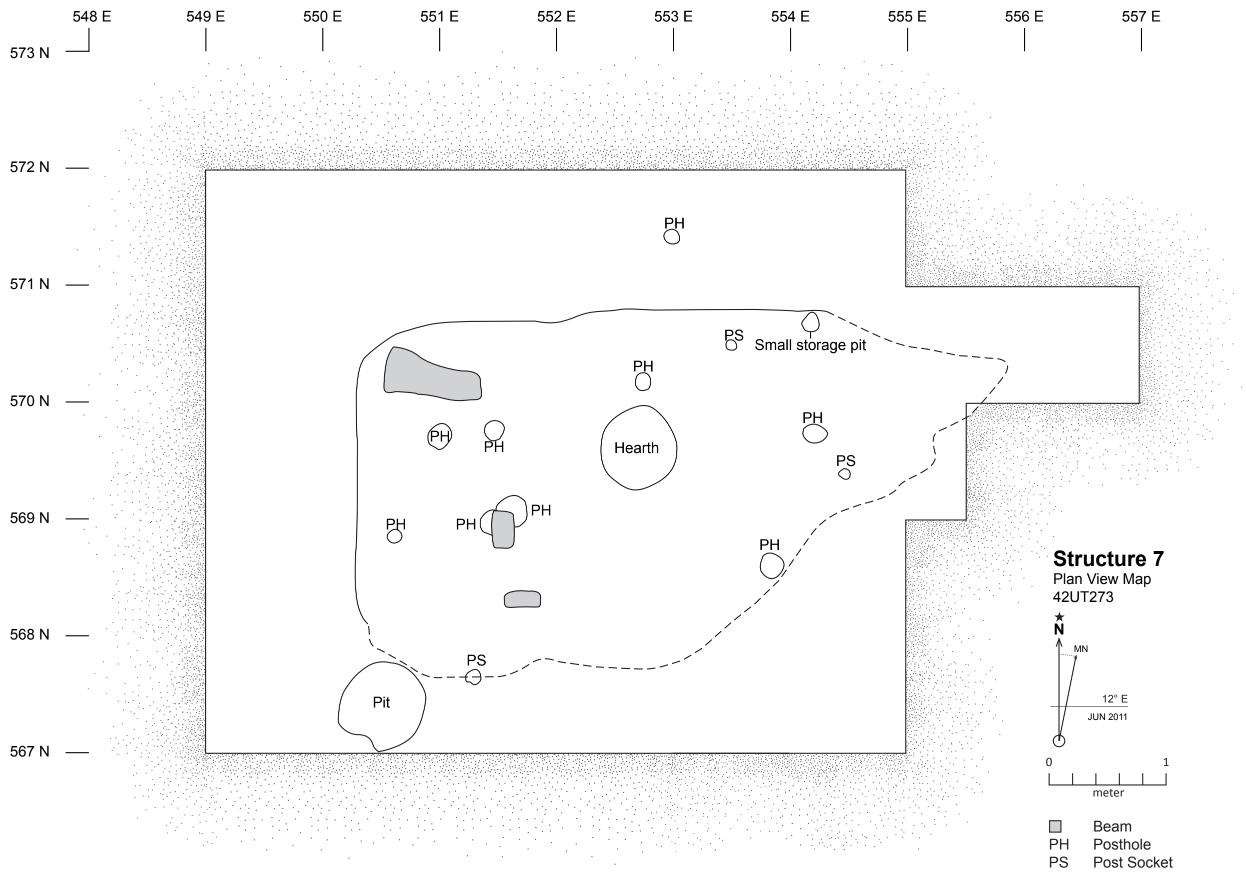

Figure 2.8. Plan map of Structure 7 at Wolf Village. Figure after Johansson et al. (2014:Figure 9).

Structure 8 is a sub-rectangular pithouse, north of Structure 2 (Figure 2.9). Structure 8 could have functioned as a communal building due to its large floor area and hearth. Johansson et al. (2014:51) speculate that Structure 8 “may have been used in different ways and for different purposes than a typical pithouse.” The structure was not burned at the end of its use and a significant number of artifacts were located directly on the floor. In addition, artifacts in the fill of a south-facing ventilation tunnel include antlers and ceramics (Abo 2016:14–16). An upper use surface was directly above Structure 8 (Figure 2.10). Johansson et al. (2014:43) state that this was a “compact use surface and hearth… found in the fill of Structure 8, indicating that after it was abandoned the depression made by the collapsed pithouse was occupied for a short period of time.” The use surface appears to be a formal floor with artifacts found on the surface.

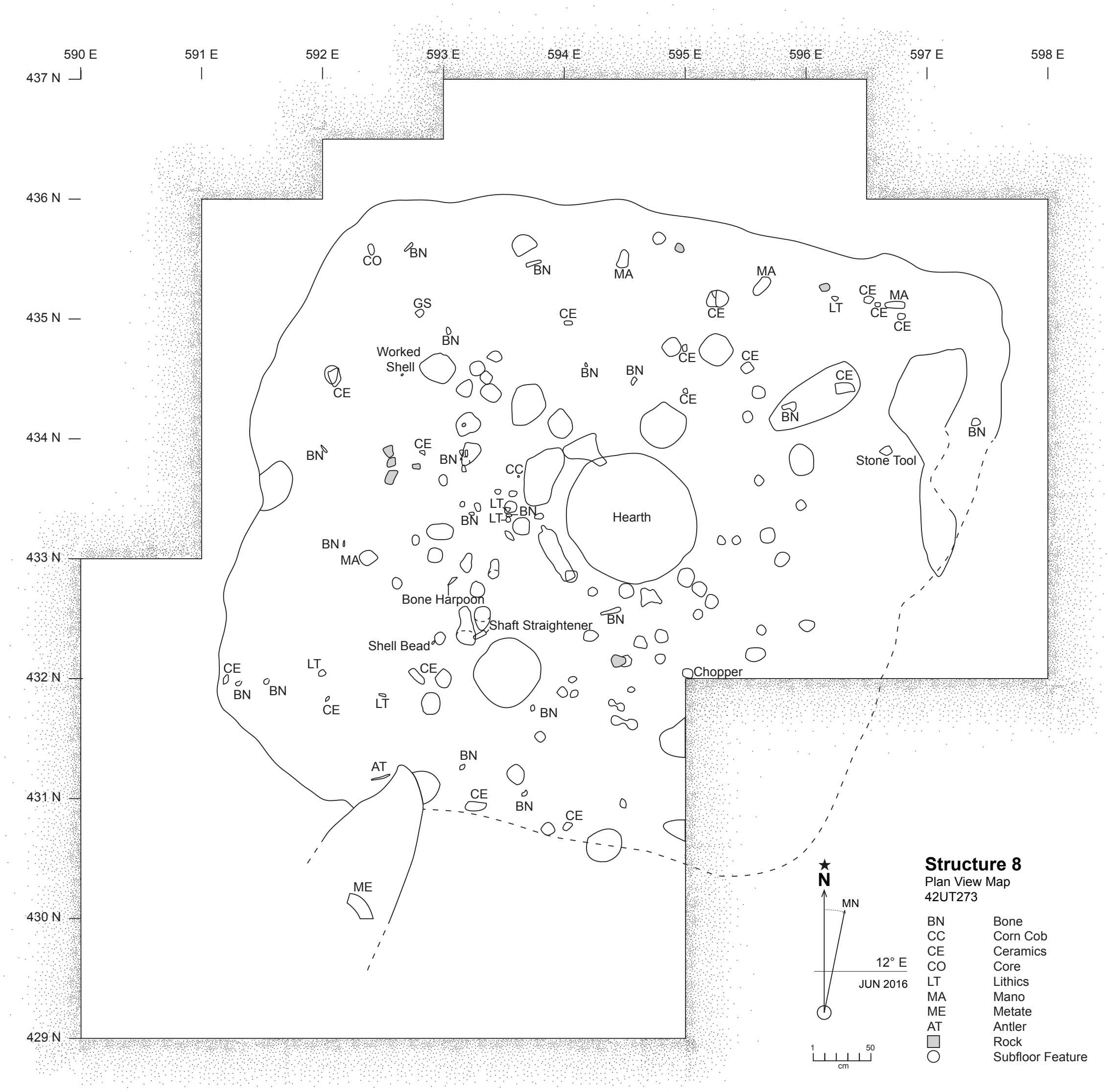

Figure 2.9. Plan map of Structure 8 at Wolf Village. Updated and expanded by the author after Johansson et al. (2014:Figure 10).

The presence of postholes suggest the use surface may have been a superimposed structure over Structure 8. While the upper use surface could be either a ramada or pithouse, the ambiguity of the walls makes it difficult to define the area as a structure. Therefore, to err on the side of caution, I refer to the area as Activity Area 4. A concentration of worked bone gaming pieces was identified on the use surface.

Structure 9 is a partially excavated sub-rectangular pithouse (Figure 2.11). The walls were

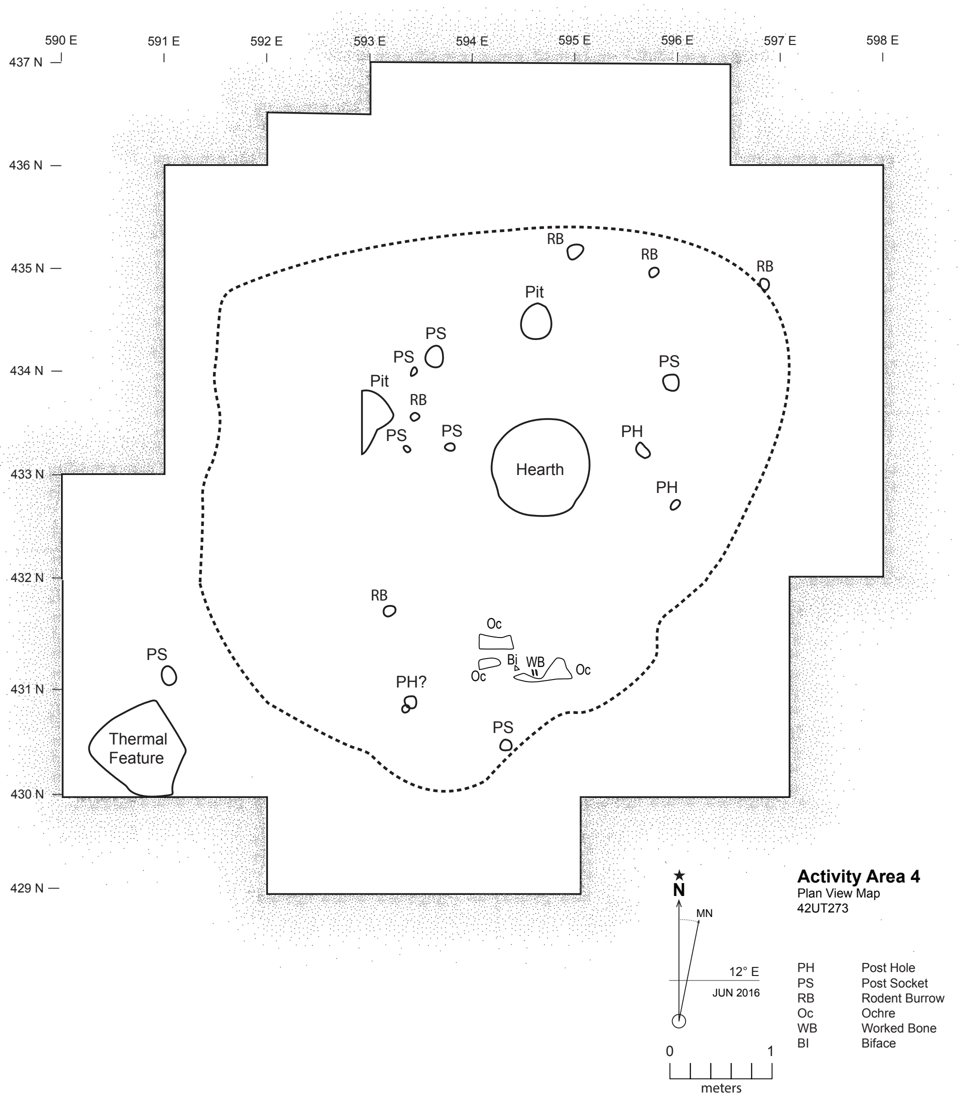

Figure 2.10. Plan map of Activity Area 4 at Wolf Village at the end of the 2016 excavations. Map by Robert J. Bischoff with expansions by the author.

defined in the 2016 field season but excavations were not completed in the northwest quarter of the structure. The floor area is 15 m^2. The structure was burned after its use, as evidenced by a bright orange floor and walls, as well as a layer of burned roof over the floor. The prehistoric ground surface on the north end of Structure 9 was still intact, indicating that the building was excavated approximately 1 meter into prehistoric ground surface (Johansson et al. 2014:43). The ventilation tunnel contained possible ritual objects, including almost complete bowls, lumps of

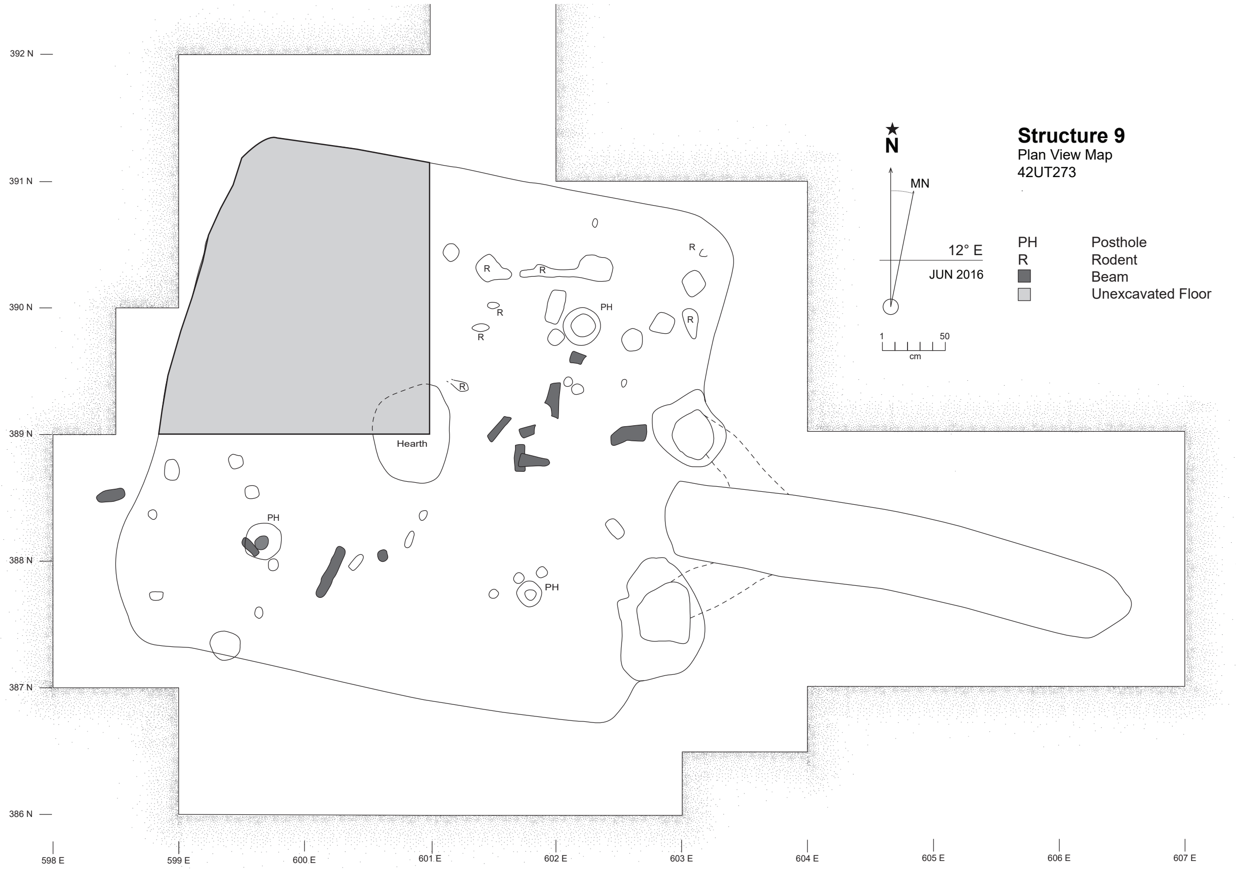

Figure 2.11. Plan map of Structure 9 at Wolf Village. Updated and expanded by the author after Johansson et al. (2014:Figure 11).

red ochre, one mandible of a bighorn sheep, one mandible of a pronghorn, and an articulated spine of a bighorn sheep, in addition to other small artiodactyl elements (Abo 2016:16–17).

Surface Structures

Structure 1 is a multi-room surface building, east of Structure 2 (Figure 2.12). At least 24 rooms have been excavated, including a habitation room, four smaller storage rooms to the north and east of the habitation room, and many other smaller rooms in the north portion of the building. The habitation room measures 14.6 m^2. Excavations in 2016 resulted in the identification of at least 20 small rooms north of the habitation room. The other rooms were probably used for storage, but several yielded very few artifacts. The extra rooms may have

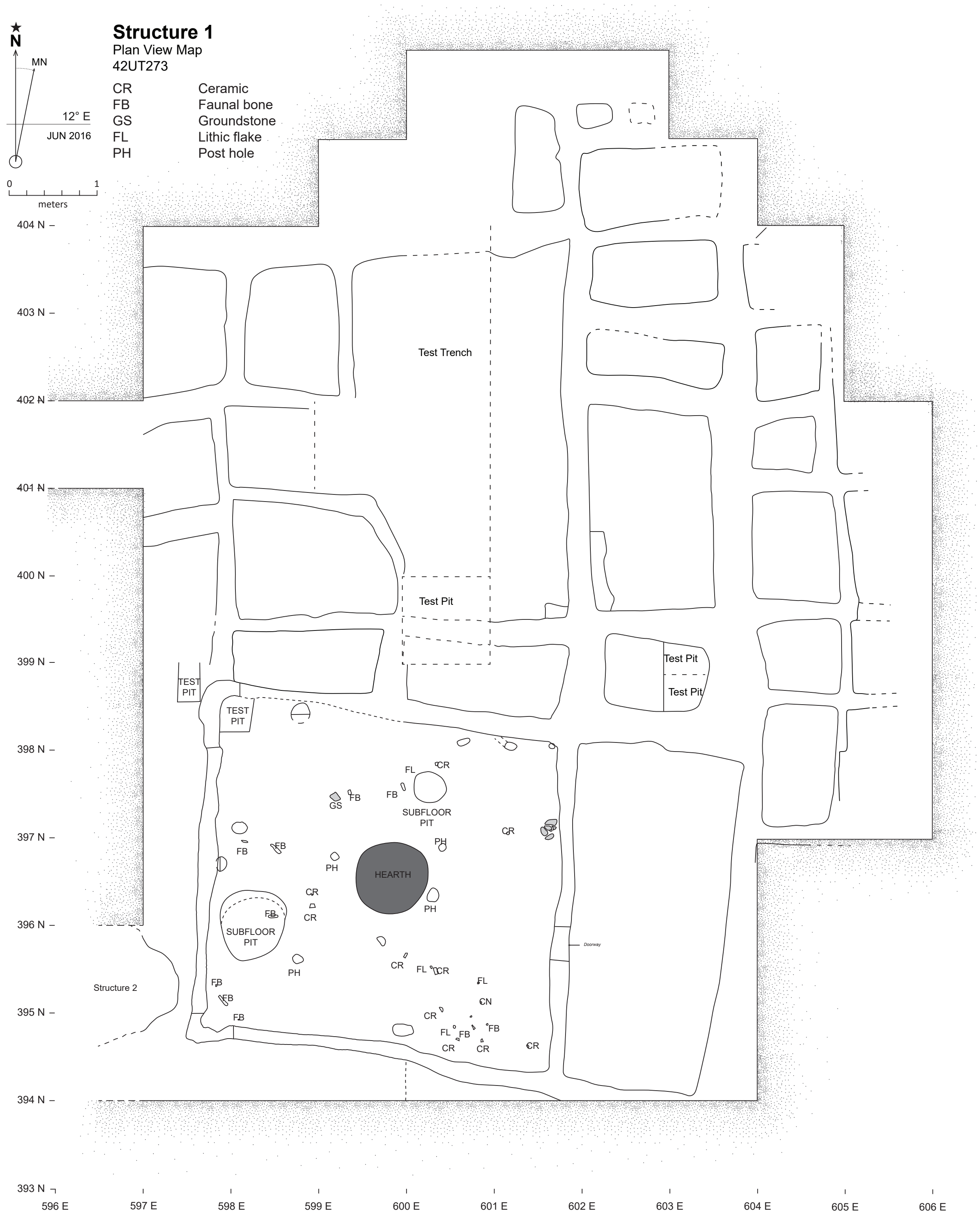

Figure 2.12. Plan map of Structure 1 at Wolf Village. Map by Katie K. Richards. Updated and expanded after Johansson et al. (2014:Figure 12).

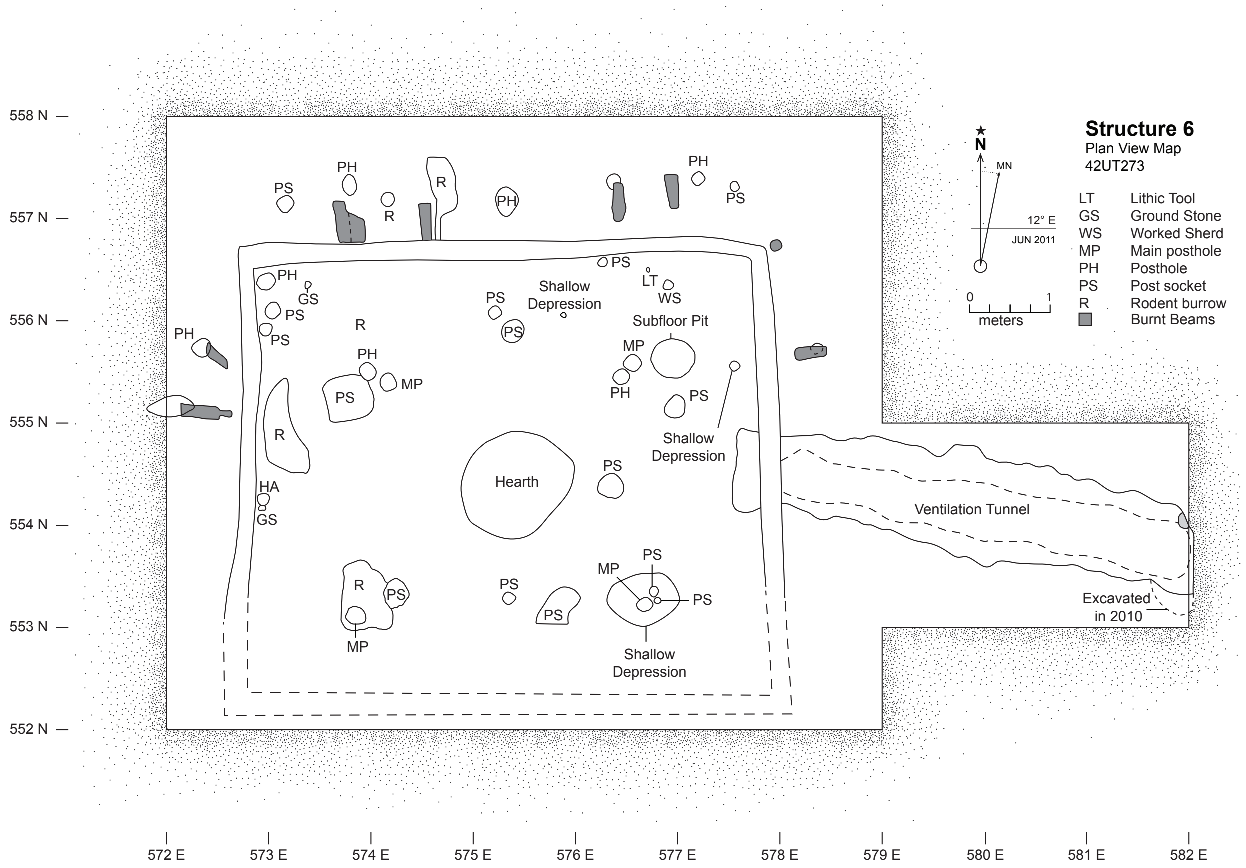

Figure 2.13. Plan map of Structure 6 at Wolf Village (Johansson et al. 2014:Figure 13).

been built to increase the size of the structure and were merely for show (Richards et al. 2018). The building is constructed from coursed adobe and there is no evidence that it was burned when it was abandoned. Talbot (2000a:139) argues that surface buildings of this type likely housed important village leaders or an individual with some degree of prestige. Johansson et al. (2014:47) agree with this statement and suggest that Structure 1 may have housed "someone of elevated status."

Structure 6 is a surface building with a ventilation shaft (Figure 2.13). The building is rectangular shaped and measures to 22 m^2. The building's walls are constructed from adobe with a layer of plaster on the interior portion of the building. The plaster covering was fired hard and preserved by the heat, which was likely caused by a fire started by the Fremont as part of the abandonment of the building (Johansson et al. 2014:44). Johansson et al. (2014:44–45) explain that the ventilation tunnel is unique since it is the only one of its kind associated with a Fremont surface structure. Johansson et al. (2014:50) argue that the building may have been used in part for ritual purposes, as evidenced by two figurines found along the exterior of the northern wall, other figurines found within the building, and articulated mule deer mandibles and groundstone artifacts found in the ventilation shaft (see also Wilson 2013). There is a midden covering the building, likely associated with the building's abandonment. Wilson (2013:39–40) suggests that due to the ritual abandonment characteristics (i.e., the figurines, articulated mandibles, and the burning of the building), Structure 6 was probably the home of an individual with special status.

3 Methods of Faunal Bone Identification

The purpose of this chapter is to describe the sampling strategy and methods I used while identifying the Wolf Village faunal bone material. My methods for identifying and recording the faunal bone material were derived from Grayson (1984), Lyman (1994), and Reitz and Wing (2008). First, I describe the Wolf Village faunal bone assemblage and the logic behind my sampling methods. Second, I describe my methods for identifying faunal skeletal material. Third, I define the two kinds of data that result from the identification of faunal skeletal material: primary and secondary data. Finally, I describe the procedures that I used when identifying element types and animal species and discuss the different ways of determining the relative frequencies of taxa at Wolf Village.

SAMPLING STRATEGY

My research materials include the non-human bones, hereafter referred to simply as "bones," from all excavated buildings and activity areas at Wolf Village. At the end of the 2016 field season, there were 168,441 bone specimens recovered from Wolf Village, including both worked bone and unmodified bones. By "specimen," I refer to Donald Grayson's definition, which he defines as either a complete or fragmented bone or tooth collected from an archaeological context (Grayson 1984:16). In this study, I included worked and unworked bones from Wolf Village. Due to the high quantity of bone specimens recovered from the excavations at Wolf Village, I identified a sample of the bones from areas that will best answer my research questions. In total, I identified 46,167 bone specimens, approximately 27 percent of the total Wolf Village faunal bone assemblage.

It is beyond the scope of this thesis to determine the function of buildings and activity areas at Wolf Village. I identified the bone specimens from the activity areas and buildings at Wolf Village since they come from cultural contexts with radiocarbon dates. I did not assume that every bone specimen from the fills of the buildings was associated with the activities that occurred in those buildings. However, I do assume that the bone specimens recovered from the storage pits and features in Activity Areas 1 and 2 were associated with Period I, and that the bone specimens recovered from the floor zones and fills of each building were associated with Period II activities at Wolf Village.

Part of my sampling strategy focused on bones found in the floor zones of buildings. I define "floor zones" as the area within 10 centimeters of the cultural floor. I focused specifically on identifying the bones from a series of storage pits and activity areas from Period I (A.D. 650 – 800) as well as bones from the floor zones, subfloor features, and fill of all nine structures at Wolf Village dating for Period II (A.D. 1000 – 1150). For the activity areas, I focused only on identifying bones from pits and postholes since much of the overlying sediments were mixed with sediments dating to Period II. I identified 41,297 bones from these areas.

I identified all bone specimens found in the floor zones and fills of Structures 1, 3, 4, 5, 6, 7, 8, and 9. Structure 6 contained a midden overlying the structure. I identified all bones from within the midden over Structure 6. Like Structure 6, Structure 2 also had a midden overlying the structure. After Structure 2 was burned, a layer of rich midden was deposited over the collapsed roof. The midden contained artifacts such as figurines, pipes, beads, bone gaming pieces, and a large quantity of unworked bones (Johansson et al. 2014:39). The midden likely accumulated over a long period of time at another location but was deposited over the building after its

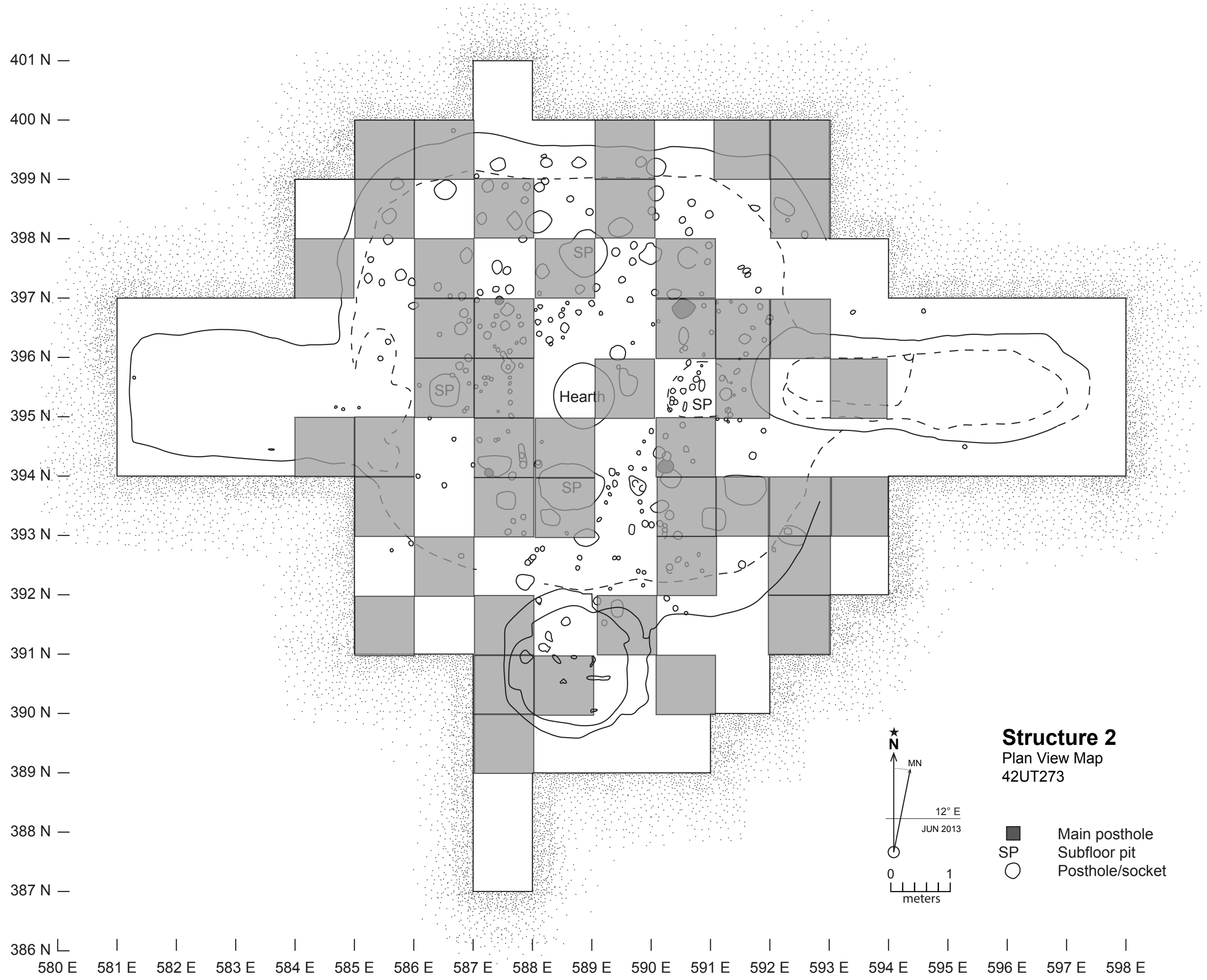

Figure 3.1. Structure 2 at Wolf Village showing the sampling strategy. All bone specimens resulting in a NISP count were identified in the 46 shaded excavation units. Only artiodactyl bones identifiable to a specific element were analyzed in the blank units. Map by Katie K. Richards (Johansson et al. 2014:Figure 4).

disuse. The Structure 2 midden contained the majority of bone specimens excavated at Wolf Village (n=45,291). Due to time restraints, I only identified a sample of the bones in the fill and stratigraphic layers over Structure 2 using two different sampling methods.

First, I identified bones from the midden within 46 out of 92 excavation units overlying Structure 2 (Figure 3.1). I randomly selected the 46 units using MiniTab software. The midden layer within these 46 units contained 23,175 bone specimens, approximately half the bones within the Structure 2 midden. I identified all bones that could be identified to at least the taxonomic rank of family, and in the case of artiodactyls to the taxonomic rank of order. In other words, I only counted bones that resulted in a NISP count (see below for a discussion on NISP). I identified 4,054 bone specimens using this method. I rely on the bone data from the activity areas, floor zones, fills, and storage units from all previously discussed sampling areas to measure the relative abundance of taxa at Wolf Village.

My second sampling method differs from the methods used to measure the relative abundance of Wolf Village taxa. Since my research interests include the large game transport practices of Fremont hunters at Wolf Village, I focused primarily on identifying the bones of small and large artiodactyls to compare to Binford's MGUI. In order to obtain the most data regarding artiodactyl hunting, I also identified a portion of the rest of the midden-fill over Structure 2 (i.e., all of the excavation units over Structure 2 not shaded in Figure 3.1). Since Binford's MGUI can only measure meat utility based on known bone elements (i.e., humeri, femurs, ribs, mandibles, etc.), I identified only artiodactyl bones that could be recognized as specific skeletal elements. Therefore, unidentifiable long bones and flat bones were not counted in this sample. I identified 816 artiodactyl bone elements from these excavation units. When measuring the relative abundance of taxa at Wolf Village, I do not include the bones from this second sample. To do so would skew the results to favor higher artiodactyl counts than may actually have been representative at the site.

I relied on a mixed sampling strategy, meaning that I specifically chose locations that provide the most data to address my research questions. For example, I identified all bones from the floor zones of architectural features because they were from the clearest contexts. Bones from the floor zone are from contexts most likely to have been associated with the use of the structures. In addition, the midden over Structure 2 contains the most bones from Wolf Village, which may be representative of some animals exploited by the Fremont at the site during Period II. If the Structure 2 midden was the result of some feasting activities, then the midden may not be representative of regular hunting activities at Wolf Village. Regardless, I include the bones from the midden because it provides the most artiodactyl bone data for evaluating my research objectives.

Although Drennan (2009:86) cautions against the use of judgmental sampling, he states that it may be justified in certain situations. To be fair, many of the bone specimens were collected as part of a judgmental sampling of the site. Excavations at Wolf Village largely focused on living areas and activity areas (see BYU Anthropology 2016; Johansson et al. 2014; Lambert et al. 2016). I make the assumption that my sampling strategy will group data that accurately represents the larger population. For the purpose of this research, the population is all the bones recovered from living areas (consisting of activity areas, structures, and middens) at Wolf Village.

To summarize my sampling strategy, I identified all bone specimens from the floor zones and fills of Structures 1, 3, 4, 5, 6, 7, 8, and 9, in addition to bones in storage pits at the north end of Wolf Village. In addition to identifying all bone specimens from the floor zone of Structure 2, I also identified a sample of the bones from the midden-fill overlying Structure 2. I identified all bones that resulted in a NISP count from 46 excavation units that are within Structure 2. All of the bones identified from these sampling methods are used to measure the relative abundance of taxa at Wolf Village.

I also identified all artiodactyl bones recognizable to specific skeletal elements from the other remaining units over Structure 2. In essence, this sampling strategy has resulted in the identification of most of the artiodactyl bones at Wolf Village. Again, the 816 artiodactyl bones identified using this method were not included when measuring the relative abundance of taxa.

METHODOLOGY

In order to identify as many specimens as possible to a taxonomic classification, I compared all bone specimens in my sample to the comparative collection of modern animal bones at the Museum of Peoples and Cultures (MPC). My analysis was also facilitated with faunal references by Gilbert (1990) and France (2009). Bone specimens were separated by morphological and size characteristics. Each specimen was identified to the lowest taxonomic rank possible given the fragmentation of each specimen. If a lower taxonomic rank could not be determined, the specimens were categorized by class (e.g., mammals, birds, fish, etc.) and size (e.g., small, medium, and large). Like previous faunal bone analyses (Johansson 2013; Newbold 2009; Stauffer 2012), I define small mammals as small rodents (e.g., mice, muskrats, and squirrels) and lagomorphs (e.g., cottontails and jackrabbits) (see also Museum of Peoples and Cultures 2010). Medium mammals include canids, felines, and large rodents such as beavers and porcupines. Large mammals include bears and artiodactyls. In many cases artiodactyls could be further grouped into large artiodactyls (e.g., elk and bison) and small artiodactyls (e.g., mule deer, mountain sheep, and pronghorn).

Bone specimens were also separated by element type (e.g., tibia, humerus, femur, vertebrae, etc.). If a bone element type could not be determined then I separated the specimens into three categories: long bones, flat bones, and unidentifiable elements. “Long bones” include all limb bones such as the tibia, humerus, femur, radius, metapodials, etc. “Flat bones” include the pelvis, scapula, ribs, and cranial elements. Identification slips were placed with each group of specimens and bagged according to their MPC accession numbers. I enlisted the help of several undergraduate student volunteers from Brigham Young University and Utah Valley University to assist in the identification of the bones. I trained these volunteers and double-checked their work. In the end, I ensured that all bone elements identified by the student volunteers were accurate and met my own standards.

PRIMARY DATA

The analysis of faunal bone remains results in two different types of data, which

Clason (1972) refers to as primary and secondary data. Reitz and Wing (2008:153) define primary data as the descriptive parts of the analysis, which includes element representation and taxonomic identification. In essence, primary data “are facts that can be replicated by subsequent investigators” (Reitz and Wing 2008:153). Primary data includes taphonomic information. Taphonomy is the study of both natural and cultural changes that occur in bones from the time an animal is first caught by hunters to the time it is analyzed by zooarchaeologists. This includes information about breakage, burning, cut or butchering marks, gnawing, and weathering. An outline of the procedures for recording these type of data is found in Reitz and Wing (2008) and the Museum of Peoples and Cultures Handbook for Faunal Analysis (Museum of Peoples and Cultures 2010).

Taphonomic Modification

Taphonomic modification includes all processes that affect bones before the death of an animal and before the study of those bones by an analyst (Lyman 2005:858). These modifications are studied by zooarchaeologists in order to understand what cultural and non-cultural impacts affected the faunal bone assemblage that resulted in their current state. Taphonomic modifications include breakage, burning, butchering marks, gnawing, and weathering. I describe each of these modifications in more detail.

Breakage

Bone breakage is caused by force being applied to bones that results in their fracture. This force can be caused either by humans, animals, or natural processes. In this research, I recorded five types of fractures on artiodactyl long bones: spiral, oblique, transverse, stepped, and splintered (see Lyman 1994:318–324; Reitz and Wing 2008:169) (Figure 3.2). Spiral fractures are curved in a helical pattern around the bone shaft. In general, spiral fractures occur

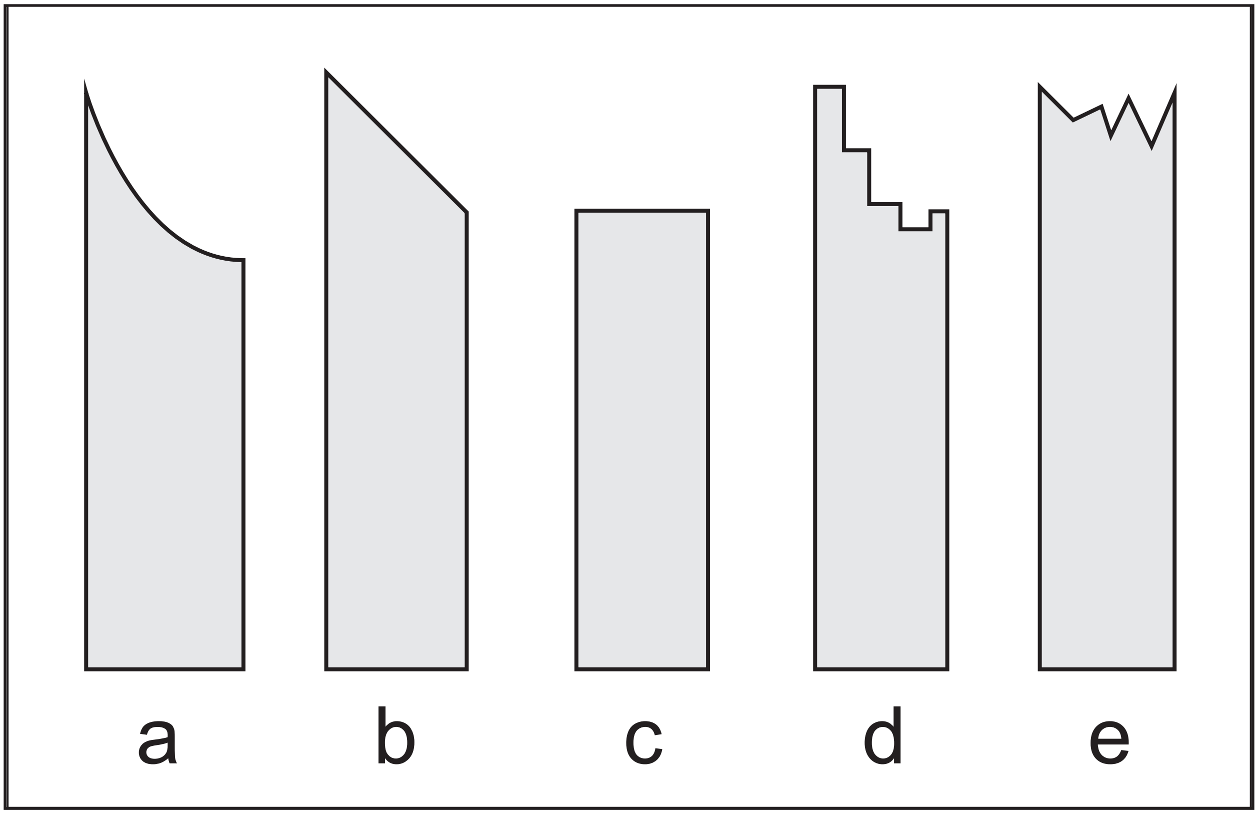

Figure 3.2. Examples of common long bone breakage patterns: (a) spiral, (b) oblique, (c) transverse, (d) stepped, and (e) splintered.

when a bone is still fresh. Oblique fractures are diagonal in shape and also suggest that the bone was fresh while fractured. Transverse fractures are lateral and can occur by either cultural or natural causes. Stepped fractures and splintered fractures can also be caused by either human or non-human forces. Specific fractures do not necessarily indicate human processing strategies. Even spiral fractures and oblique fractures only suggest that bones were fresh when fractured. Regardless, there is value in recording fractures on artiodactyl long bones since humans often break bones during butchering and processing to access bone marrow. Prehistoric hunters and craftspeople may have broken bones as an initial step in manufacturing bone tools or other worked bone objects.

Burning

Burn marks on bones are the result of intense heat affecting and changing the appearance of the bone specimen. I recorded three different types of burning: scorched, charred, and calcined/oxidized. Usually the color of a bone specimen can indicate whether a bone is burned or unburned, and indicate the temperatures to which a bone was exposed. Scorching, or superficial burning, causes bones to appear light to dark brown. Charred bones are blackened and were exposed to higher heat temperatures (<400°C) than scorched bones. Calcined bones are white, gray, or blue in appearance. Calcined bones indicate that a bone was exposed to high heat temperatures (≥600°C) for a long period of time (Lyman 1994:386).

Burned bones within a faunal assemblage suggest human activity caused the bones to change appearance, and that the bones were exposed to fire either through cooking, food preparation, disposal, or as fuel for fires (Lyman 1994:388). However, some archaeologists suggest that not all burned bones is the result of human behavior. David (1990) compared bones burned in brush fires and anthropogenic hearths. His results indicated that non-cultural agents such as brush fires can cause bones to become scorched and charred (David 1990:68–71). However, none of the bones in his experiment calcined in the brush fire since the fire did not attain high enough temperatures. He concludes that when large portions of bones are calcined, it is most likely that "one can safely infer anthropogenic prolonged fires under high temperatures" (David 1990:75). In other words, these types of burned bones were likely affected by human behavior.

Butchering Marks

Butchering marks are the result of humans dismembering animal parts. Butchering and cooking techniques are particularly important in this research. Lyman (1987:252) defines butchering as "the act of human reduction and modification of an animal carcass into consumable parts.” The term “consumable” in this context is not restricted to food, since animal carcasses are butchered and processed to make tools, clothing, and more (Lyman 1987:251–252; see also Lyman 1994:294). Butchering marks are notable by the presence of several thin cut mark and deep V-shaped marks (Reitz and Wing 2008:127–128). Marks are usually identified on or near the joints of long bones, but are also found on the shafts. Binford (1981) notes three types of butchering marks based on their location on the bone and which element was butchered. These include skinning cut marks along the phalanges and shafts of the lower limbs, cut marks found on the pelvic parts and vertebrae, and filleting marks that are parallel along the long axis of the bone (Binford 1981:46–47). Reitz and Wing (2008:126–130) further explain that hack marks on bone specimens are associated with primary butchering, cuts on bone shafts are connected to filleting, and cuts on the cranium, mandible, and metapodial fragments are usually from skinning. Other butchering practices include using hammerstones to break the bone open to use the bone marrow. Bone marrow can be used in soups such as with the Hadza hunters of Africa (Bunn 1993:164). These marks appear as flaking or puncture marks on the bone.

Butchering marks can also be used to infer the ethnic identity of the butcher, their social status, and whether the butcher was a specialist (Reitz and Wing 2008:242). These types of questions are outside the scope of this thesis research. During this analysis, I noted whether butchering marks were present on each bone specimen.

Gnawing

As previously described in Chapter 1, carnivore disturbance can greatly affect a faunal bone assemblage. Scavengers are attracted to edible portions of animals and can destroy or gnaw on some faunal bones. Therefore, gnaw marks on bones are usually attributed to carnivores and rodents. Recording the presence of gnaw marks or lack of their presence on bone specimens from an assemblage can help determine how much of the assemblage is cultural or non-cultural.

Rodent gnawing is identified by "parallel grooves that are closely spaced and flat bottomed" (Reitz and Wing 2008:135; see also Lyman 1994:197), while larger carnivore gnawing marks leave "irregular, broad grooves and pit-like features" (Reitz and Wing 2008:135; see also Binford 1981:44). Carnivore gnawing was previously discussed (see Chapter 1: Conditions of Recovery and Assumptions–Carnivore Disturbance). In this analysis, very few bones exhibited gnaw marks.

Weathering

Weathering is the natural decomposition of bones caused by chemical and physical processes. Weathering affects bones while *in situ*, and includes desiccation, saturation, and temperature changes (Lyman 1994:354; Miller 1975:217). Most of the Wolf Village faunal bone assemblage was very-well preserved (although many specimens did exhibit root-etching); however, bones exhibiting weathering were noted during their identification.

SECONDARY DATA

Secondary data are derived from primary data by using indices and other quantification techniques. While primary data are important to record when identifying bone elements, the goal of most faunal bone analyses is to compare and quantify the relative frequencies of taxa and bone elements to one another across sites and larger culture areas. Relative frequencies of taxa are important for measuring the relative importance of different animal species at a site. Skeletal frequency is used to reconstruct hunting, processing, and transport techniques used by past peoples. In summation, primary data are based on observations and can be replicated by future analysts, while secondary data summarizes data in ways that facilitate interpretation and explanation (Reitz and Wing 2008:182).

Relative Frequencies of Taxa

One of the main purposes of faunal bone analysis is to identify the relative frequencies of taxa within a faunal bone assemblage. The relative frequency of taxa is used by archaeologists to infer the importance of certain animal species to diet and procurement practices. The number of identified specimens (NISP) and the minimum number of individuals (MNI) are used to measure the abundance of each species at a given site or study area (Grayson 1984:17; Reitz and Wing 2008:153). The NISP is the "basic counting unit that must be used in any attempt to quantify the abundances of taxa within a given faunal assemblage" (Grayson 1984:17). The MNI refers to the minimum number of individual animals necessary to account for all the skeletal elements found in a faunal bone assemblage (Lyman 1994:100). In essence, the NISP is the maximum number of individuals possibly represented by identified bones in a faunal bone assemblage and the MNI is the minimum number of individuals present. NISP and MNI are used to compare the percentages of taxa using indices.

Number of Identified Specimens (NISP)

The analysis of faunal bones results in two basic count types: the number of identified specimens (NISP) and the number of unidentified specimens (NUSP). NISP is the number of specimens that has been identified to at least the taxonomic level of family. As previously stated, Grayson (1984:16) defines specimens to include fragmented teeth which can be potentially problematic when accounting for NISP (although fragmented bones can also cause the same problem). Fisher (2015:768) notes some complications of including teeth as part of NISP counts, but ultimately states that regardless of how the faunal analyst accounts for teeth, the procedures should be explicitly stated in the article or report to assist future archaeologists seeking to replicate the data. In my own analysis, I excluded teeth from the NISP count since they can be discarded before the death and butchering of an animal and are present in differing numbers between various species.

In addition to changing the definition of NISP in regards to fragmented teeth, I chose to redefine NISP to include not only the number of specimens identifiable to at least the taxonomic rank of family, but also animals identified to the taxonomic order of Artiodactyla. Other faunal analyses from Fremont and Promontory sites have been done using a similar method (Johansson 2013; Sharp 1992; Stauffer 2012) I followed this method because in the region around Wolf Village, small artiodactyls include only mule deer, bighorn sheep, and pronghorn. Many of the small artiodactyl specimens were easily identified to order, but were too similar to one another to identify to species. Without including artiodactyls in the NISP counts, it would have skewed the data to appear as though small artiodactyls were less important to the Fremont at Wolf Village than they likely were.

The usefulness of NISP has been discussed at length by Grayson (1984). He describes several weaknesses associated with using NISP when quantifying the relative frequency of taxa. NISP is affected by both cultural and natural processes, including transportation, butchering, cooking, disposal, non-subsistence uses of bones, and weathering (Reitz and Wing 2008:203; see also Grayson 1984:20–24). For example, hunters may only collect some elements from hunting expeditions that make their way back to a village or camp. Other smaller animals may be brought back whole for butchering. Some bones may also have been intentionally crushed in order to make bone grease soup as done by Hadza hunters (Bunn 1993:164; Talbot et al. 2000:483).
In addition, NISP is reliant on the skill level of the analyst. Sharp (1992:154) notes that some elements (such as long bones, mandibles, and foot bones) are easier to identify to species than cranial, vertebrae, or innonimate elements. Clearly, NISP counts cannot be directly converted into animal quantities at a site.

Minimum Number of Individuals (MNI)

One of the weaknesses of NISP is the potential interdependence of units being counted. It is difficult to tell whether a fragmented tooth or bone came from the same animal represented by other elements. One crushed bison skull could result in 30 NISP counts, while only representing one animal. This plausible scenario could result in a sample inflation issue (Grayson 1984:23–24). The minimum number of individuals (MNI) addresses the interdependence of specimen counts.

The use of MNI by zooarchaeologists became popular after Theodore White, a paleontologist, introduced it to archaeology. Grayson (1984:27) notes that it is not unusual that a paleontologist would introduce the use of MNI into archaeology, since vertebrate paleontologists had long used minimum numbers to quantify their data. White (1953) rejected the use of NISP since differences in butchering techniques among peoples could skew the faunal bone data. He also recognized that each species represented in an assemblage did not contribute equally to human diet (Grayson 1984:27). For example, four deer would be required to equal the amount of meat provided by one bison. White (1953:397) was attempting to determine the amount of meat supplied by any given species. Therefore, White recommended the use of "the number of individuals" (now called MNI), which is calculated by "determining the minimum number of individual animals necessary to account for all the kinds of skeletal elements found in the skeleton" (Lyman 1994:100). In other words, if an assemblage contains four right mule deer tibias and five left mule deer tibias, the NISP would be nine, while the MNI would be five, the number of individual animals necessary to account for the five left tibias. As Grayson (1984:27) notes, the use of MNI potentially solves problems of interdependence found in NISP counts.

As previously stated, the NISP and MNI represent the minimum and maximum number of individuals present within an assemblage. However, one of the main weaknesses of using MNI to quantify faunal bone data is the MNI values can change depending on how the assemblage is aggregated. For example, dividing a faunal bone collection by structure at Wolf Village will result in different values than if calculating the MNI of all faunal bones at Wolf Village together (see Grayson 1984:29 for a discussion on aggregating faunal assemblages). Grayson (1978) explains how sample size and aggregation methods can greatly affect MNI. He also explains how in small assemblages, the MNI can exaggerate the importance of rare taxa in a collection (Grayson 1978:54).

Grayson (1978) discusses two approaches when dealing with MNI and sample size: the maximum distinction approach and the minimum distinction approach. The maximum distinction approach results in larger MNI numbers since faunal bones are aggregated into different units (based on stratigraphy, arbitrary levels, buildings, etc.), while the minimum distinction approach results in smaller values since it groups all faunal bone material from a site into one cluster from which the MNI is calculated (Grayson 1978:60). In this analysis, I lean towards a minimum distinction approach and group all faunal from the structures into one aggregate. Since there are at least two occupation periods at Wolf Village, I quantify the faunal data separately between the two periods. While I could have subdivided the later occupation by each structure, I chose not to since radiocarbon dates from the structures suggest that they were "occupied within a few decades in the 11th or early 12th centuries A.D." (Johansson et al. 2014:33). Therefore, it is possible that occupants of various living areas were dividing up their meat portions, and many of the bone specimens found at one dwelling could have belonged to the same animal as bones recovered from another dwelling. In this thesis, taxonomic abundance is measured using the percent of NISP following methods advised by Grayson (1984); however, data concerning the minimum number of individuals (MNI) is also presented.

Minimum Number of Animal Units (MAU)

Rather than using MNI, Binford (1978, 1984) proposed the use of minimum number of animal units (MAU). He argued that based on his ethnographic experience with the Nunamiut people of Alaska, people do not utilize animal portions by only one element (e.g., only one humerus or femur). Instead, he argued, that Nunamiut hunters butcher animals into segments, which include whole legs, arms, or torso (Binford 1984:50; see also Grayson 1984:88–89). He did not believe that MNI adequately accounted for this fact and designed MAU to calculate animal portions rather than pieces.

MAU is calculated by "dividing the observed bones count for a given identification unit by the number of bones in the anatomy of a complete animal of that unit" (Binford 1978:70). In other words, the minimum number of elements (MNE) were calculated by adding the most abundant end (proximal or distal) of an element. For example, if a faunal assemblage contains 12 proximal femur ends, then the MNE for that element is 12. The MAU is calculated by dividing the total MNE for an element and dividing it by the number of that element within the skeleton of that specific animal (e.g., if 12 proximal femurs from a mule deer are present in the assemblage, then that number is divided by 2, the number of femurs in a mule deer, which results in a MAU value of 6). The percentage of MAU (%MAU) is calculated by dividing the MAU for an element by the highest value of MAU in the assemblage (Grayson 1984:89). For example, if the mule deer femur has a MAU value of 6 and the highest MAU value for mule deer is 50, then you would divide 6 by 50 and then multiply by 100 to determine the percentage ($[6 \div 50] \times 100 = 12$). As stated, I use the percent of NISP when discussing the relative frequency of taxa at Wolf Village; however, the percent of MAU is important for calculating and discussing economic utility as discussed below (see Modified General Utility Index).

Artiodactyl Index and Other Indices

Indices are used to make comparisons between relative abundances of taxa. One of the better known indices used in modern Great Basin research is the Artiodactyl Index (see Bayham

1977; Broughton et al. 2011; and Janetski 1997b for examples of research done with the index). Lagomorphs (hares, rabbits, and pikas) and artiodactyls (bison, elk, mule deer, bighorn sheep, and pronghorn) are the main orders identified in Fremont faunal bone assemblages. At Wolf Village the only lagomorphs identified are cottontails and jackrabbits, and the only artiodactyls are bison, mule deer, bighorn sheep, and pronghorn. The Artiodactyl Index calculates the ratio of artiodactyls to the total number of artiodactyls and lagomorphs (Driver 2002; Driver and Woiderski 2008). The equation is:

$$\sum \text{NISP Artiodactyls} \,/\, \sum \text{NISP [Artiodactyls + Lagomorphs]}$$

Bayham (1977) assumed that that hunters will focus their energy on animals that will provide the most caloric value. He stated that “it is assumed that deer are the most preferred food item, and therefore, the representation of rabbit species in the diet is an indirect index of how abundant deer were” (Bayham 1977:357). In other words, the Artiodactyl Index is used to indicate the availability of large game. I disagree with this assumption. The Artiodactyl Index really only indicates the relative abundance of large game to small game within a faunal bone assemblage. Other factors besides caloric value can drive hunters to focus on large game hunting over small game hunting, such as prestige hunting. Some Fremont hunters may have maximized their prestige by hunting large or rare animals (Fisher 2010). In essence, the closer the index is to one, the greater availability or emphasis on large game hunting (Driver 2002; Driver and Woiderski 2008).

Other indices are used by zooarchaeologists to make comparisons between other taxa. The Lagomorph Index measures the availability of cottontails to other lagomorphs. Similar to the Artiodactyl Index, the Lagomorph Index calculates the ratio of cottontails by dividing the total NISP of cottontails by the total number of lagomorphs. The equation is:

∑NISP Cottontails / ∑NISP [Cottontails + Jackrabbits]

Since cottontails prefer habitats with shrubs and jackrabbits prefer open area environments, variations in the index suggest possible changes in the environment, including humans clearing land for farming. Variations in the Lagomorph Index could also suggest changes in hunting techniques regarding communal rabbit drives (Driver and Woiderski 2008).

In this research, I explore the relative abundance of artiodactyls to lagomorphs using the Artiodactyl Index in order to examine the availability of large game in the area around Wolf Village. Since muskrat is also abundant at Wolf Village, I also use a Muskrat Index (∑NISP Artiodactyls / ∑NISP [Artiodactyls + Muskrats + Lagomorphs]). I also explore the relative abundance of cottontails to jackrabbits at Wolf Village using the Lagomorph Index.

Relative Frequencies of Skeletal Elements

Exploring the frequency of specimens from different parts of the skeleton is important in studying taphonomy. Skeletal frequencies help zooarchaeologists to understand butchering techniques, food preparation, disposal habits, site function, and economic institutions (Reitz and Wing 2008:213). Some studies have used skeletal frequencies to study social organization and feasting (see Hockett 1998 and Stauffer 2012 for Fremont examples). Utility indices rank skeletal parts of animals based on their caloric usefulness. The assumption behind utility indices is that hunters made butchering and transport decisions at a kill site based on the caloric value of animal body parts (Reitz and Wing 2008:225; see also Binford 1978). Determining the utility of animal portions can be difficult since some portions have utility beyond food value. In most faunal bone research, utility indices are based solely on caloric value and are calculated based on the amount of meat, marrow, or grease on a bone element or portion. While fat and meat were obvious factors in transport decisions, ethnographic observations suggest that butchering and transport decisions were based on a number of considerations that are not always related to food value (O'Connell and Marshall 1989; O'Connell et al. 1990). In my research, I study the skeletal frequencies at Wolf Village in order to examine the utility of large game skeletal portions and transport decisions among Fremont hunters.

Modified General Utility Index (MGUI)

Binford (1978:72–74) created the general utility index (GUI) by dissecting both a domestic sheep (*Ovis aries*) and a Nunamiut caribou (*Rangifer tarandus*). He estimated the weight portions of meat, marrow, and grease in the appendicular skeleton of each animal. He used these values to create indices of food values for various animal portions, such as the ribs, cranial elements, and the distal and proximal ends of each long bone. He compared the anatomy of the caribou and domestic sheep to the butchering practices of the Nunamiut people. He assumed that decisions regarding the utility of animal portions and transportation methods were determined only by caloric value, meaning the amount of meat, marrow, and grease associated with each portion (Binford 1978:72; Lyman 1994:225). Binford (1978:74) noted that while the GUI is accurate, it is an impractical analytical tool since animals are butchered not by single bone elements, but in whole units (see the above discussion on MAU). For instance, a metatarsal (an element with a low-caloric value) is connected to the same limb as a tibia and femur (both high-caloric elements). Binford (1978:74) referred to low-caloric elements of these types as "riders" since they are transported not for their caloric value, but due to their relationship with elements of high-caloric value. Since some skeletal parts with a low GUI value are attached to parts with a high GUI value, Binford reasoned that the low-caloric parts should take on a utility value equal to the mean of the two separate values (Jones and Metcalfe 1988, Metcalfe and Jones 1988).

The MGUI was created by Binford (1978:12) to discuss the transport and utility of animal parts. He argued that archaeofaunal assemblages can provide insight into site function based on the presence of high- or low-caloric body parts. Binford noted that Nunamiut hunters make decisions on how to butcher and transport an animal in the field. He states, “The butcher’s interest is in which parts of the animal are best for the greatest variety of potential uses” (Binford 1978:72). In essence, Binford argued that the Nunamiut often left low-caloric elements at a kill site, with high-caloric elements taken to a residential site to be butchered since they provide the greatest portions of meat (Binford 1978:19). Low-caloric elements include foot bones (i.e., tarsals, carpals, metapodials, etc.), mandibles, and various appendicular parts with very little meat. High-caloric elements include femora and axial portions with a significant amount of meat. The MGUI values used in this research were borrowed from Binford (1978:74) and are presented in Table 3.1.

Like other Fremont scholars (Janetski 2000; Rood and Butler 1993; Sharp 1992; Stauffer 2012; Todd 1993), I use the Nunamiut processing and recovery techniques as an analogy to Fremont processing and recovery practices, specifically the MGUI as presented by Binford (1978). In theory, the greater the number of low-caloric elements that the Fremont brought back to Wolf Village, the more likely that the site functioned in part as a kill/butchering area. According to the MGUI, low-caloric elements would be left at a kill site after butchering, since they do not provide enough caloric value to warrant the time and energy needed to bring them back to an occupation site. However, since the MGUI values are purely based on food value with no regard to non-food value, I do not assume the results of the MGUI are truly reflective of the utility of animal body parts. Recent research on Fremont abandonment rituals (Abo 2016) and the use of animal bones in the construction of bone tools and gaming pieces (Bryce 2016; Robbins and Lambert 2016) suggest that at least some low-caloric elements were important to the Fremont for non-food use. For example, mandibles and vertebrae are found in possible abandonment contexts at Wolf Village (Abo 2016). In addition, metapodials were important

Table 3.1. Modified General Utility Index (MGUI) Values for Caribou and Domestic Sheep from Binford (1978).

Anatomical Part	Caribou	Sheep
Antler/Horn	1.0	1.0
Cranium	17.49 (8.74)*	25.74 (12.87)*
Mandible	13.9	11.7
Atlas	9.8	18.7
Axis	9.8	18.7
Cervical vertebrae	35.7	55.3
Thoracic vertebrae	45.5	46.5
Lumbar vertebrae	32.1	38.9
Pelvis	47.9	81.5
Ribs	49.8	100.0
Sternum	64.1	90.5
Scapula	43.5	45.1
Proximal humerus	43.5	37.3
Distal humerus	36.5	32.8
Proximal radio-cubitus	26.6	24.3
Distal radio-cubitus	22.2	20.1
Carpals	15.5	13.4
Proximal metacarpal	12.2	10.1
Distal metacarpal	10.5	8.5
Proximal femur	100.0	80.6
Distal femur	100.0	80.6
Proximal tibia	64.7	52.0
Distal tibia	47.1	37.7
Tarsals	31.7	23.1
Astragalus	31.7	23.1
Calcaneus	31.7	23.1
Proximal metatarsal	29.9	15.8
Distal metatarsal	23.9	12.1
Phalanges	13.7	8.2

*Realistic values for the skull (values in parentheses) are based on one-half the measured values, since so much of the measured weight is cartilage and not usable meat (Binford 1978:74).

in the construction of worked bone awls (Bryce 2016:56–58) and gaming pieces (Robbins and Lambert 2016). This suggests that any discussion on the utility of animal parts as viewed by the Fremont must also consider other uses of animal parts beyond their food value.

4 | Wolf Village Faunal Bones

This chapter presents the faunal bone information recovered from the activity areas and architectural features at Wolf Village. The Wolf Village faunal bone assemblage is divided into two aggregates based on time period. First, I provide counts for each represented species in the faunal bone assemblage. I describe the relative abundance of taxa for both periods at Wolf Village. Both NISP and MNI are presented, although only NISP is used to measure the relative abundance of taxa. Next, I present primary data derived from the faunal analysis, including taphonomic modifications such as butchering marks, burn marks, and breakage of artiodactyl long bones. Lastly, I attempt to resolve some biases in this analysis by discussing carnivore disturbance and by comparing the percent of survivorship on artiodactyl bones to density values provided by Lyman (1994).

TAXONOMY

I analyzed a portion of the faunal bone material collected during the 2009 – 2016 field seasons from Wolf Village. In total, I analyzed 2,273 bone specimens from the activity areas dating to Period I, and 43,078 bone specimens from architectural features dating to Period II. A total of 45,351 bone specimens were identified from both periods at Wolf Village. Of those, 15,799 (35 percent) specimens were identified to order or lower taxonomic rank. The Period I faunal bone assemblage contained 526 identified specimens, while the Period II faunal bone

Table 4.1. Comparison of the Number of Identified Specimens (NISP) from Wolf Village.

Taxa	Period I	Period II	Total
Artiodactyla	454	10,933	11,387
Carnivora	–	21	21
Lagomorpha	18	1,966	1,984
Rodentia	18	1,306	1,324
Avifauna	31	249	280
Cypriniformes	5	798	803
Total	526	15,273	15,799

Table 4.2. Comparison of the Percentage of NISP (%NISP) from Wolf Village.

Taxa	Period I	Period II
Artiodactyla	86.3	71.6
Carnivora	–	0.1
Lagomorpha	3.4	12.9
Rodentia	3.4	8.6
Avifauna	5.9	1.6
Cypriniformes	1.0	5.2
Total	100.0	100.0

assemblage contained 15,273 identified specimens (Tables 4.1 and 4.2). I identified six major groups of animals across both occupations of Wolf Village, including Artiodactyla, Rodentia, Lagomorpha, Carnivora, Cypriniformes (bony fish), and Aves. Nearly all of the specimens in both periods are artiodactyls (Figure 4.1).

Many of the bone specimens collected from Wolf Village are highly fragmented and therefore, unidentifiable to a taxonomic order or family. The majority of the unidentified specimens from Period I are from large mammals (220 specimens, 12.6 percent) and small mammals (576 specimens, 33 percent). Likewise, the majority of unidentified specimens from Period II are also from large mammals (5,966 specimens, 21 percent) and small mammals (5,620

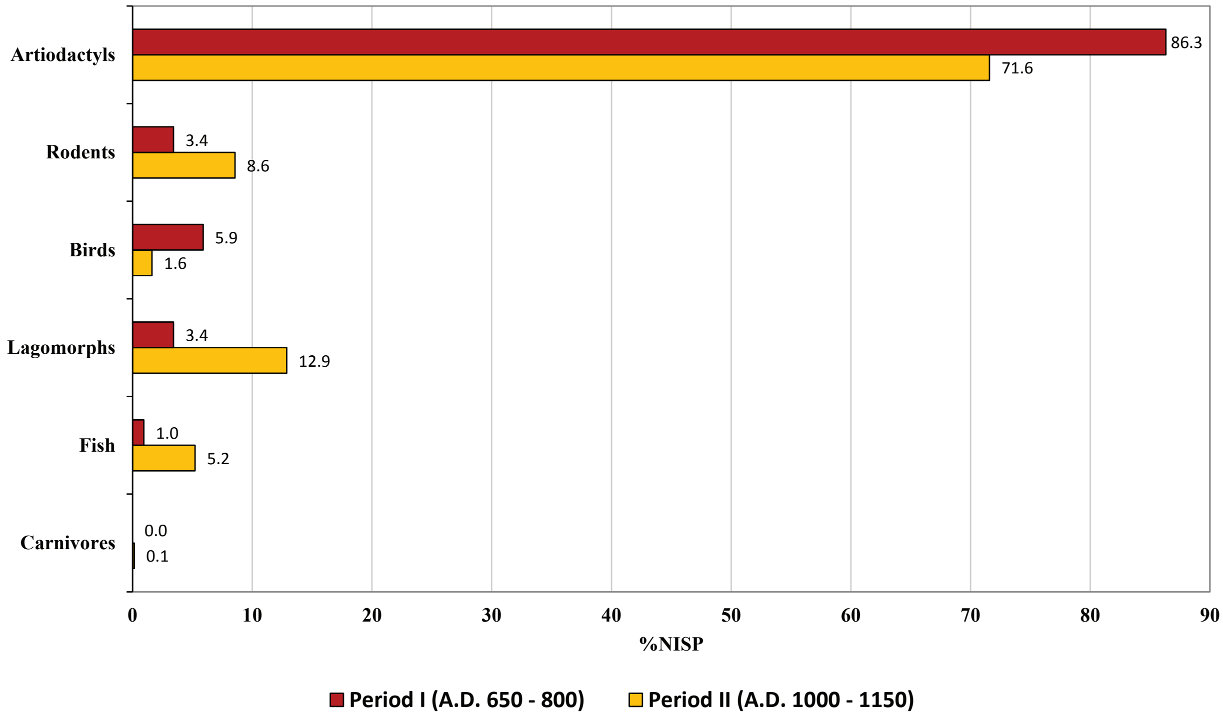

Figure 4.1. Comparison of the relative proportions of taxa (%NISP) at Wolf Village for Periods I and II.

specimens, 20 percent) (Tables 4.3 and 4.4). A descriptive summary of each taxon and element count for Period I and Period II fauna is in Appendix A.

Relative Abundance of Taxa at Wolf Village

Taxonomic abundance is measured in %NISP rather than %MNI, following methods advised by Grayson (1984). As stated, when comparing the Period I and II relative frequencies of taxa, I only compared NISP counts identified using the same sampling methods (i.e., I do not include the Structure 2 units where I only counted artiodactyl bones). The relative abundance of taxa changes between both periods (see Figure 4.1). For example, artiodactyls were more abundant in the Period I assemblage compared to the Period II assemblage. This suggests that while large game hunting was important in both periods, there seems to have been a slight resource depression of artiodactyls in Period II. The lower populations of artiodactyls around

Table 4.3. Comparison of the Number of Unidentified Specimens (NUSP) from Wolf Village.

Category	Period I	Period II	Total
Large Mammal	220	5,966	6,186
Medium Mammal	3	362	365
Small Mammal	576	5,620	6,196
Rodents	6	692	698
Unidentified Mammal	881	12,953	13,834
Large Bird	34	67	101
Medium Bird	6	167	173
Small Bird	4	185	189
Unidentified Bird	–	40	40
Unidentified Fish	17	1,742	1,759
Amphibians	–	11	11
Total Unidentifiable	1,747	27,805	29,552
Total NISP	526	15,273	15,799
TOTAL ALL BONES	2,273	43,078	45,351

Table 4.4. Comparison of the Number of Unidentified Specimens (%Category) from Wolf Village.

Category	Period I	Period II
Large Mammal	12.6	21.5
Medium Mammal	0.2	1.3
Small Mammal	33.0	20.2
Rodents	0.3	2.5
Unidentifiable Mammal	50.4	46.6
Large Bird	1.9	0.2
Medium Bird	0.3	0.6
Small Bird	0.2	0.7
Unidentifiable Bird	–	0.1
Unidentifiable Fish	1.0	6.3
Amphibians	–	0.0
Total	100.0	100.0

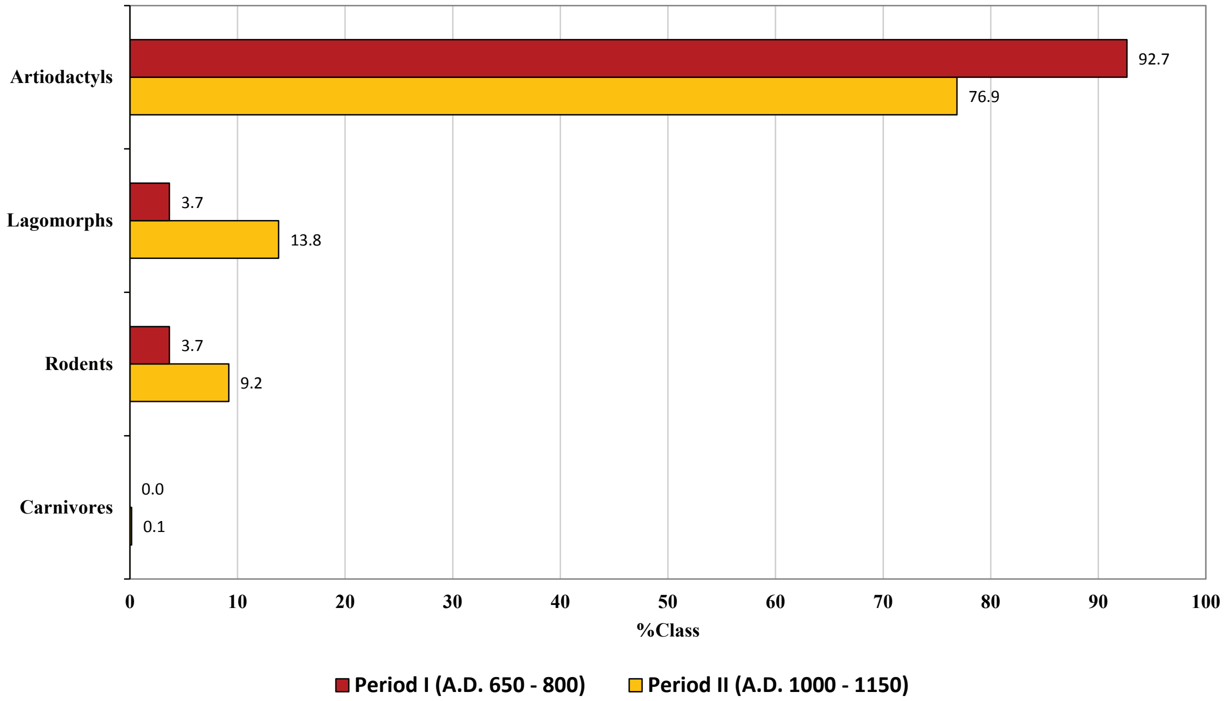

Figure 4.2. Relative proportions of identified mammalian orders (%Class) at Wolf Village.

Wolf Village may mean that Fremont hunters focused more on small game and fish in Period II compared to Period I. It is also possible that as people from Wolf Village relied more on domesticated maize and other crops for sustenance (see Dahle 2011), there was less emphasis on large game hunting. The data also suggest that carnivores were rarely used in both periods. Birds were a relatively important secondary resource during Period I at Wolf Village, but seem to have been less used during Period II. The relative abundance of taxa is further explored according to the class biological classification.

Class: Mammalia

Mammals nearly dominate the faunal bone assemblage from both Period I (Table 4.5) and Period II (Table 4.6) at Wolf Village. Artiodactyla is the most abundant mammalian order in both periods (Figure 4.2). Artiodactyls are even-toed ungulates that include sheep, deer, goats, pigs,

Table 4.5. NISP and MNI Counts for Mammalian Taxa from Wolf Village, Period I.

Taxon	NISP	MNI*	%NISP	%Class
Artiodactyla				
Antilocapra americana	3	1	0.6	0.6
cf. *Antilocapra americana*	2	–	0.4	0.4
Odocoileus hemionus	29	2	5.5	5.9
cf. *Odocoileus hemionus*	14	–	2.7	2.9
Ovis canadensis	2	1	0.4	0.4
cf. *Ovis canadensis*	3	–	0.6	0.6
Small Artiodactyla	401	–	76.2	81.8
Lagomorpha				
Lepus townsendi	3	1	0.6	0.6
cf. *Lepus townsendi*	1	–	0.2	0.2
Sylvilagus audubonii	5	1	1.0	1.0
cf. *Sylvilagus audubonii*	1	–	0.2	0.2
Leporidae	8	1	1.5	1.6
Rodentia				
Spermophilus armatus	3	1	0.6	0.6
cf. *Spermophilus armatus*	1	–	0.2	0.2
cf. *Spermophilus variegatus*	1	–	0.2	0.2
Spermophilus sp.	4	1	0.8	0.8
Marmota sp.	1	1	0.2	0.2
cf. *Ondatra zibethicus*	3	–	0.6	0.6
Neotoma cinerea	3	1	0.6	0.6
cf. *Neotoma cinerea*	1	–	0.2	0.2
Thomomys bottae	1	1	0.2	0.2
Total Identifiable Mammals	490	12	93.2	100.0

*MNI only calculated for taxa identified to family, genus, or species levels, excepting those labelled “cf.”

bison, and other relatives. There are three main families of artiodactyls in the Great Basin region: Cervidae (deer and elk), Bovidae (sheep, goats, and bison), and Antilocapridae (pronghorns). Artiodactyls were the highest calorically ranked and economically important animals for prehistoric peoples in western North America, and therefore, their bones usually dominate the archaeological faunal bone record (Broughton and Miller 2016:120). This is the case with the

Table 4.6. NISP and MNI Counts for Mammalian Taxa from Wolf Village, Period II*.

Taxon	NISP	MNI**	%NISP	%Class
Artiodactyla				
Antilocapra americana	97	5	0.6	0.7
cf. *Antilocapra americana*	13	−	0.1	0.1
Odocoileus hemionus	543	11	3.6	3.8
cf. *Odocoileus hemionus*	52	−	0.3	0.4
Ovis canadensis	156	7	1.0	1.1
cf. *Ovis canadensis*	17	−	0.1	0.1
Bison bison	3	1	0.0	0.0
Large Artiodactyla	17	−	0.1	0.1
Small Artiodactyla	10,019	−	65.6	70.4
cf. Small Artiodactyla	16	−	0.1	0.1
Carnivora				
Canis latrans	3	1	0.0	0.0
cf. *Canis latrans*	2	−	0.0	0.0
Canis sp.	11	1	0.1	0.1
Canidae	1	1	0.0	0.0
cf. Canidae	1	−	0.0	0.0
cf. *Procyon lotor*	3	−	0.0	0.0
Lagomorpha				
Lepus californicus	56	4	0.4	0.4
cf. *Lepus californicus*	3	−	0.0	0.0
Lepus townsendi	138	11	0.9	1.0
cf. *Lepus townsendi*	3	−	0.0	0.0
Lepus sp.	562	11	3.7	4.0
Sylvilagus audubonii	647	27	4.2	4.5
cf. *Sylvilagus audubonii*	20	−	0.1	0.1
Sylvilagus sp.	305	7	2.0	2.1
cf. *Sylvilagus* sp.	1	−	0.0	0.0
Leporidae	221	3	1.4	1.6
cf. Leporidae	10	−	0.1	0.1
Rodentia				
Castor sp.	2	1	0.0	0.0
Erethizon dorsatum	1	1	0.0	0.0
cf. *Erethizon dorsatum*	1	−	0.0	0.0
Spermophilus armatus	62	8	0.4	0.4
cf. *Spermophilus armatus*	14	−	0.1	0.1

Table 4.6. Continued.

Taxon	NISP	MNI**	%NISP	%Class
Spermophilus variegatus	17	6	0.1	0.1
cf. *Spermophilus variegatus*	2	–	0.0	0.0
Spermophilus sp.	185	18	1.2	1.3
Sciuridae	9	1	0.1	0.1
Ondatra zibethicus	711	35	4.7	5.0
cf. *Ondatra zibethicus*	34	–	0.2	0.2
Neotoma cinerea	27	5	0.2	0.2
Neotoma stephensi	7	3	0.0	0.0
cf. *Neotoma stephensi*	3	–	0.0	0.0
Neotoma sp.	54	6	0.4	0.4
cf. *Neotoma* sp.	1	–	0.0	0.0
Microtus sp.	52	5	0.3	0.4
cf. *Microtus* sp.	1	–	0.0	0.0
Cricetidae	75	8	0.5	0.5
Mus musculus	23	3	0.2	0.2
Thomomys bottae	14	6	0.1	0.1
cf. *Thomomys bottae*	1	–	0.0	0.0
Thomomys sp.	5	2	0.0	0.0
cf. *Dipodomys deserti*	1	–	0.0	0.0
Dipodomys sp.	4	1	0.0	0.0
Total Identifiable Mammals	14,226	199	93.1	100.0

*Artiodactyl bone specimens from the blank units in Figure 3.1 are not included in this table.

**MNI only calculated for taxa identified to family, genus, or species levels, excepting those labelled "cf."

faunal bone assemblages from both periods at Wolf Village.

Other mammalian orders represented in the faunal bone assemblage include Rodentia, Lagomorpha, and Carnivora. Rodentia includes the largest number of mammal species. Most rodents are small herbivores that are similar in size to rats and mice, although the American Beaver (*Castor canadensis*) and North American Porcupine (*Erethizon dorsatum*) are larger. Families from the order Rodentia include Aplodontiidae (mountain beaver), Sciuridae (squirrels, chipmunks, and marmots), Castoridae (beavers), Heteromyidae (kangaroo rats, kangaroo mice, and pocket mice), Geomyidae (pocket gophers), Dipodidae (jumping mice), Cricetidae (Cricetid rats and mice), and Erethizontidae (New World porcupines). Rodents have one set of ever-growing incisors and no canines (Broughton and Miller 2016:95).

Only two lagomorph families are present in the western United States, Leporidae (rabbits and hares) and Ochotonidae (pikas). Lagomorphs differ from rodents since they are born with three incisors on each side of the premaxilla, although one set is deciduous. Pikas are uncommon in the western United States and are noted for their small ears, no tail, and small size. Members of the family Leporidae, on the other hand, are relatively more common than pikas in the west, have giant ears, enlarged hind legs, and fluffy tails. The two genera in the west include *Lepus* (hares and jackrabbits) and *Sylvilgus* (cottontails).

Families from the order Carnivora include Felidae (cats), Canidae (dogs and foxes), Ursidae (bears), Mustelidae (weasels, badgers, and otters), Mephitidae (skunks), and Procyonidae (raccoons). As the name implies, species belonging to the order Carnivora are carnivorous, meaning that they catch and kill prey animals (although not all are strictly meat eaters). Although all of the above families were present within prehistoric Utah (Broughton and Miller 2016:112–119), no carnivores were identified among the Period I faunal bone assemblage, and very few were identified among the Period II assemblage (see Figure 4.2). Broughton and Miller (2016) explain that the lack of carnivores present among prehistoric faunal bone assemblages is not unusual since their population densities are much smaller compared to those of herbivorous mammals. Also, carnivores were not common prey animals for prehistoric peoples, although some were exploited for fur, or as companion animals in the case of hunting dogs (Broughton and Miller 2016:112; see also Lupo and Janetski 1994).

Period I

The Period I faunal bone assemblage suggests that the mammalian taxa at Wolf

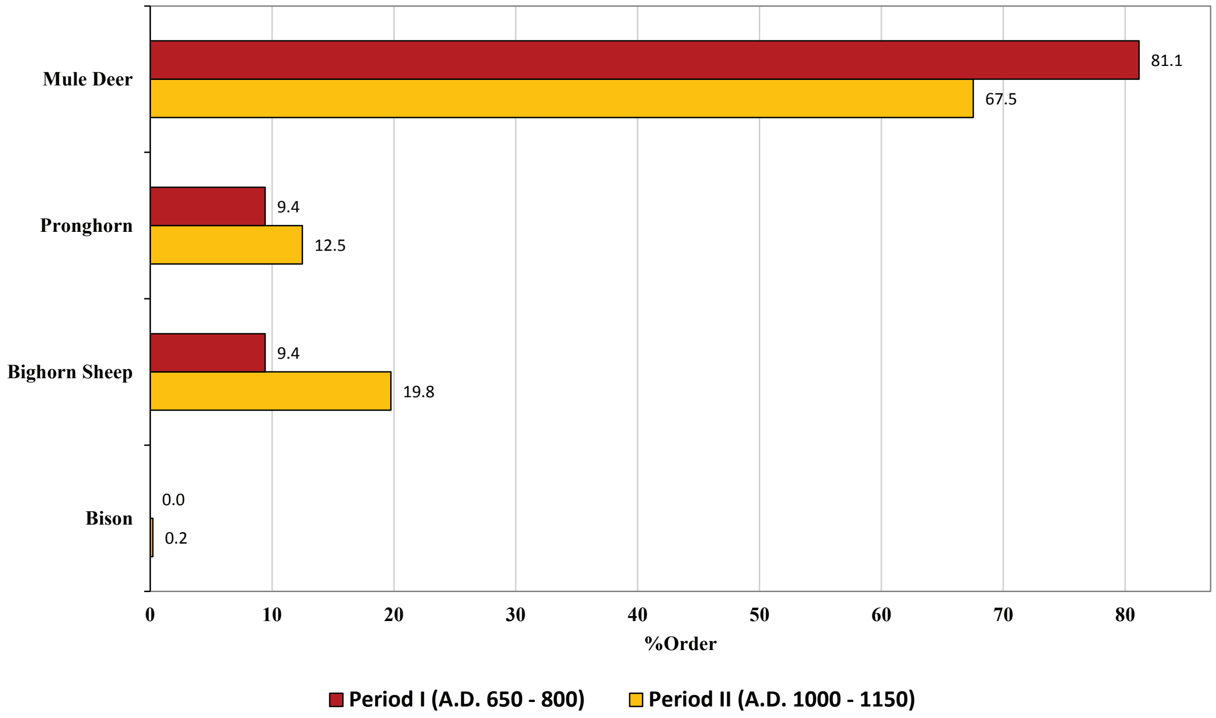

Figure 4.3. Relative proportions of identified artiodactyls (%Order) at Wolf Village.

Village was dominated by artiodactyls (454 specimens, 93 percent) (see Figure 4.2). Identified artiodactyls from Period I include pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), and mule deer (*Odocoileus hemionus*). Rodents and lagomorphs were equally represented among the Period I mammalian taxa (18 specimens each, 4 percent each). Rodents identified during Period I included various squirrels, rats, and gopher. Lagomorphs identified at Wolf Village include only jackrabbits and cottontails.

As stated, artiodactyl bones were the most abundant bone specimens among the Period I assemblage. When comparing only mammal elements to others in their class, artiodactyls vastly outnumber other mammalian orders (see Figure 4.2). Of the artiodactyls identified to species, mule deer bones were more common than bones from other artiodactyl species (43 specimens, 81 percent) (Figure 4.3). This suggests that mule deer was more common at Wolf Village than other artiodactyl species. The %NISP of identifiable artiodactyls during Period I suggests that bighorn sheep and pronghorn were equally exploited (5 specimens each, 9 percent each). Bison or other large artiodactyl elements were not identified among the Period I assemblage.

Period II

The Period II faunal bone assemblage suggests that mammalian taxa used at Wolf Village was dominated by artiodactyls, but in much less percentage than in the Period I assemblage (10,933 specimens, 77 percent) (see Figure 4.2). Identified artiodactyls include pronghorn, bighorn sheep, mule deer, and bison. Lagomorphs make up the second largest order among the mammalian assemblage (1,966 specimens, 14 percent), consisting again of jackrabbits and cottontails. Rodents were fairly common among Wolf Village mammals (1,306 specimens, 9 percent), and consisted of beavers, squirrels, rats, and, mice. Lastly, although carnivores were present among the Period II assemblage, there were very few specimens (21 specimens, <1 percent). Carnivores consisted primarily of coyotes and other canids, although there are raccoon specimens present.

As with Period I, artiodactyls appear to have been the most abundant order of mammals utilized at Wolf Village during Period II. This suggests that large game hunting was important to the Fremont at Wolf Village in both periods. Artiodactyls from Period II were more diverse and contained specimens from large artiodactyls, including bison (see Figure 4.3). The relative abundance of artiodactyl taxa changed between both periods, again suggesting there was a resource depression of at least mule deer around Wolf Village. Fremont hunters focused more on hunting pronghorn, bighorn sheep, and bison, perhaps as a result of a resource depression of mule deer. Regardless, as with Period I, the greatest majority of identified artiodactyl bones are mule deer (595 specimens, 68 percent). Bighorn sheep appears at least slightly more common than pronghorn, while bison is rare (3 specimens, <1 percent). Besides bison, no other large artiodactyl specimens were identified to family, genus, or species rank.

Many artiodactyl bones are associated with the nine structures, as were the bones of marsh animals (muskrat, swan, waterfowl, etc.) and small mammals (jackrabbits, cottontails, squirrels, etc.). This wide range of animal types suggests that the Fremont at Wolf Village were supplementing their carbohydrate-dominated diets with protein from local animals attracted by farming activities and the nearby creek and fields. In addition to using small local animals, the Fremont of Wolf Village also appear to have gone on hunting expeditions for large game. Artiodactyl elements vastly outnumbered any other types of mammals (see Figure 4.2), suggesting that the Fremont of Wolf Village regularly exploited them. Mule deer specimens were more common than bighorn sheep and pronghorn specimens combined (see Figure 4.3), suggesting that the Fremont likely hunted close to Wolf Village and ventured far from the site, at least some of the time. Jackrabbits, cottontails, and muskrat appear to have been a strong secondary source of meat protein.

Although the purpose of this thesis research is to examine large game transport practices by Fremont hunters, other classes of taxa were identified at Wolf Village and are worth mentioning. Hunting practices often adapt according to the relative abundance of other types of taxa. Also, the Fremont at Wolf Village hunted more than just large game, and their bird hunting and fishing strategies are also worth briefly exploring.

Class: Aves

Although relatively small in number when compared to mammal bone specimens, the avifauna record suggests that birds were an important secondary source of animal protein at Wolf Village. Birds were present during both periods of Wolf Village. There were numerous bird orders present in prehistoric Utah (see Lambert et al. 2017 and Parmalee 1980). The ones identified at Wolf Village include Podicipediformes (grebes), Pelecaniformes (pelicans and herons), Anseriformes (swans, ducks, and geese), Falconiformes (falcons), Galliformes (grouse

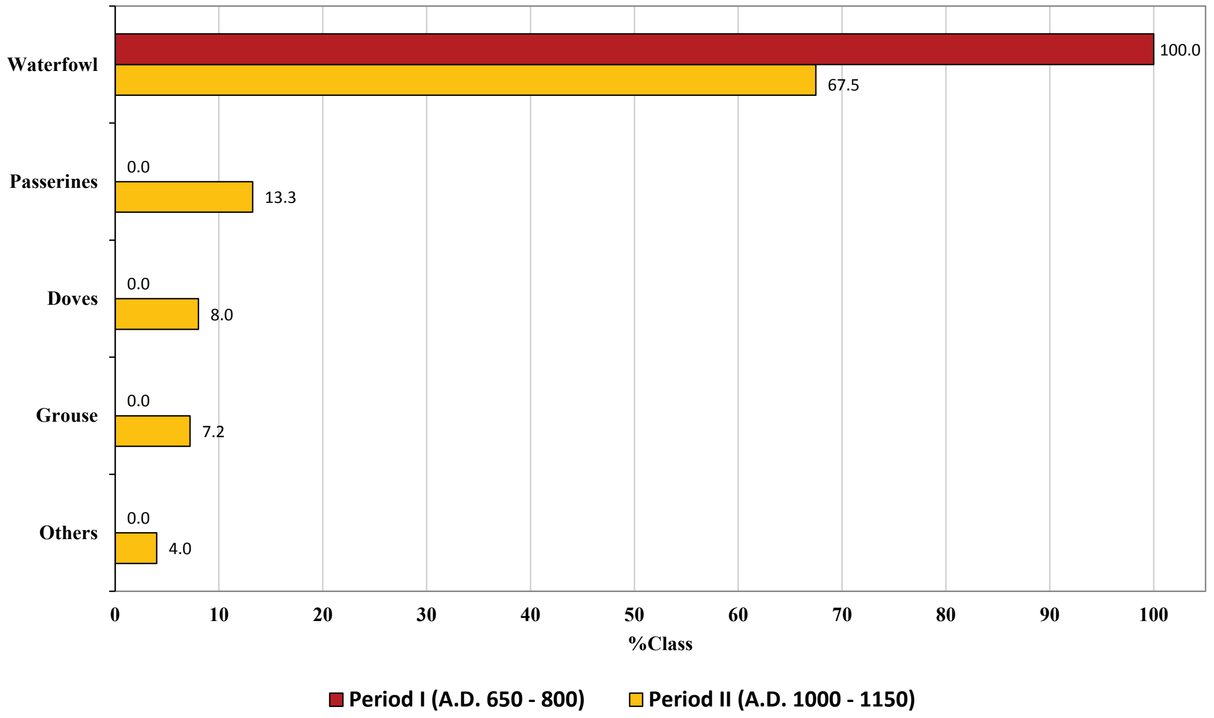

Figure 4.4. Relative proportions of bird orders (%Class) at Wolf Village.

and other ground-feeding birds), Charadriiformes (snipes and avocets), Columbiformes (pigeons and doves), Strigiformes (owls), Piciformes (flickers and woodpeckers), and Passeriformes (perching birds).

Period I

The avifauna record from Period I suggests that at least one order of birds was important for the Fremont at Wolf Village: waterfowl from the order Anseriformes (Figure 4.4). Birds made up roughly 6 percent of the faunal bone assemblage for Period I, mainly due to the presence of swan (*Cygnus* sp.) in Pit 9 (n=28 specimens). Other waterfowl includes mallard (*Anas platyrhynchos*). The lack of other bird orders suggests that waterfowl were the most used birds during Period I (Table 4.7).

Table 4.7. NISP and MNI Counts for Aves Taxa from Wolf Village, Period I.

Taxon	NISP	MNI*	%NISP	%Class
Anseriformes				
Anas platyrhynchos	1	1	0.2	3.2
Cygnus sp.	28	4	5.3	90.3
cf. *Cygnus* sp.	1	–	0.2	3.2
Medium Anatidae	1	1	0.2	3.2
Total Identifiable Avifauna	31	6	5.9	100.0

*MNI only calculated for taxa identified to family, genus, or species levels, excepting those labelled "cf."

Period II

Unlike Period I, birds were less utilized during Period II. The combined percentage of identified birds make up slightly more than 1 percent of the total NISP; however, there was much more diversity among the Period II bird bone assemblage (see Figure 4.4). All of the above mentioned bird orders were represented among the Period II assemblage in varying degrees (Table 4.8). Recent research has noted that species from several of those families were likely important to the Fremont for their feathers, for exploiting their bones in tool making, and as cultural symbols (Lambert et al. 2017). Some significant birds noted by Lambert et al. (2017) include grebes, waterfowl, hawks, eagles, grouse, avocets, owls, flickers, finches, and robins, some of which have been identified among the Wolf Village avifauna assemblage.

Waterfowl from the order Anseriformes dominate the bird bone assemblage during Period II at Wolf Village. This is not surprising since waterfowl were often the most economically important family of birds in aquatic regions (Lambert et al. 2017; Parmalee 1980), and ducks and geese were abundant in these regions occupied by the Fremont. Swan and other waterfowl from the family Anatidae seem to have been important to the Fremont, making up 73 percent of all bird bones in a study across 11 Fremont sites (Parmalee 1980:245) and at least 20 percent of all birds in a more recent study from 12 different Fremont sites (Lambert et al. 2017). Most of the

Table 4.8. NISP and MNI Counts for Aves Taxa from Wolf Village, Period II.

Taxon	NISP	MNI*	%NISP	%Class
Podicipediformes				
Aechmophorus occidentalis	1	1	0.0	0.4
Pelecaniformes				
Ardea alba	1	1	0.0	0.4
Pelecanus erythrorhynchos	1	1	0.0	0.4
Anseriformes				
Anas platyrhynchos	108	7	0.7	43.4
cf. *Anas platyrhynchos*	7	–	0.0	2.8
Anas crecca	1	1	0.0	0.4
Anas americana	2	1	0.0	0.8
Anas sp.	34	3	0.2	13.7
Cygnus sp.	12	2	0.1	4.8
cf. *Cygnus* sp.	1	–	0.0	0.4
Small Anatidae	2	1	0.0	0.8
Large Anatidae	1	1	0.0	0.4
Falconiformes				
Falco mexicanus	1	1	0.0	0.4
Galliformes				
Dendragapus obscurus	13	4	0.1	5.2
cf. *Dendragapus obscurus*	1	–	0.0	0.4
Dendragapus sp.	2	1	0.0	0.8
Tetraoninae	2	1	0.0	0.8
Charadriiformes				
Recurvirostra sp.	1	1	0.0	0.4
Gallinago gallinago	1	1	0.0	0.4
cf. *Gallinago gallinago*	1	–	0.0	0.4
Columbiformes				
Zenaida macroura	19	5	0.1	7.6
Zenaida sp.	1	1	0.0	0.4
Strigiformes				
Strigidae	1	1	0.0	0.4
Piciformes				
Colaptes auratus	2	1	0.0	0.8
Passeriformes				
Bombycilla cedrorum	5	2	0.0	2.0
cf. *Bombycilla cedrorum*	1	–	0.0	0.4

Table 4.8. Continued.

Taxon	NISP	MNI*	%NISP	%Class
Corvus brachyrhynchos	4	1	0.0	1.6
Corvidae	1	1	0.0	0.4
Turdus migratorius	14	3	0.1	5.6
cf. *Turdus migratorius*	7	–	0.0	2.8
Turdidae	1	1	0.0	0.4
Total Identifiable Avifauna	249	44	1.6	100.0

*MNI only calculated for taxa identified to family, genus, or species levels, excepting those labelled "cf."

Anatidae bones from Wolf Village were of mallard and swan, although at least two other species, the common teal (*Anas crecca*) and the American widgeon (*Anas americana*), were present in much smaller degrees. Lambert et al. (2017) state that the high percentage of waterfowl in Parmalee's (1980) study is probably because most of the Fremont sites in that study were located near major water sources. Likewise, Fremont sites excavated after Parmalee's study suggest that Fremont who lived in or around lacustrine or riverine environments also exploited waterfowl over other bird families (Lambert et al. 2017:8).

Not all bird species among the faunal bone assemblage were necessarily food sources. Food birds likely included grouse and waterfowl, although perching birds, flickers, and Corvids may have sometimes been utilized in part as food (Talbot et al. 2000:489). Later Great Basin groups that postdate the Fremont did not usually eat crows, eagles, hawks, mockingbirds, or bluebirds but did eat owls, quail, grouse, and waterfowl (Stewart 1942:244; Steward 1941:277). Talbot et al. (2000:488–489) suggest that birds gathered by the Fremont for feathers included woodpeckers, passerines, and some Corvids. In other words, some birds were gathered for decoration, while others (such as waterfowl and grouse) were collected primarily for food. In addition, Parmalee (1980) and others (see Lambert et al. 2017) have suggested that some birds may have been collected for more than just meat, but also for feathers and their bones. Indeed,

Table 4.9. NISP and MNI Counts for Fish Taxa from Wolf Village, Period I.

Taxon	NISP	MNI	%NISP	%Class
Catostomus ardens	1	1	0.2	20.0
Gila atraria	4	2	0.8	80.0
Total Identifiable Fish	5	3	1.0	100.0

birds may have been an important cultural symbol (Lambert et al. 2017; Watkins 2016).

Class: Actinopterygii

Actinopterygii is a class of bony fishes. This class includes several orders, only one of which was identified during this analysis: Cypriniformes (minnows and suckers). Two fish species were identified from this order: Utah sucker (*Catostomus ardens*) and Utah chub (*Gila atraria*). Identifying fish is extremely complicated, and many fish elements in this research were indistinguishable between species. In addition, despite only identifying Utah sucker among the family Catostomidae, some of the suckers may have been June suckers (*Chasmistes liorus*). June sucker and Utah sucker are difficult to distinguish; therefore, despite only Utah chub and Utah sucker being identified in the Wolf Village faunal bone assemblage, a more skilled fish analyst may be able to identify other species such as June sucker and trout (see Baker and Janetski 2004:38; see also Heckman et al. 1981 and Janetski 1990). Sucker and chub were mainly identified due to their distinctive pharyngeal arches, so I am confident that their identification to at least the family class is mostly accurate. Both fish species were present in both periods at Wolf Village, although fish, in general, appear to have been more exploited during Period II.

Period I

Very few fish elements were identified for Period I at Wolf Village (Table 4.9). While chub make up 80 percent of the identified fish, there are only four specimens identified. While

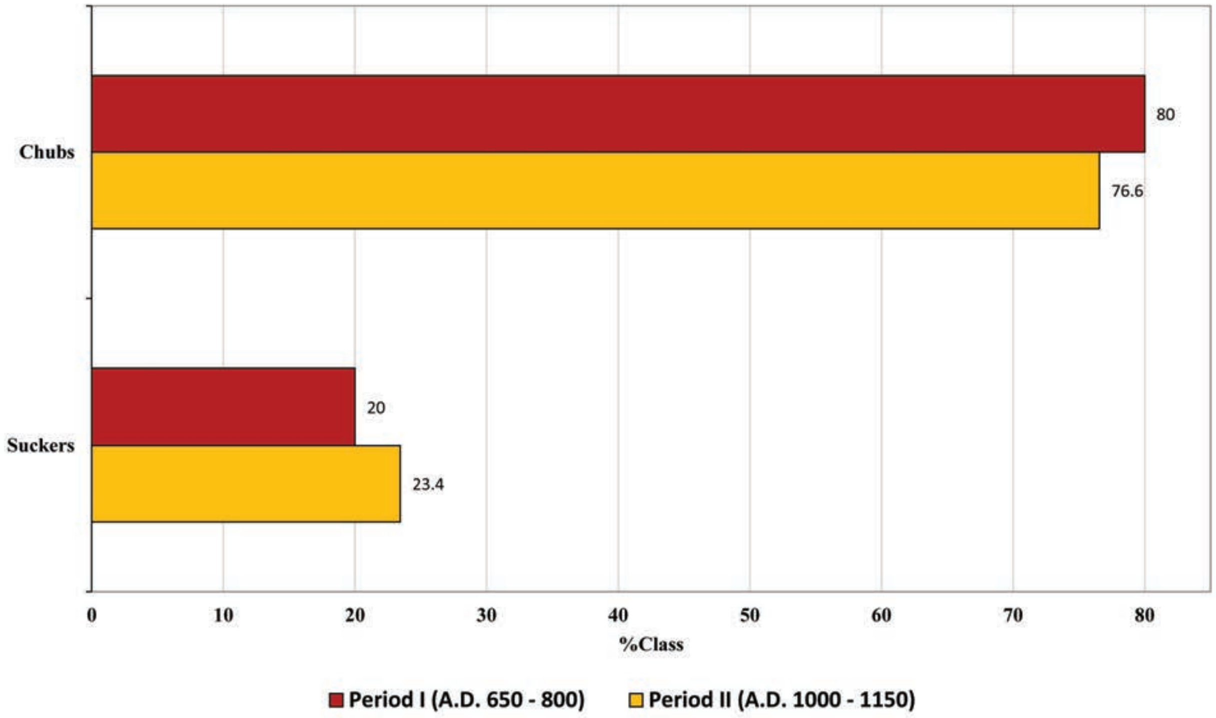

Figure 4.5. Relative proportions of identified fish taxa (%Order) at Wolf Village.

it would be unwise to suggest that chub was used more by the Fremont during Period I than other species of fish, there is a chance that this is accurate (Figure 4.5). It is interesting to note that all fish remains from Period I at Wolf Village were recovered from pits in Activity Area 1. While Activity Area 2 did contain some marshland animals (such as muskrat and waterfowl), no fish remains were recovered from the area. Regardless, the data suggest that fish were not used as much as other meat resources during Period I; fish bones make up only 1 percent of the total NISP (see Figure 4.1).

Period II

Fish appear to have been more plentiful among the Period II faunal bone assemblage, and make up approximately 5 percent of the faunal bone assemblage (Table 4.10). At least two species were identified, Utah chub and Utah sucker, although a third smaller *Gila* species was

Table 4.10. NISP and MNI Counts for Fish Taxa from Wolf Village, Period II.

Taxon	NISP	MNI*	%NISP	%Class
Catostomus ardens	166	11	1.1	20.8
cf. *Catostomus ardens*	21	–	0.1	2.6
Gila atraria	528	150	3.5	66.2
cf. *Gila atraria*	17	–	0.1	2.1
Gila sp.	66	32	0.4	8.3
Total Identifiable Fish	798	193	5.2	100.0

also identified. Chub species dominated the identifiable fish remains (611 specimens, 77 percent). Suckers were also present at Wolf Village, although in much smaller numbers than chub (187 specimens, 23 percent) (see Figure 4.5). Fish make up a small percentage of total NISP in both periods at Wolf Village, suggesting that fish were probably not as important to Fremont diet as other animal classes.

Class: Amphibia

There were at least 11 amphibian specimens identified in the Period II assemblage (see Tables 4.3 and 4.4). None of the specimens was identified to a family, genus, or species; therefore, amphibians do not appear to have been a significant part of Fremont meat subsistence at Wolf Village.

TAPHONOMY

As discussed in Chapter 2, certain taphonomic modifications suggest human behavior or natural destructive agents. Large game transport decisions by Fremont hunters at Wolf Village cannot adequately be examined without considering certain taphonomic processes. These include burn marks, butchering marks, and breakage type. These three types of modification are strongly associated with transport and processing practices, and often suggest cooking practices. The Wolf

Table 4.11. NISP and %NISP of Burned Artiodactyl Specimens from Wolf Village.

	Period I		Period II	
Burn Category	NISP	%NISP Burned	NISP	%NISP Burned
Scorched	1	25.0	1,354	48.5
Charred	–	–	985	35.3
Calcined	3	75.0	454	16.3
Total	4	100.0	2,793	100.0

Village faunal bone assemblage did not contain a large number of specimens with butchering or burning marks. However, some butchered and burned elements were identified and may provide evidence of how Fremont hunters processed large game carcasses. In this section I examine burn marks, butchering marks, and breakage types on small artiodactyl long bones from both periods at Wolf Village.

Burning

There are 2,797 burned small artiodactyl bone specimens identified in the Wolf Village faunal bone assemblage (Table 4.11). Analysis of the Period I bone assemblage resulted in the identification of only four burned specimens (<1 percent). One unidentified long bone specimen exhibits scorching, while three unidentified long bone fragments display calcification. Unfortunately, there is too little data from Period I to make any inferences about cooking techniques among the Fremont from that period. The lack of burning on the other remaining artiodactyl bone specimens in the assemblage (n=450) suggests, however, that animal bones were not often subjected to intense heat. This suggests that either meat was not cooked in intense flames, that meat was removed from bones to be cooked, or that meat was boiled while still on the bone.

The analysis of the Period II faunal bone assemblage resulted in the identification of

2,793 burned small artiodactyl specimens (25 percent of the total artiodactyl specimens). Most of these specimens were scorched (1,354 specimens, 48 percent of burned specimens), although there was a fair number of charred (985 specimens, 35 percent) or calcined specimens (454 specimens, 16 percent). The other small artiodactyl specimens displayed no visible signs of burning (8,140 specimens, 75 percent of the total artiodactyl bone assemblage). Of the 2,793 burned artiodactyl specimens from Period II, 547 were identified to a specific skeletal element (Table 4.12). Most of the burned specimens were from ribs and leg bones. Ribs are a mid- to high-caloric area on artiodactyls; therefore, burning on ribs is not unexpected. Whole legs may have been burned during the cooking process, since high-caloric elements such as femurs and tibias were presumably burned about as often as low-caloric metatarsals (Figure 4.6). The burning on artiodactyl bone specimens suggests that the associated animals were food species used by the Fremont. The other non-burned specimens suggest that not all portions of artiodactyls were subjected to intense cooking temperatures, or that these portions were cooked in ways that did not leave any visible burn marks. Regardless, the fact that roughly 25 percent of all small artiodactyl bones from Period II exhibited signs of burning, compared to the less than 1 percent in Period I, strongly suggests that there were changes in cooking practices between the two periods.

Butchering

Very few bones from either assemblage at Wolf Village exhibited signs of butchering. There are at least three probable reasons for this. First, the Wolf Village faunal bone assemblages are highly fragmented for both periods, and many bone specimens are heavily weathered. Similar conditions also affected the amount of butchering marks identified on bones in other faunal bone assemblages at Five Finger Ridge (Janetski 2000:74–75) and North Creek Shelter (Newbold 2009:78–79). Second, some butchering techniques leave no identifiable marks (Reitz and Wing

Table 4.12. Number of Identified Artiodactyl Specimens with Evidence of Burning at Wolf Village, Period II.

Skeletal Element	NISP Burned
Antler	13
Cranium	5
Mandible	45
Hyoid	1
Cervical vertebra	10
Thoracic vertebra	12
Lumbar verebra	4
Pelvis	15
Rib	87
Sternum	1
Scapula	34
Humerus	22
Radius	29
Ulna	9
Carpal	4
Metacarpal	39
Femur	41
Tibia	48
Tarsal	10
Astragalus	6
Calcaneus	10
Metatarsal	57
First phalanx	19
Second phalanx	16
Third phalanx	10
Total	547

2008:126). Third, the Nunamiut used metal tools to dismember and butcher animals (Binford 1981:98). Metal tools likely cause more noticeable damage (i.e., they leave more marks) than the stone tools used by the Fremont. The lack of butchering marks on animal bones from Wolf Village may be the result of the Fremont processing animal body parts with stone tools rather than with metal ones. These potential reasons could account for the lack of butchering marks on

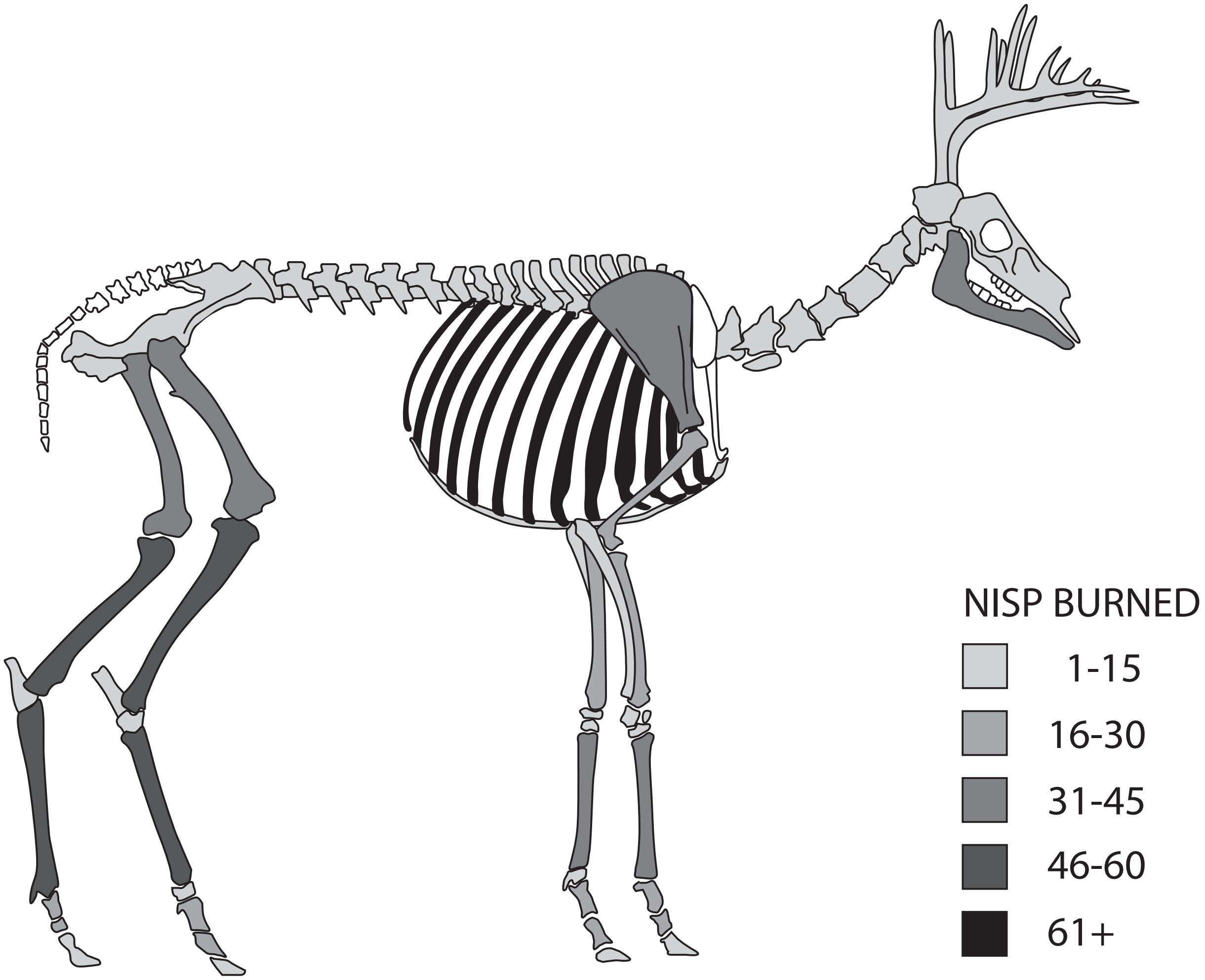

Figure 4.6. Distribution of burning on large mammal bones from Period II, Wolf Village.

bones in the Wolf Village faunal bone assemblage.

Evidence of butchering activities are valuable in my analysis since they could indicate how portions of meat were transported, distributed, and prepared (Reitz and Wing 2008:126). Binford (1981:107) noted four types of butchering activities: (1) skinning, (2) dismemberment, (3) filleting, and (4) marrow consumption. Each of these activities leaves distinctive marks. Skinning marks are the result of removing animal skins from bones to use for other products. Skinning marks are usually found on mandibles, cranial elements, metapodials, and phalanges. Dismemberment marks (here called chop or hack marks) are made while separating body elements around large joints. Filleting is the removal of meat from a bone and can result in cuts

Table 4.13. NISP and %NISP of Butchered Artiodactyl Specimens from Wolf Village.

	Period I		Period II	
Butchered Category	NISP	%NISP Cut	NISP	%NISP Cut
Skinning	–	–	9	12.7
Hack/chop	–	–	11	15.5
Cuts/slices	6	75.0	46	64.8
Scrapes	2	25.0	5	7.0
Total	8	100.0	71	100.0

or slice marks around bone joints and bone shafts. Marrow consumption marks are evidenced by distinctive blows with a hammerstone or other heavy objects. In my analysis, I also looked for scrape marks, distinctive as small, shallow cuts along a bone surface. This analysis was adapted after Noe-Nygaard (1989).

Only 8 small artiodactyl bone specimens from Period I displayed butchering marks (8 specimens, 2 percent of the total artiodactyl assemblage) (Table 4.13). Most of the butchering marks appear to be caused by filleting (6 specimens). There are at least two scrape marks present among the Period I assemblage. Of the butchered specimens that were identified to an element, there is one specimen from each of the following elements: a rib, scapula, radius, metacarpal, and tibia. Unfortunately, as with burn marks, there is simply too little data from Period I to make any sound inferences about butchering practices among the Fremont at Wolf Village.

There were more artiodactyl bone specimens identified from Period II with evidence of butchering marks (71 specimens, <1 percent of the total artiodactyl assemblage) (see Table 4.13). Most of the butchering marks identified among the assemblage were cut and slice marks likely caused by filleting (46 specimens, 65 percent). Other marks identified include five scrape marks (7 percent), nine skinning marks (13 percent), and 11 hack/chop marks (15 percent). Most long bones from Wolf Village were very fragmented, suggesting that marrow was extracted often.

Long bones were fragmented as part of tool production, marrow extractions, or both. Filleting may have been a popular method of butchering, meaning that meat was cooked either off the bone and/or stored for later use. Many of the artiodactyl bone specimens exhibited no butchering marks. This suggests that the Fremont either butchered artiodactyls in such a way as to leave no visible marks (such as using stone tools), or that fragmenting bones as part of marrow extraction or tool production destroyed most of the butcher marked specimens. Of the 71 small artiodactyl elements exhibiting butchering marks, 51 were identified to a specific element (Table 4.14). Most of the specimens with butchering marks were from high-caloric elements, including femora, tibias, and humeri (Figure 4.7). Low-caloric elements, including metapodials and cranial bones, also show evidence of butchering marks. The analysis of butchering marks suggests that animal carcasses were disarticulated by cutting through joints. Bones were also defleshed, either as part of cooking practices or in preparation for marrow extraction.

Breakage

Breakage types were recorded for all artiodactyl bones from Wolf Village (Table 4.15). Breakage types were only recorded for long bones, and only long bones that could be clearly identified to a specific breakage type. In other words, highly fragmented long bones and all flat bones were not included in this analysis. In Period I, spiral breaks were identified on 5.6 percent of the artiodactyl long bone specimens (n=20). Oblique breaks were more common among the Period I assemblage (222 specimens, 62 percent). Spiral and sometimes oblique breaks are often the result of people hitting freshly wet bones at each end with large rocks or objects to obtain the inside marrow. Together, spiral and oblique breaks account for 68 percent (n=242) of the Period I specimens with breakage present. Likewise, spiral and oblique breaks account for 34 percent (n=1,364) of the artiodactyl long bones with breaks from Period II, suggesting that many of the artiodactyl long bones with breaks are the result of human processing practices, probably the

Table 4.14. Quantification of Butchering Marks by Element on Small Artiodactyl Specimens from Wolf Village.

Element	Period I			Period II		
	Cut	NISP	%NISP Cut	Cut	NISP	%NISP Cut
Antler/Horn	–	–	–	–	38	0.0
Cranium	–	10	0.0	1	112	0.9
Mandible	–	9	0.0	5	200	2.5
Cervical vertebrae	–	–	–	–	45	0.0
Thoracic vertebrae	–	1	0.0	1	78	1.3
Lumbar vertebrae	–	1	0.0	2	45	4.4
Pelvis	–	4	0.0	1	132	0.8
Ribs	1	29	3.4	6	717	0.8
Sternum	–	–	0.0	–	1	0.0
Scapula	1	9	11.1	–	127	0.0
Humerus	–	3	0.0	7	163	4.3
Radius	1	11	9.1	5	151	3.3
Ulna	–	1	0.0	–	19	0.0
Carpals	–	6	0.0	–	24	0.0
Metacarpal	1	4	25.0	3	216	1.4
Femur	–	11	0.0	6	202	3.0
Tibia	1	36	2.8	7	273	2.6
Tarsals	–	6	0.0	–	58	0.0
Astragalus	–	–	–	–	32	0.0
Calcaneus	–	3	0.0	2	55	3.6
Metatarsal	–	5	0.0	2	247	0.8
Phalanges	–	6	0.0	3	368	0.8
Total	5	155		51	3,303	

extraction of marrow.

Transverse breaks are the result of bones being broken horizontally, either during food preparation or tool manufacturing. In Period I, transverse breaks account for 23 percent of the small artiodactyl long bones with breakage types (n=83), while in Period II, transverse breaks account for 38 percent of the long bones (n=1,517) (Figure 4.8). Stepped and splintered breaks can easily be the result of natural or cultural processes, such as carnivore gnawing or human

Table 4.15. NISP and %NISP of Breakage Types on Artiodactyl Specimens at Wolf Village.

Butchered Category	Period I		Period II	
	NISP	%NISP	NISP	%NISP
Spiral	20	5.6	129	3.2
Oblique	222	62.4	1,235	31.1
Transverse	83	23.3	1,517	38.2
Splinter	7	2.0	155	3.9
Stepped	24	6.7	940	23.6
Total	356	100.0	3,976	100.0

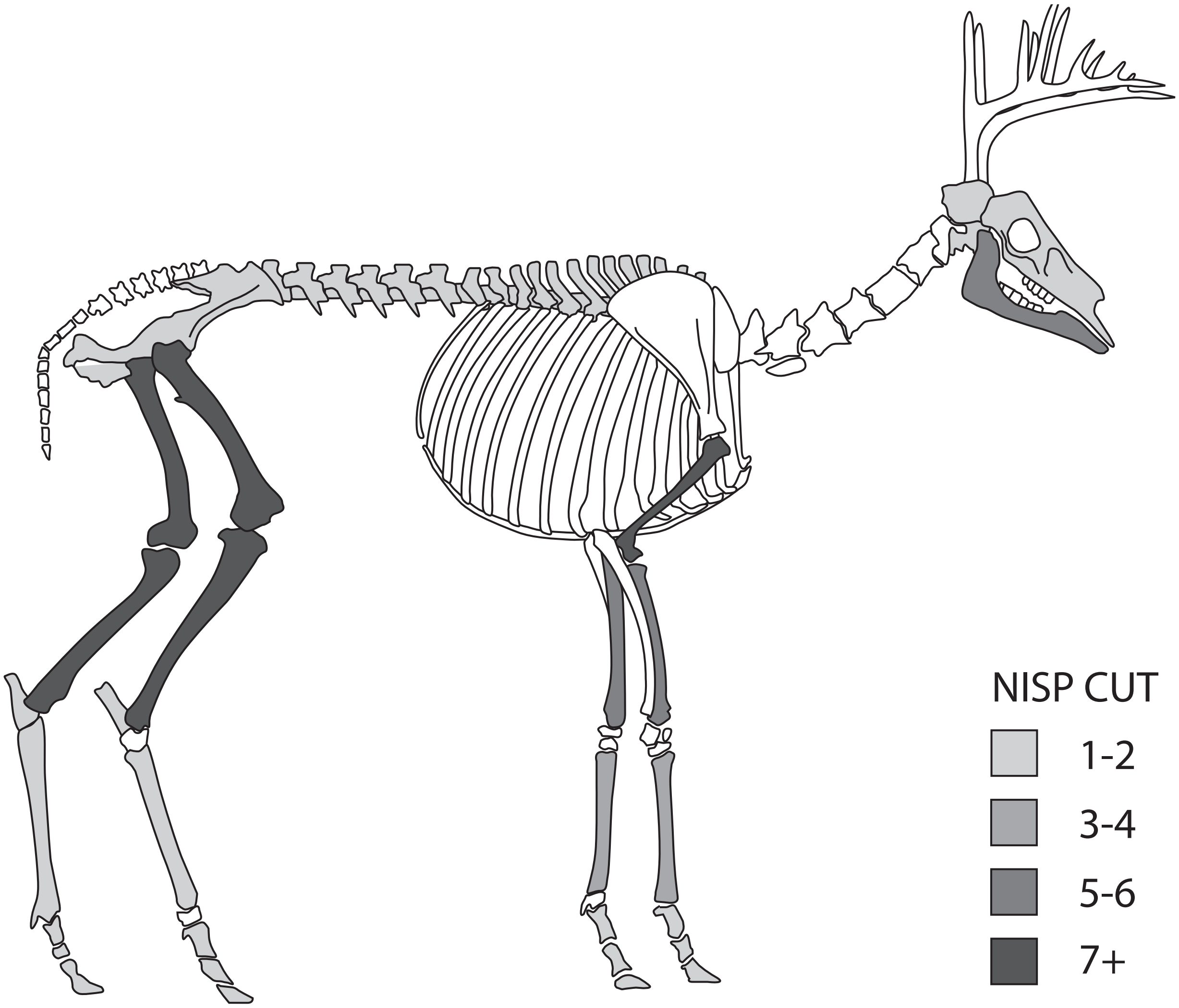

Figure 4.7. Distribution of cut marks on all large mammals from Period II, Wolf Village.

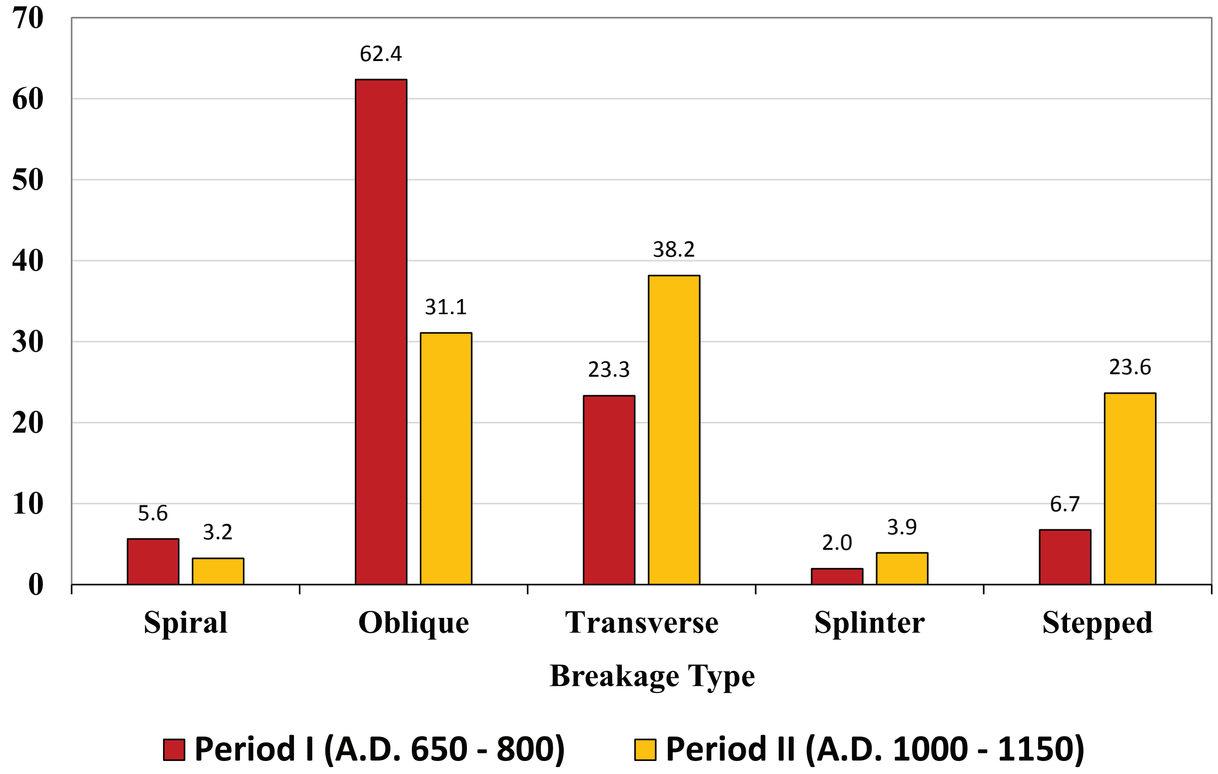

Figure 4.8. Bar chart of breakage types on artiodactyl long bones from Wolf Village.

agents breaking bones to extract marrow. Stepped and splintered breaks account for 8.7 percent of artiodactyl long bones with breaks (n=31) from Period I, and 27.5 percent of breaks (n=1,095) from Period II. In all cases, breakage types merely suggest human processing behaviors. It possible that some of the small artiodactyl long bones were broken due to natural processes. Regardless, the breakage data do provide possible clues of the processing behaviors of the Fremont of Wolf Village.

Weathering

There are 1,063 (38 percent of all taxa) specimens from Period I that show signs of weathering. In the Period II assemblage, there are 1,982 (4.5 percent of all taxa) specimens that are weathered. Much of the weathering appears to have been caused by root etching.

RESOLUTION OF BIASES

Density-Mediated Attrition

As stated in Chapter 1, the frequency of skeletal elements can be affected by both human impacts (such as transport decisions) and attrition caused by skeletal density. Grayson (1989:650–651) has argued that density-mediated attrition has resulted in many examples of reverse utility curves at archaeological sites. To determine whether the faunal assemblages from Periods I and II at Wolf Village were affected by density-mediated attrition, I calculated the percentage of survivorship (%survivorship) of artiodactyl remains and graphed them against structural density values provided by Lyman (1994:246–248; see also Lyman 1984) for deer, pronghorn, and sheep. The percentage of survivorship is calculated by determining the MNE for each bone element type per species, then dividing that total by the number of elements present to account for the MNI of the species, and then multiplying the results by 100. In other words, the percent of survivorship is equal to the percent of MAU for each species (Lyman 1994:255–256). Lyman (1994:234) states that if there is a higher proportion of dense bones (i.e., the distal ends of long bones, carpals, tarsals, phalanges, mandibles, etc.), then density-mediated attrition may be responsible for the state of the faunal assemblage at a site.

For the Period I assemblage, I only plotted this relationship for mule deer to the structural density of deer provided by Lyman (1994) (Figure 4.9). This was because there were very few specimens of bighorn sheep (5 specimens) and pronghorn (5 specimens) identified to species (see Table 4.5). For the Period II assemblage, I plotted the relationship for mule deer, bighorn sheep, and pronghorn (see Figure 4.9).

The results of this analysis are ambiguous. This ambiguity is likely due to at least two factors. First, many of the artiodactyl specimens in the Wolf Village Period I assemblage could not be identified to a species (Table 4.16), which was reflected in the survivorship. Second, Lyman (1994) only provides structural density measurements for certain anatomical parts of

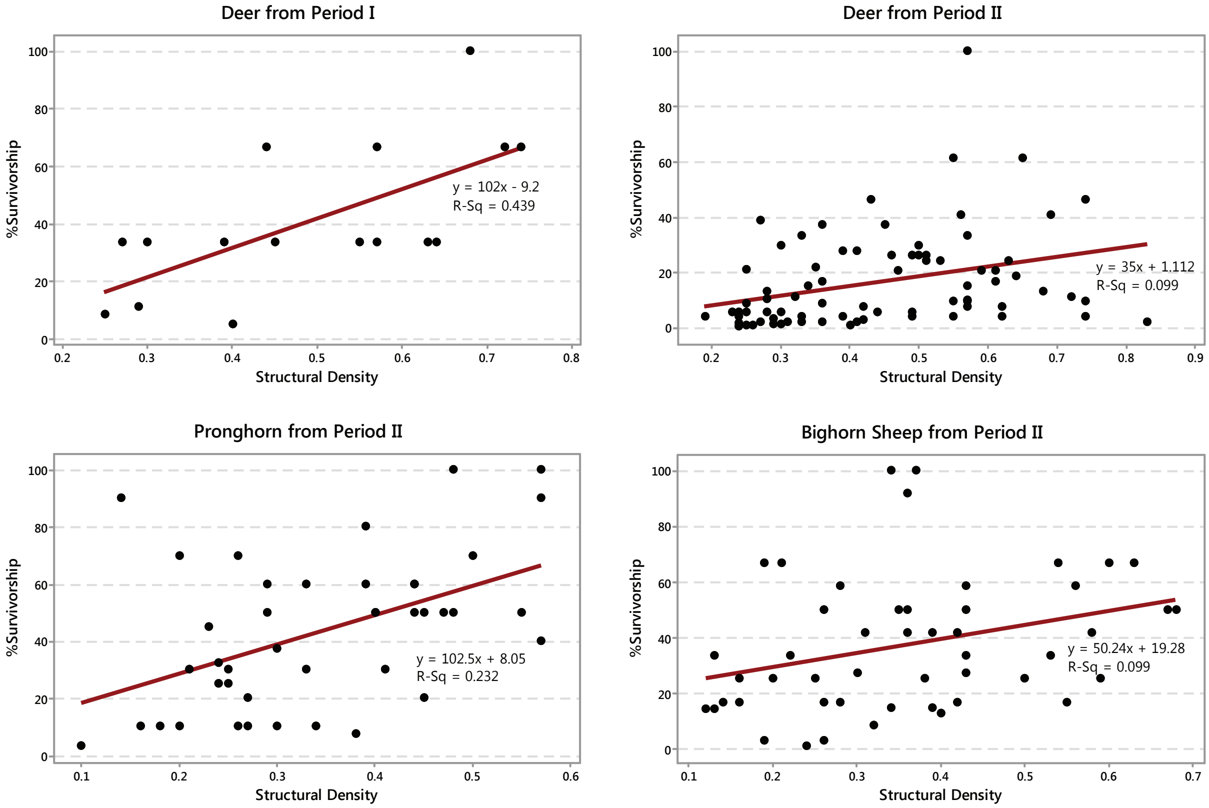

Figure 4.9. Scatterplots depicting %survivorship of artiodactyls compared to structural density values provided by Lyman (1994).

pronghorn and domestic sheep when compared to deer; therefore, I had to omit values for ribs, mandibles, thoracic vertebrae, and other elements for those two species. As such, the Period II mule deer was the only sample size large enough (n=784) to provide a meaningful analysis (see Figure 4.9). Even so, there was a weak correlation to the results of the Period II mule deer survivorship to the structural density of deer ($r^2 = 0.099$). Since the statistical relationship appears insignificant, density mediated attrition does not appear to be important in the survivorship of artiodactyl bone elements, or at least mule deer, at Wolf Village.

Carnivore Disturbance

Lastly, very few of the bones from either assemblage displayed evidence of carnivore disturbance. As previously discussed, carnivores (such as canids and felids) may scavenge

Table 4.16. Number of Small Artiodactyl Specimens Identified to Species for Wolf Village.

Taxon	Period I	Period II
Mule Deer	43	784
Bighorn Sheep	5	209
Pronghorn	5	175
Total	53	1,168

faunal material left by humans which may affect an assemblage; therefore, carnivore disturbance among the Wolf Village faunal bone assemblages is possible. There is no way to account for bones that may have been removed from Wolf Village by carnivores, but during analysis of the bones recovered from the site, I noted whether carnivore gnawing was present. In addition, there are other attributes to consider when determining whether the primary cause of a faunal bone assemblage is through non-human carnivore activities. These attributes include an over-abundance of cranial elements and many gnawed bones (Stiner 1991). In addition, low ratios of artiodactyl long bone ends to shafts can also signify that an assemblage was impacted by non-human carnivores, or at least highly disturbed by them (Lyman 1994:215).

There are few gnawed bone specimens identified in the Period I assemblage (2 specimens) or the Period II assemblage (8 specimens). There are only 20 small artiodactyl cranial elements in the Period I assemblage (2.5 percent of the total artiodactyls from Period I), and only 370 cranial elements in the Period II assemblage (3 percent of the total artiodactyls from Period II). Cranial elements do not dominate either assemblage at Wolf Village, suggesting that the assemblages are not the result of, or not highly disturbed by, carnivore activities.

The ratios of artiodactyl long bone ends to shafts at Wolf Village is unusual (Table 4.17). The ratio for Period I is 3 long bone ends to every 348 (or 1:116). For Period II, the ratio is 495 long bone ends to every 6,780 long bone shafts (or 33:452). Therefore, long bone shafts are more abundant than long bone proximal and distal ends in the Wolf Village assemblages. If

Table 4.17. Comparison between Small Artiodactyl Long Bone Ends and Shafts at Wolf Village.

Proximity	Period I	Period II
Ends	3	495
Shafts	348	6,780
Total	351	7,275

Lyman (1994) is correct in his assumption that the ratio of long bone ends to shafts indicates that assemblages resulted from non-human carnivores, then most of the Wolf Village faunal bones may have been brought back to the site by non-human carnivores. This is unlikely to be the case, since many of the bones were recovered from cultural contexts (i.e., buildings, storage pits, subfloor features, etc.) and found with cultural artifacts (i.e., stone tools, ceramics, lithic flakes, gaming pieces, etc.). The over-abundance of long bone shafts at Wolf Village is most likely the result of the Fremont processing large game bones for marrow and for tool manufacturing. Domestic dogs were present among the Fremont (see Lupo and Janetski 1994) and several canid and other carnivore elements were identified among the Period II assemblage (see Table 4.6). It is possible that dogs chewed on proximal and distal ends of long bones, making it so some high-caloric elements did not survive taphonomic processes. Although carnivores were present at Wolf Village and likely impacted the faunal bone assemblages in some way, their affect was not large as far as I can tell. Most of bones in the assemblages seem to be the result of human behavior due to their context, breakage types, burning, and butchering marks.

5 | Large Game Transport Practices by Fremont Hunters at Wolf Village

In this chapter, I use data derived from the identification of the Wolf Village faunal bones to address large game transport practices by Fremont hunters at Wolf Village. First, I discuss taxonomic richness and diversity among the Wolf Village faunal bone assemblage using the Shannon-Weaver Index. Next, I present the results of the Artiodactyl, Lagomorph, and Muskrat Indices to explore whether resource depression at Wolf Village affected where large game was obtained. Then, I explore Wolf Village large game transport practices by presenting the skeletal frequencies of small artiodactyls and comparing them with the modified general utility index (MGUI). I conclude this chapter with a discussion on large game transport decisions among the Fremont of Wolf Village.

TAXONOMIC RICHNESS AND DIVERSITY

Faunal bone data can help make inferences about site function. By “site function,” I refer to which types of activities were performed by the Fremont inhabitants of Wolf Village. For instance, the architectural features from Period II suggest that Wolf Village was a residential base, meaning that people lived at the site for long periods of time. The midden deposits further suggest that the site was residential, due to the rich presence of faunal bones, ceramics, stone tools, and other cultural artifacts. In addition, taxonomic richness and diversity among a faunal bone assemblage can further provide clues about site function.

Table 5.1. Taxonomic Richness and Sample Size (NISP) at Wolf Village.

Provenience	Richness	Sample Size (NISP)
Activity Area 1	6	40
Activity Area 2	13	486
Structure 1	24	1,318
Structure 2	32	8,580
Structure 3	4	12
Structure 4	13	229
Structure 5	2	6
Structure 6	22	1,169
Structure 7	9	159
Structure 8	22	2,527
Structure 9	25	1,273
Period I Total	15	526
Period II Total	39	15,273

Taxonomic Richness

Taxonomic richness refers to the number of species present in a faunal bone assemblage (Reitz and Wing 2008:110). Taxonomic richness is often correlated to the sample size of each assemblage. As the sample size (NISP) increases, the taxonomic richness is also expected to increase. This trend holds true for the two assemblages at Wolf Village. For example, the analysis of the Period I assemblage (n=526) resulted in the identification of 15 species (i.e., a richness value of 15), while the Period II assemblage (n=15,273) resulted in the identification of 39 species (a richness value of 39) (Table 5.1). Jones et al. (1989:73) state that using regression to compare richness to sample sizes with varying values should show a strong correlation when logarithmically transformed. A comparison of logarithmically transformed taxonomic richness and sample size values across provenience (i.e., activity areas and architectural features), shows a positive correlation between richness and sample size (Figure 5.1). The NISP counts for each provenience at Wolf Village is in Appendix B.

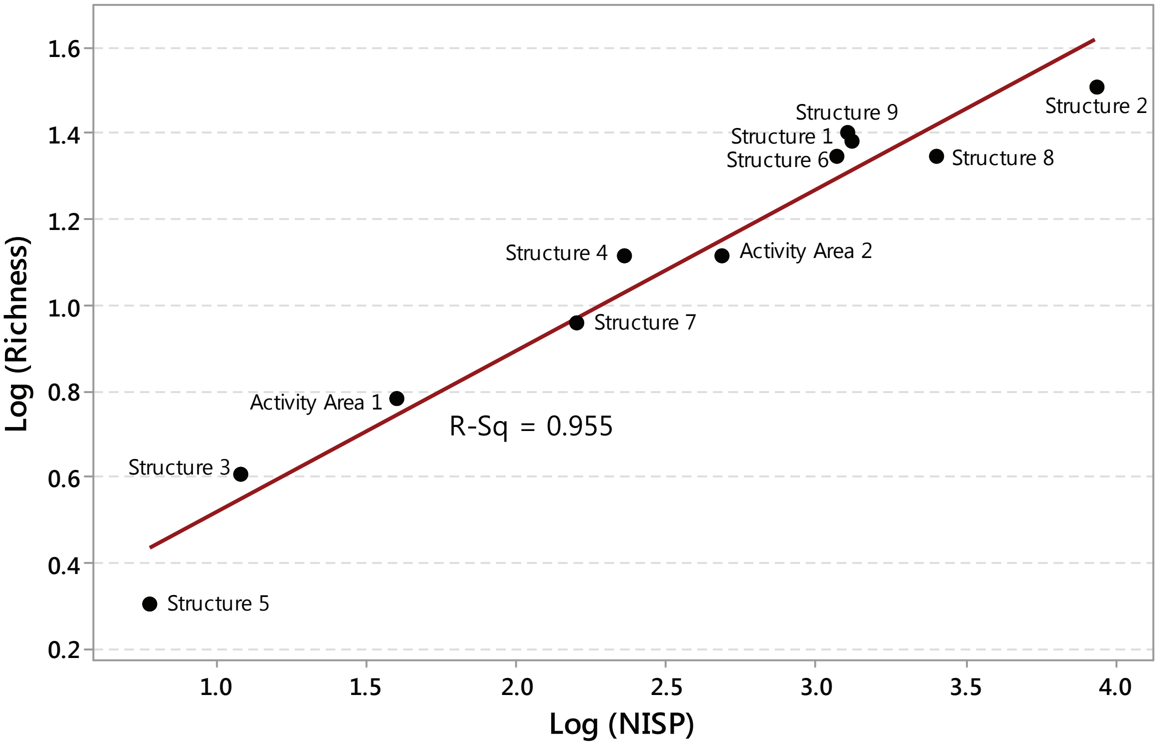

Figure 5.1. Comparison of log (richness) to log (NISP) for Wolf Village structures and activity areas.

Taxonomic Diversity

Once the taxonomic richness is known for a site, taxonomic diversity indices can be used to compare the number of taxa (taxonomic richness) to the NISP counts for each taxa to measure how even the sample is (Reitz and Wing 2008:111). Taxonomic evenness refers to how even each category of species is in proportion to others. The diversity of a faunal assemblage is based on the richness and the evenness. There are multiple ways of measuring diversity, including the Brillouin, Simpson, and Shannon-Weaver Indices (Kintigh 1989; Magnussen and Boyle 1995). In this research, I use only the Shannon-Weaver Index to measure taxonomic diversity.

The Shannon-Weaver Index (see Shannon and Weaver 1949), also called the *H*-statistic, is used to calculate diversity at Wolf Village. Before calculating diversity using the *H*-statistic, I calculated the relative frequency of each category (or species). The equation is:

$$P_i = \frac{f_i}{n}$$

Where P_i is the proportion of each category, f is the frequency of category i, and n is the sample size. The *H*-statistic measures evenness, or the proportion of species compared to the whole assemblage. The equation is as follows:

$$H = -\sum_{i=1}^{k} P_i \log (P_i)$$

Where H is the Shannon-Weaver Index, P_i is the proportion of each category, and k is the number of categories. Next, I used the following equation to determine the maximum value of H:

$$H_{max} = k\left(\frac{1}{k}\right) \times \log\left(\frac{1}{k}\right)$$

or

$$H_{max} = \log k$$

Where H_{max} is the maximum value of H if all species were represented evenly and k is the number of categories. Finally, I calculated the ratio of the observed H to an index of evenness using the equation:

$$J = \frac{H}{H_{max}}$$

Where J is the evenness of the assemblage. The closer the value of J is to one, the more even the assemblage (Kintigh 1989:29; see also Hegmon 1995:196 and Stauffer 2012:50–51).

In this research, I calculated the Shannon-Weaver Index values for animals from Periods I and II and grouped them by taxonomic order and family. When considering the values by taxonomic order, Period II has greater richness than Period I, although both periods are roughly equal in evenness (Table 5.2). When considering the values by taxonomic family, Period II has far greater richness than Period I, but Period I is far more even (Table 5.3).

Table 5.2. *J* Values by Taxonomic Order.

	J value	Richness
Period I	0.35	6
Period II	0.36	15

Table 5.3. *J* Values by Taxonomic Family.

	J value	Richness
Period I	0.78	11
Period II	0.58	29

Conclusions about Site Function

The results of the richness and diversity analyses are important for drawing conclusions about site function at Wolf Village. Higher values of richness and diversity are expected at residential sites than at camping or hunting sites. The use of the Shannon-Weaver Index to measure taxonomic diversity resulted in *J* values that seem high. Whether they are high enough to indicate that Wolf Village was a residential site would require *J* values from campsites and other non-residential sites. The results do suggest that the occupants of Wolf Village during Period II had a much more diverse meat diet than those of Period I. Nevertheless, mule deer, bighorn sheep, and pronghorn appear to have been a major source of meat protein in both periods.

PROCUREMENT PRACTICES

My goals for this research include understanding Fremont butchering and transport practices at Wolf Village and determining whether the MGUI is a viable method of inferring these practices. In order to address my research goals, as well as to explore evidence of resource depression in the local region, I used the Artiodactyl, Lagomorph, and Muskrat Indices. If there is evidence that resource depression occurred in the region around Wolf Village, then Fremont hunters may have had to travel far from the site to obtain large game. If they were returning with low-caloric elements, then some of these elements may have had value to the Fremont beyond calories.

Artiodactyl Hunting and Resource Depression

Optimal foraging models are used to predict the decisions that prehistoric peoples made when hunting. The main assumption behind optimal foraging models is that hunting and foraging decisions are made according to which action will maximize net caloric gain, an aspect of human behavioral ecology (see Kelly 1995:73; see also Bettinger 1993, Grayson and Cannon 1999, and O'Connell et al. 1982 for examples in Great Basin archaeology). The model predicts that hunters will focus on obtaining small, low-ranked animals only if large, high-ranked animals (such as artiodactyls) are rare or unavailable on the local landscape. The ranking of animals as either low or high is dependent on their caloric gain. The decrease in frequency of certain large game animals is known as "resource depression." For example, at Wolf Village there was a decrease in the relative frequency of artiodactyls between Periods I and II (see Figure 4.1). Although artiodactyls made up approximately 86 percent of the total NISP for Period I, during Period II artiodactyls only made up 71 percent of the total NISP. This may suggest that artiodactyls were more ubiquitous around Wolf Village in Period I than in Period II, suggesting a possible resource depression. It may also mean that more reliance on domesticates like maize in Period II, caused the Fremont of Wolf Village to focus less on hunting large game since maize could supplement their diet. Consequently, the Fremont in Period II may have supplemented their diet with more lagomorph species than during Period I and with more diverse artiodactyl species, such as bison. Janetski (1997b:1075) suggests that resource depression at Fremont sites was caused by increasing human population. While I do not agree with all aspects of human behavioral ecology (see Chapter 7), these foraging models are valuable for serving as a theoretical basis for reconstructing prehistoric procurement strategies.

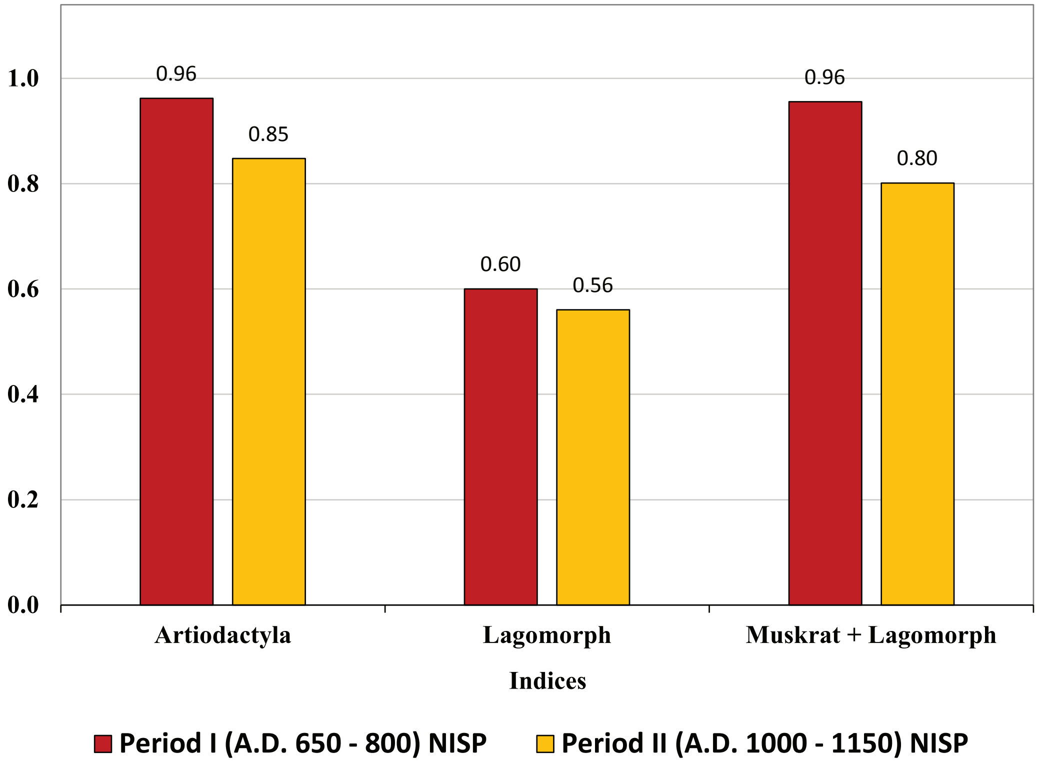

Figure 5.2. Bar charts portraying the results of the Artiodactyl, Lagomorph, and Muskrat Indices.

The percentage of artiodactyls to lagomorphs varied through the two periods at Wolf Village. I calculated the Artiodactyl Index using the equation (∑NISP Artiodactyls / ∑NISP [Artiodactyls + Lagomorphs]). As stated, the closer this index is to one, the greater availability or emphasis on large game hunting. The Artiodactyl Index suggests that small game was less important than large game during both periods (Figure 5.2). However, as with the varying frequencies of artiodactyls in Periods I and II (see Figure 4.1), the Artiodactyl Index may suggest that the Fremont at Wolf Village experienced a slight resource depression of artiodactyls in Period II compared to Period I. The resource depression may have been partially the result of increasing human population at Wolf Village and surrounding sites between Periods I and II, although this is largely speculative. The Muskrat Index (∑NISP Artiodactyls / ∑NISP [Artiodactyls + Muskrats + Lagomorphs]) did not greatly vary from the results of the Artiodactyl Index, again suggesting that while large game were plentiful, there may have been a slight resource depression in Period II at Wolf Village. If artiodactyls were less frequent in Period II compared to other orders of animals, then Fremont hunters may have travelled farther from Wolf Village when compared to Period I to obtain large game.

The Lagomorph Index (∑NISP Cottontails / ∑NISP [Cottontails + Jackrabbits]) indirectly suggests some interesting environmental factors at Wolf Village (see Figure 5.2). Both Periods I and II have a Lagomorph Index between 0.60 and 0.56, suggesting that the ratio between consumed cottontails and jackrabbits was roughly the same during both periods. Cottontails appear to have been slightly more common as a food resource at Wolf Village. In general, cottontails are more common than jackrabbits in dense vegetative environments, while jackrabbits are more common than cottontails in open settings (Broughton and Miller 2016:108). The higher number of cottontail bones to jackrabbit bones suggests that the environment around Wolf Village was more suitable for cottontails, meaning that there were at least some dense areas of vegetation near Wolf Village. The data suggest that rabbits and hares from the genus *Lepus* make up approximately 39 percent of the total number of lagomorphs of the Period II assemblage, while cottontails make up approximately 50 percent (Table 5.4). According to optimal foraging models, Fremont hunters spent most of their energy obtaining food that provides the most caloric return. The expectations of an optimal foraging model is that the Fremont would have preferred cottontail over jackrabbit because cottontails would have provided greater returns in terms of pursuit time, handling time, and caloric return. However, it may be that cottontails were simply easier to hunt around Wolf Village or were tastier to the Fremont in that area.

Catching cottontails may have been easier than catching jackrabbits due to the environment around Wolf Village. Regardless, jackrabbits were also exploited by the Fremont (see Table 5.4). Archaeological evidence suggests that jackrabbit drives were a communal activity to some groups of people (Driver and Woiderski 2008, Schmidt 1999, Stauffer 2012).

Table 5.4. Relative Abundance of Lagomorphs at Wolf Village, Period II.

Lagomorpha	NISP	%NISP	%Order
Lepus californicus	56	0.4	2.8
cf. *Lepus californicus*	3	0.0	0.2
Lepus townsendi	138	0.9	7.0
cf. *Lepus townsendi*	3	0.0	0.2
Lepus sp.	562	3.7	28.6
Sylvilagus audubonii	647	4.2	32.9
cf. *Sylvilagus audubonii*	20	0.1	1.0
Sylvilagus sp.	305	2.0	15.5
cf. *Sylvilagus* sp.	1	0.0	0.1
Leporidae	221	1.4	11.2
cf. Leporidae	10	0.1	0.5
Total	1,966	12.9	100.0

Hockett (1998) analyzed faunal bone remains from Baker Village to explore the sociopolitical practices of the site. He argues that the high number of faunal remains (including a high quantity of lagomorphs) in the central structure at Baker Village suggests that there was feasting at the site. He suggests that the large numbers of rabbit and pronghorn bones suggest increased complexity at Baker Village, and that "rabbit bosses" or "antelope shamans" lived among the Fremont, held political status, and conducted rituals associated with central structures (Hockett 1998:298). A more recent analysis of the central structure at Baker Village by Johansson (2014) agrees with Hockett's statement that the majority of the bones from Baker Village came from the central structure; however, she disagrees with the proportions of lagomorphs to artiodactyls. Her reanalysis suggests that artiodactyl bones (91 percent) dominated the assemblage of bones from the central structure rather than leporids (Johansson 2014).

Feasting at Wolf Village

An in-depth analysis of feasting at possible Wolf Village communal structures (Structures

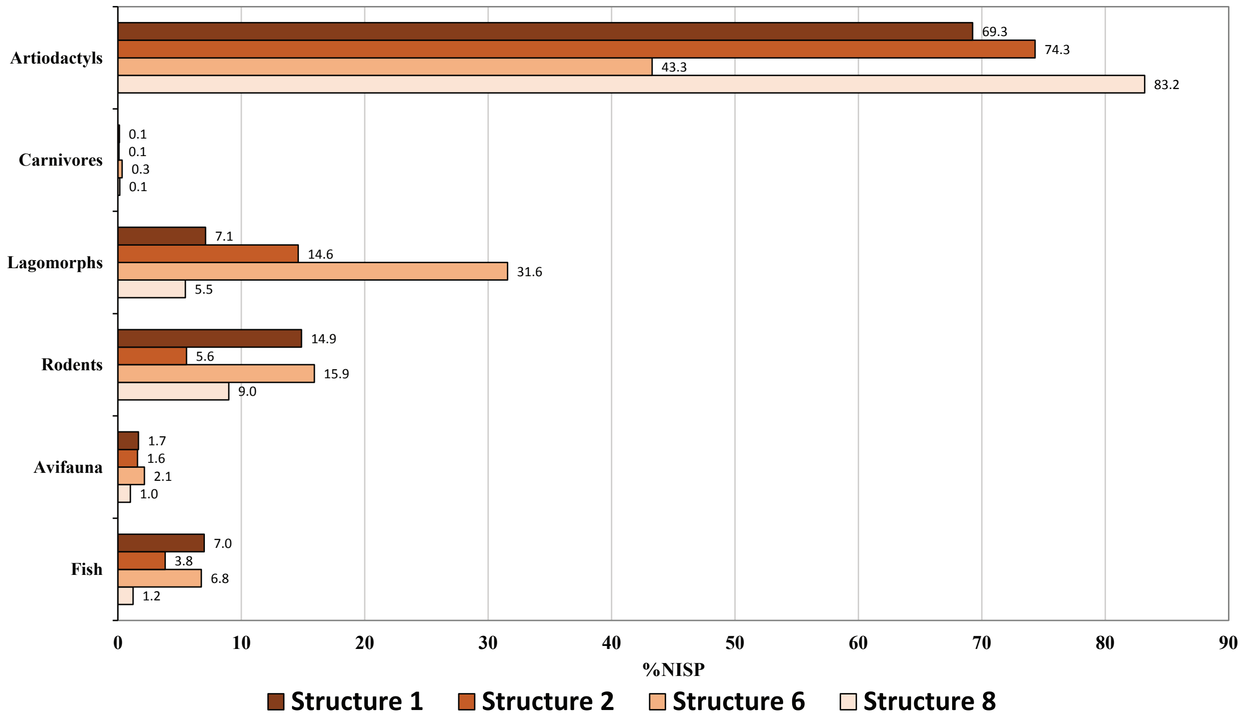

Figure 5.3. Comparison of the %NISP of Structures 1, 2, 6, and 8 at Wolf Village.

1, 2, 6, and 8) is outside the scope of this thesis; however, the relative frequencies between structures provides interesting insights. Feasts are a form of public ritual centered on the communal consumption of food and/or drink (Dietler 2001:67). Feasting rituals usually involve sharing special foods during special events, such as marriages, deaths, or trade festivals (Stauffer and Johansson 2016; see also Hall 2008; Potter 2000). When only considering bones from the floor zones and subfloor features of Structures 1, 2, 6, and 8 (see Appendix B), artiodactyls are more frequent than other orders of animals (Figure 5.3). At Structure 2, however, lagomorphs make up a relatively higher percentage (14.6) of animals than at Structures 1 and 8 (7.1 and 5.5 percent respectively). Artiodactyls make up 74 percent of the Structure 2 assemblage (n=1,592). This suggests that lagomorphs were associated with Structure 2 activities more than other possible communal structures, excluding Structure 6. Likewise, the comparison of artiodactyls to lagomorphs at Structure 2 is slightly less than to Structures 1 and 8 (Figure 5.4). Whether this is

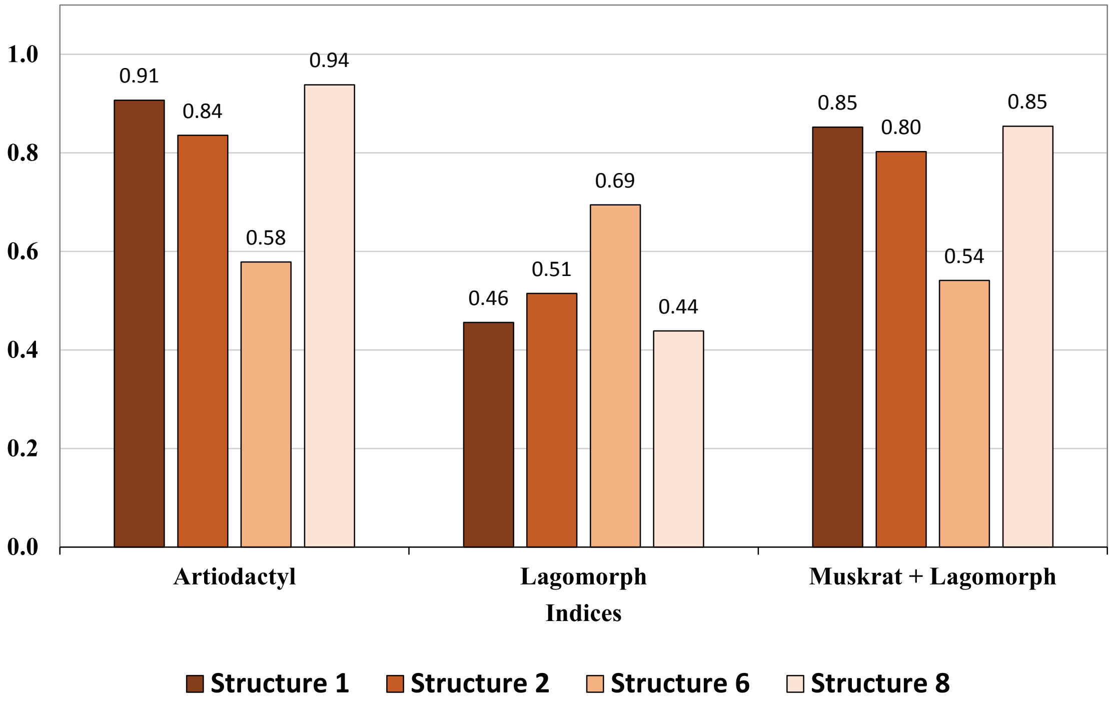

Figure 5.4. Comparison of the results of the Artiodactyl, Lagomorph, and Muskrat Indices between Structures 1, 2, 6, and 8 at Wolf Village.

related to feasting activities associated with Structure 2 remains to be seen, but can be explored in future research.

The faunal bones associated with Structure 6 also present interesting insights into the use of the structure. Johansson et al. (2014:50) state that while not a central or communal structure, Structure 6 may have been a "special building" as evidenced by how it was abandoned. The presence of figurines, the articulated deer mandibles placed in the ventilation tunnel, and the burning of the structure all suggest it was ritually abandoned. The faunal bone data suggests that artiodactyls are much less common compared to the Structures 1, 2, and 8 assemblages (see Figure 5.3). Structures 1, 2, 6, and 8 did not contain as many jackrabbit bones as at Baker Village (Hockett 1998) nor Kay's Cabin (Janetski 2016). Baker Village yielded 3,259 rabbit specimens while Kay's Cabin yielded 2,831 rabbit specimens. Structure 6, however, has a high relative abundance of lagomorphs (n=369) compared to artiodactyls (n=506). In fact, artiodactyls and lagomorphs are nearly equal in relative abundance (see Figure 5.3). This suggests that both large and small game hunting were important at Structure 6, possibly due to its use, in part, as a "special building" (Johansson et al. 2014:50).

Hockett (1998) argues that abundances of jackrabbit bones in buildings suggests feasting and/or ritual activities. Single deposits of large amounts of faunal bone and other refuse can possibly be indicative of feasting (VanDerwarker 1999:26). In her senior thesis examining possible prehistoric communal activities in Structure 8 at Wolf Village, Julian (2017) compared faunal bone from Structures 1, 4, and 8. She argues that the relatively high number of artiodactyl long bone shafts associated with Structure 8 (see Figure 5.3), suggests the building may have housed communal activities such as feasting (Julian 2017:16). In my own analysis of Wolf Village faunal bones from floor zones and subfloor features of Structures 1, 2, 6, and 8, the weight of artiodactyl skeletal elements (in grams) largely outnumber all other taxonomic orders associated with the four buildings (Figure 5.5). Notably, there are still more lagomorph skeletal elements in Structure 6 compared to the other three buildings; although artiodactyls were probably the main source of meat protein for the people occupying Structure 6. The weights of each identified bone specimen was only recorded for Period II. The bone weights for each taxonomic order are presented in Appendix C. In summation, the relative frequencies of faunal bones from Structures 2, 6, and 8 suggest the buildings may have been used in part, as locations of feasting.

Very few scholars have examined feasting at Fremont sites (Hockett 1998, Stauffer 2012, and Stauffer and Johansson 2016 are notable exceptions). Feasting activities are sometimes associated with areas where trading occurred and the high number of artifacts recovered from Structure 2's midden suggests the area was used, in part, for trading activities. Indications of feasting in the archaeological record include large quantities of animal bones, a low degree of taxonomic diversity, an abundance of large game and rabbits, an abundance of both utilitarian

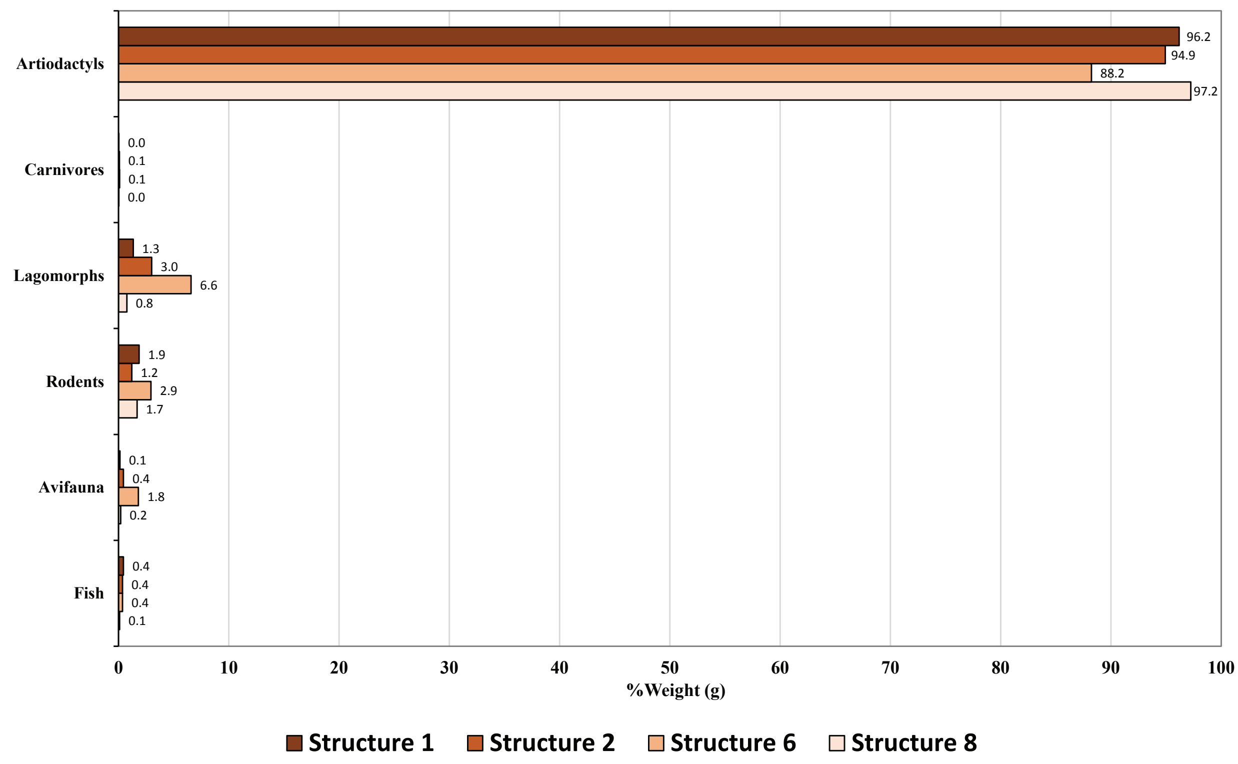

Figure 5.5. Comparison of the %Weight (g) of Structures 1, 2, 6, and 8 at Wolf Village.

and serving vessels, and unique artifacts, features, and architecture associated with the feasting area (Stauffer 2012:15–16; see also Grimstead and Bayham 2010; Janetski 1997b; Potter 1997, 2000; Stauffer and Johansson 2016). Feasting events at Wolf Village likely occurred in communal buildings. Future research on feasting at Wolf Village should include a comparison of the bones at Structures 1, 2, 6, and 8, as well as bones and artifacts associated with the midden overlying Structure 2.

Large Game Hunting and Transport Practices

As highlighted through the results of the faunal analysis, large game (primarily small artiodactyls) were present during both periods at Wolf Village. Large game appears to have been a major source of meat protein for the Wolf Village Fremont. As previously noted, according to the assumptions associated with the MGUI, the frequency of small artiodactyl skeletal elements can infer the function of archaeological sites. Skeletal frequencies can also suggest the transport and procurement practices followed by the Fremont at Wolf Village, and whether Fremont hunters obtained large game from distances near of far. The assumption of the MGUI is that the greater distance between the kill site and the habitation, the less likely that an animal would have been brought back in its entirety. Instead, hunters would select the portions with the highest caloric value (Binford 1978; Reitz and Wing 2008). I tested this assumption to the artiodactyl bone specimens at Wolf Village by using the MGUI values for caribou and domestic sheep provided by Binford (1978:74; see also Table 3.1). I compared mule deer and pronghorn skeletal frequencies to the MGUI values for caribou, and I compared bighorn sheep skeletal frequencies to values from domestic sheep. I compared combined small artiodactyl skeletal frequencies to the MGUI values for caribou.

Similar to when calculating the relative abundance of taxa, I calculated the MNE for small artiodactyl elements according to chronological period (Period I and Period II). For Period II, I calculated the MNE using NISP counts for all artiodactyl specimens identified in the assemblage. Unlike when I measured the relative abundance of taxa in Period II, I calculated MNE values by including artiodactyl specimens from all excavation units over Structure 2 (see Figure 3.1). Since I did not include all artiodactyls from the excavation units over Structure 2 to calculate the relative abundance of taxa (as discussed in chapter 3), I present the complete table of artiodactyl specimens in Table 5.5. MNE and MAU values for Periods I and II are offered in Appendix D.

Since my research questions for this thesis are about the utility of large game skeletal portions and transport decisions by the Wolf Village Fremont, I considered the MGUI for mule deer, bighorn sheep, and pronghorn separately. The results of the mule deer to MGUI analysis for Period I are graphically portrayed in Figure 5.6. The scatterplot suggests that mule deer mandibles (a low-caloric element) were transported back to Wolf Village on a regular basis,

Table 5.5. NISP and MNI Counts for All Artiodactyls Identified at Wolf Village, Period II.

Taxon	NISP	MNI*	%Order
Antilocapra americana	161	6	1.4
cf. *Antilocapra americana*	14	–	0.1
Odocoileus hemionus	720	15	6.1
cf. *Odocoileus hemionus*	64	–	0.5
Ovis canadensis	189	8	1.6
cf. *Ovis canadensis*	20	–	0.2
Bison bison	4	1	0.0
Large Artiodactyla	17	–	0.1
Small Artiodactyla	10,539	–	89.7
cf. Small Artiodactyla	16	–	0.1
Total	11,744	30	100.0

*MNI only calculated for taxa identified to family, genus, or species levels, excepting those labelled "cf."

while pelvis and rib portions (both moderate-caloric elements) were more rarely found at Wolf Village. No high-caloric elements were identified among the Period I mule deer assemblage (Figure 5.6). Like other the Fremont sites mentioned in Chapter 1, the scatterplot does not portray a true reverse utility curve. Therefore, the scatterplot displayed in Figure 5.6 portrays a reverse utility pattern.

There was not a sufficient number of identified pronghorn (n=5) or bighorn sheep (n=5) specimens among the Period I faunal bone assemblage to warrant separate MGUI analyses. I combined all small artiodactyl specimens into one group to consider the MGUI for all three species, plus unidentified small artiodactyl specimens. This technique is advised by Sharp (1992). The inability to assign some elements to species level can skew the data to make it seem as though a residential site was used as a kill/butcher area. Only when all identified small artiodactyl assemblages are combined, including those not assigned to species, can the data reflect more accurate conclusions (Sharp 1992:154). The results of the combined small artiodactyls to MGUI scatterplot portrays a reverse utility curve (Figure 5.7). Again, low-caloric

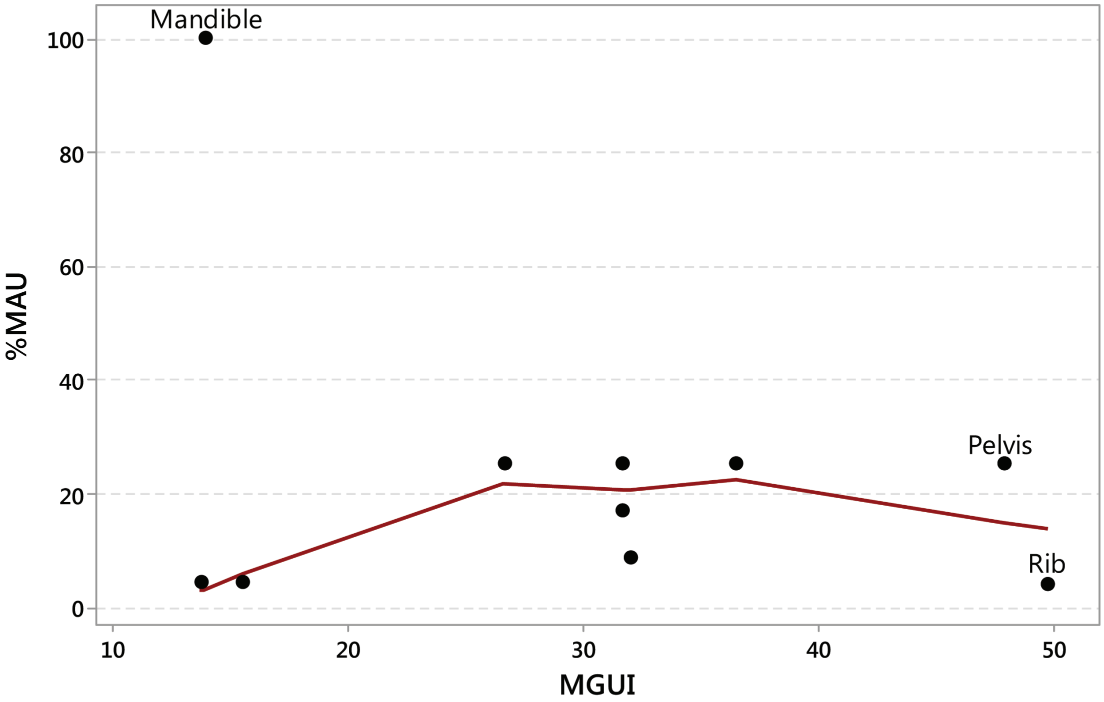

Figure 5.6. Scatterplot showing the %MAU/MGUI transport relationship for mule deer from Wolf Village, Period I ($r^2 = 0.098$). Note that the x-axis ends at 50 since no high-caloric deer bone were present in the assemblage.

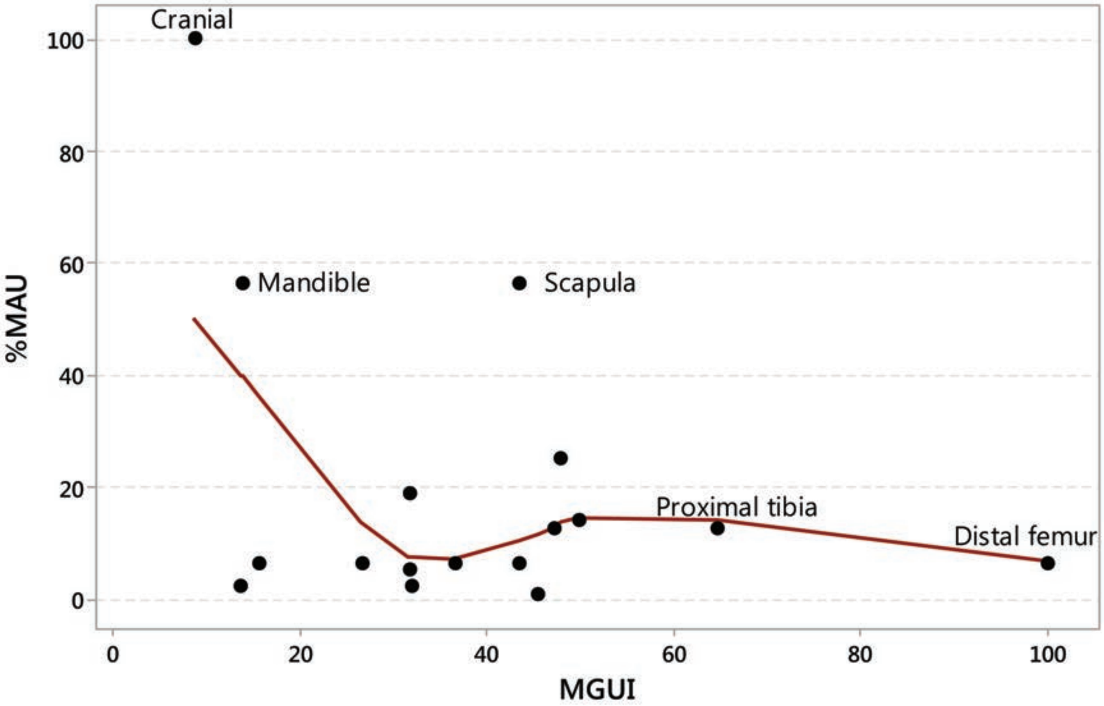

Figure 5.7. Scatterplot showing the %MAU/MGUI transport relationship for combined small artiodactyls from Wolf Village, Period I ($r^2 = 0.119$).

elements dominate the assemblage, while high-caloric elements are rarer at Wolf Village in Period I. Cranial elements and mandibles are the most dominate low-caloric elements among small artiodactyls from Period I. Interestingly, metapodials, most often used to make bone tools (Bryce 2016), were completely absent from the Period I assemblage. This suggests that those elements were not collected while hunting which may mean that the Fremont from Period I were focusing mainly on subsistence, rather than making bone tools.

The MGUI analysis for the Period II mule deer, bighorn sheep, and pronghorn shows similar results as for Period I. Mule deer (Figure 5.8) and pronghorn (Figure 5.9) scatterplots portray reverse utility patterns. Cranial elements and mandibles dominate the mule deer assemblage, while femur end pieces are rare. Mandibles and other low-caloric elements (such as calcanei, metapodials, tarsals, and phalanges) are more common than some high-caloric elements, specifically end pieces of femora. The results of the bighorn sheep to MGUI analysis portray a slight reverse utility pattern (Figure 5.10). While mandibles are common and some high-caloric elements less common, there is more diversity among the high-caloric elements (such as pelvis portions). The mule deer, pronghorn, and bighorn sheep scatterplots suggest that large game transport practices were roughly similar among the three small artiodactyl species identified in the Period II faunal bone assemblage.

I combined all small artiodactyl elements into one assemblage for Period II, using methods recommended by Sharp (1992). The results were similar to the three separate MGUI scatterplots for Period II and the combined small artiodactyl scatterplot representing Period I. The scatterplot displaying the comparison of combined small artiodactyl elements from Period II to the MGUI portrays a reverse utility pattern (Figure 5.11). Again, cranial elements and mandibles are more common than femora pieces. The results of this analysis suggests that Fremont hunters from Wolf Village returned to the site with low-caloric elements, at least part of the time. LOWESS regression comparing percent MAU values to the MGUI for mule deer,

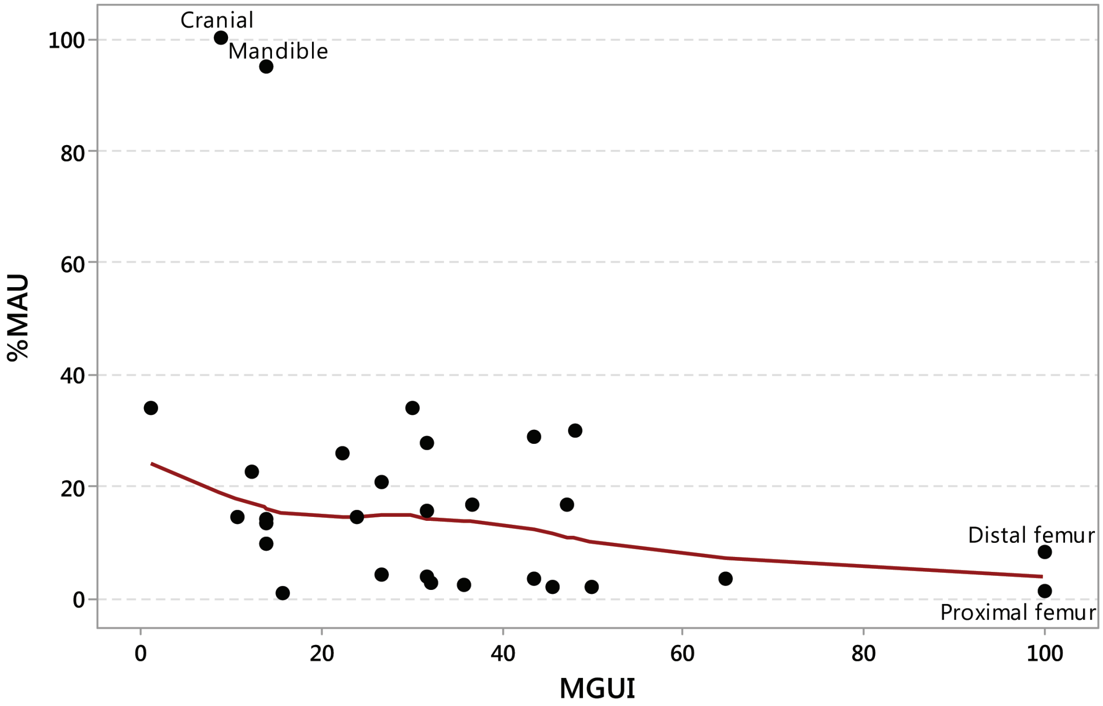

Figure 5.8. Scatterplot showing the %MAU/MGUI transport relationship for mule deer from Wolf Village, Period II ($r^2 = 0.143$).

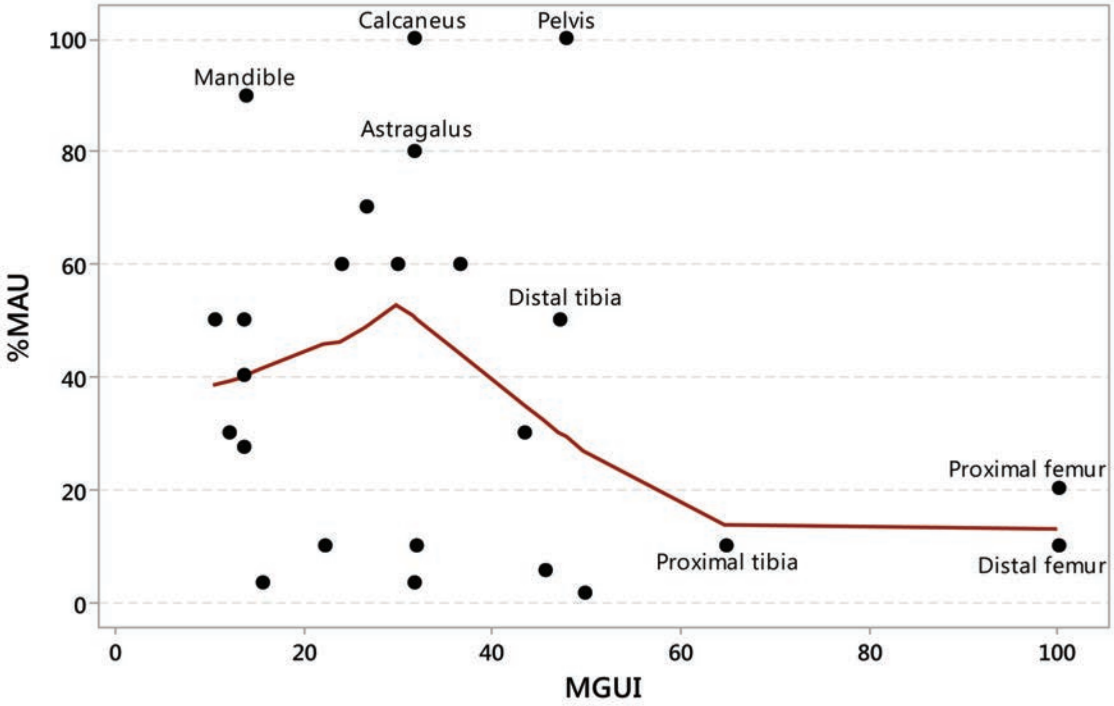

Figure 5.9. Scatterplot showing the %MAU/MGUI transport relationship for pronghorn from Wolf Village, Period II ($r^2 = 0.073$).

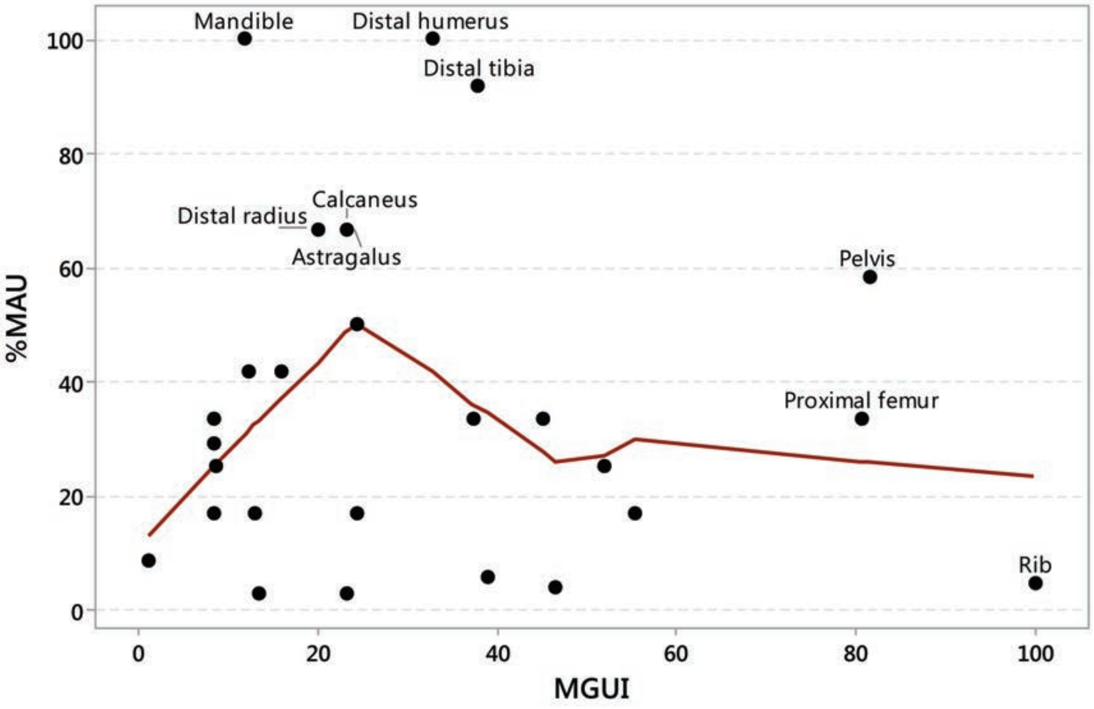

Figure 5.10. Scatterplot showing the %MAU/MGUI transport relationship for bighorn sheep from Wolf Village, Period II ($r^2 = 0.006$).

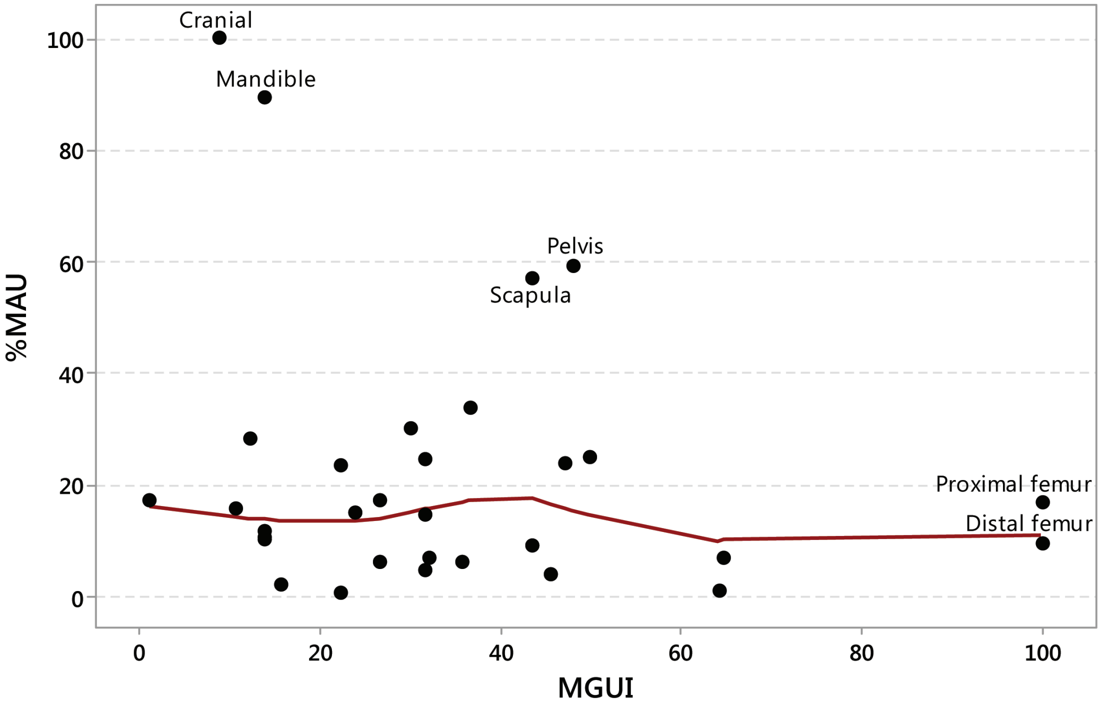

Figure 5.11. Scatterplot showing the %MAU/MGUI transport relationship for combined small artiodactyls from Wolf Village, Period II ($r^2 = 0.037$).

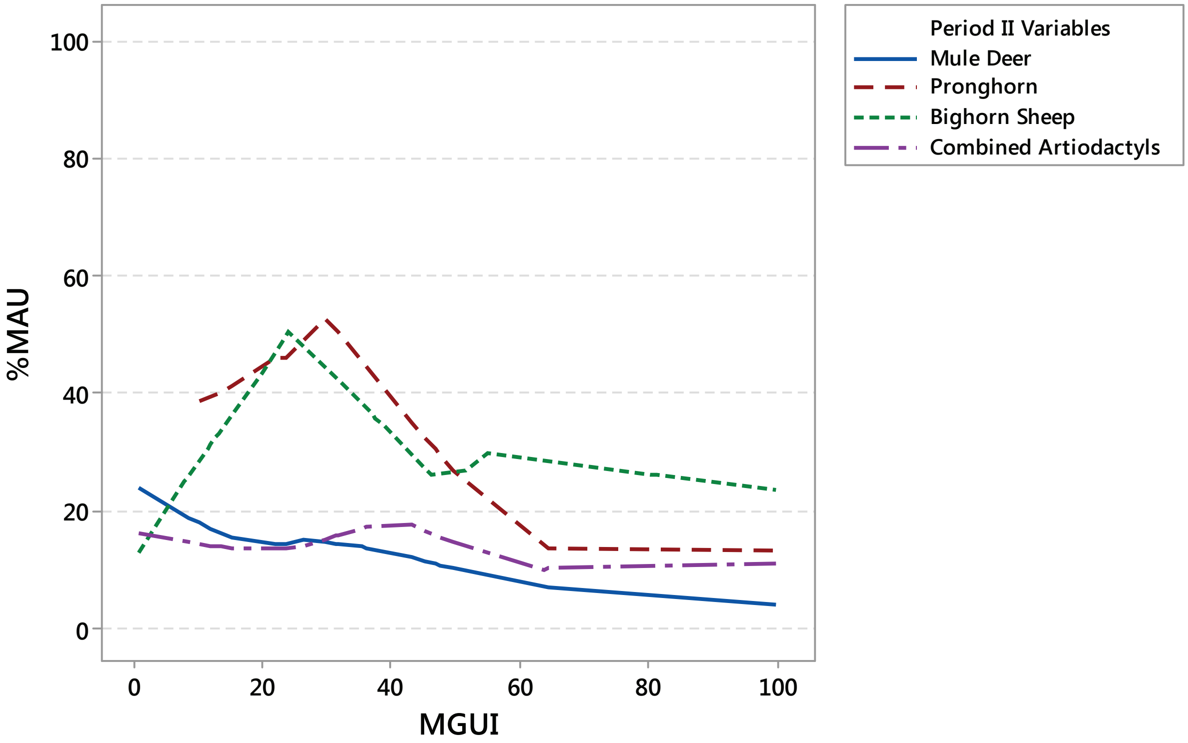

Figure 5.12. LOWESS regression of %MAU for Period II artiodactyl bones compared to the MGUI.

pronghorn, bighorn sheep, and combined artiodactyls from Period II, suggest that low-caloric and some mid-caloric elements were more common that high-caloric elements in the Period II artiodactyl bone assemblage (Figure 5.12).

Lastly, one potential problem with the MGUI is that it only uses limb element proximal and distal ends. In other words, limb element shafts are not accounted for in the MGUI analysis. This can be a problem for sites where long bone ends are rare due to processing practices. Marean and Frey (1997) noted this problem and argued that long bone shafts should be compared to the MGUI. Broughton (1999) explores resource depression and intensification during the late Holocene period of the San Francisco Bay. He notes that Binford's MGUI does not provide specific utility values for limb element shafts (Broughton 1999:59). He included shaft elements of identified long bones in the MGUI analysis by calculating the mean value for the shaft portions of those specific elements. He did this by adding the mean values for the proximal

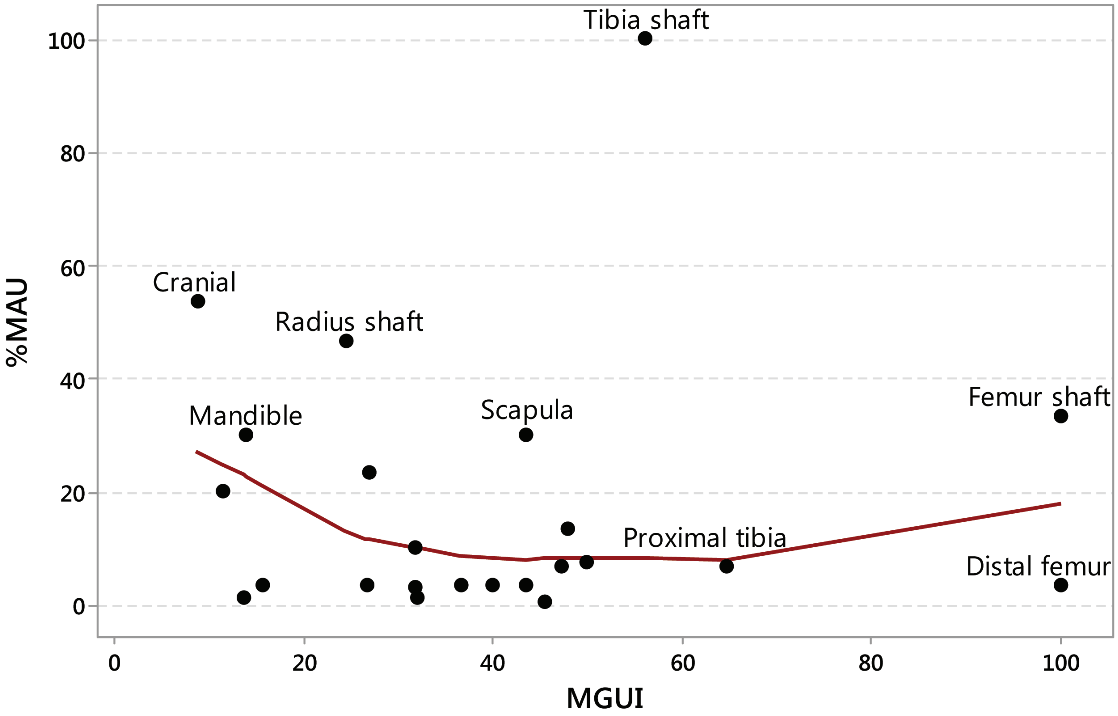

Figure 5.13. Scatterplot showing the %MAU/MGUI (with long bone shafts) transport relationship for combined small artiodactyls from Wolf Village, Period I ($r^2 = 0.000$).

and distal ends of an element and dividing by two. The resulting value was applied to the shaft portion of those elements. Since many of the elements in the NISP counts for Wolf Village were shaft pieces of identified long bones, I included them in the MGUI analysis by using the same method as Broughton (1999). Unidentified long bones and flat bones were not considered in the %MAU/MGUI analysis.

The results of the MGUI with long bone shafts is presented in Figure 5.13 for Period I and in Figure 5.14 for Period II. I performed this portion of the MGUI analysis using combined small artiodactyls for both periods. Neither of these scatterplots fit any of the five strategies proposed by Binford (1978). The r^2 values do not show any relationship between %MAU and MGUI for either occupation ($r^2 = 0.000$ for both periods). Low-caloric skeletal elements are dominant during both periods and are relatively evenly distributed. The exceptions are cranial fragments and mandibles, which have relatively high frequencies. This suggests that, at least part

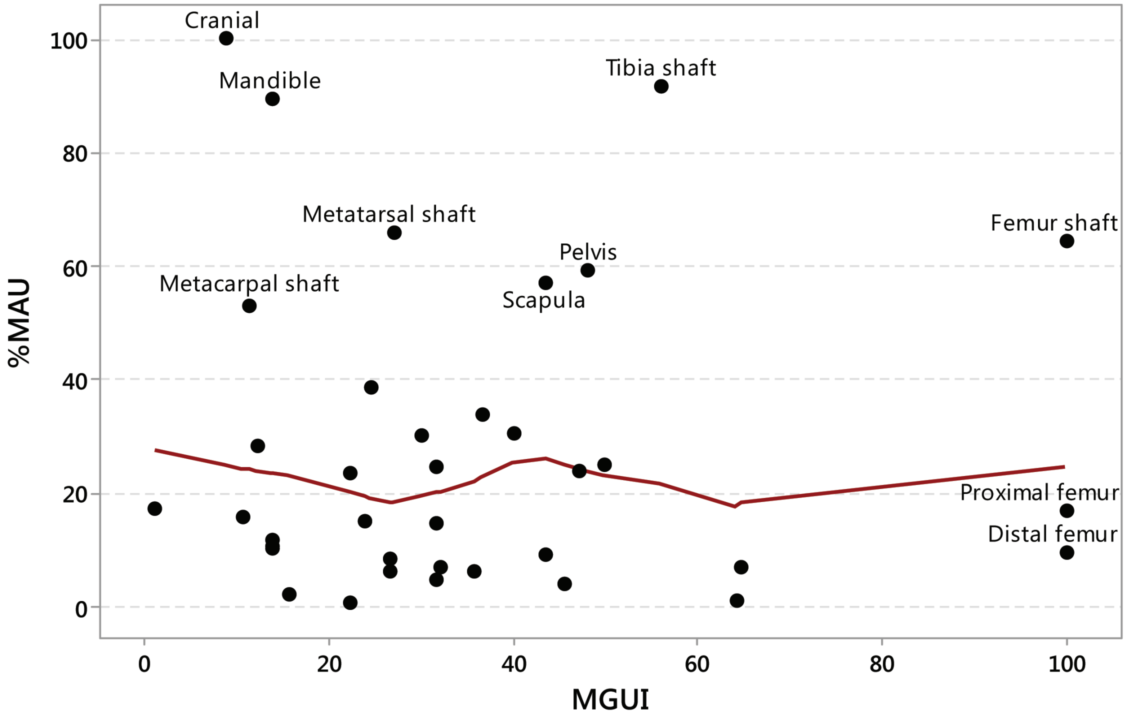

Figure 5.14. Scatterplot showing the %MAU/MGUI (with long bone shafts) transport relationship for combined small artiodactyls from Wolf Village, Period II ($r^2 = 0.000$).

of the time, small artiodactyl heads were brought back to the site.

Shaft pieces of tibias were predominant in the Period I assemblage. This suggests that butchering occurred away from Wolf Village part of the time and that high-caloric portions (such as tibias) were brought back to the site in bulk. There are few distal or proximal portions of femurs, both high-caloric elements. Their rarity suggests that either the Fremont did not transport these elements back to Wolf Village (which would be unlikely), or at least some of these elements did not survive in the archaeological record either due to butchering practices, weathering, or carnivore disturbance (i.e., canines chewing and destroying some high-caloric bones).

The MGUI analysis with shafts provides clues about the processing practices. The higher quantity of shaft pieces, when compared to proximal and distal ends of some long bones, suggests that whole long bone elements were brought back to Wolf Village from hunting expeditions. However, some end pieces were likely destroyed, either through the processing for marrow, tool production, or used as dog food, and do not appear as often in the archaeological record. Nevertheless, I compare the scatterplots of combined small artiodactyls without shaft pieces to MGUI scatterplots from other Fremont sites in Chapter 7. This is because most other Fremont archaeologists have presented their MGUI data in the same manner (see Janetski 2000; Rood and Butler 1993; Sharp 1992; Stauffer 2012; Talbot et al. 2000; Todd 1993) which allows for easier comparison between the MGUI results from Wolf Village and other Fremont sites.

RESEARCH QUESTIONS READDRESSED

My research objectives for this thesis are presented in Chapter 1. They include to determine the relative abundance of taxa at Wolf Village, to identify evidence of resource depression, and to explore the skeletal frequencies of small artiodactyls in order to identify hunting and transport practices among the Fremont of Wolf Village. As described in Chapter 4, the relative abundances of taxa for Periods I and II at Wolf Village suggest that large game animals, specifically small artiodactyls, was a major source of meat protein at the site. Small artiodactyls likely provided more meat protein than all other mammal orders, birds, and fish combined. Therefore, large game hunting appears to have been a major part of the subsistence practices at Wolf Village.

The results of the Artiodactyl and Muskrat Indices suggest that artiodactyls were plentiful in both periods at Wolf Village. In addition, the Lagomorph Index suggests that cottontails were eaten in greater frequency than jackrabbits during both occupation periods of the site. The changes in relative abundance of artiodactyls between Periods I and II, plus the values of the Artiodactyl Index suggest the Wolf Village experienced a slight resource depression of small artiodactyls. Since all three small artiodactyl species (i.e., mule deer, bighorn sheep, and pronghorn) were a regular part of the meat diet for the Fremont of Wolf Village, Fremont hunters may have travelled far from Wolf Village for large game.

Lastly, the results of the MGUI analysis provide suggestions about large game transportation decisions by Wolf Village hunters. Several scatterplots of %MAU and the MGUI values suggest that the Fremont regularly transported low-caloric elements back to Wolf Village, at least some of the time. If Binford's (1978) assumptions are correct and the MGUI can properly reveal site function, then the MAU data suggest that Wolf Village served as a kill site and hunters processed large game carcasses before returning to the habitation site. This conclusion seems unreasonable, due to the presence of permanent architectural features on the site.

There are at least three possible reasons why the analysis of small artiodactyl skeletal frequencies at Wolf Village resulted in reverse utility patterns. First, Wolf Village could have served primarily as a kill-butcher site and high-caloric portions of large game animals were transported back to a habitation site. This possibility is rejected because Wolf Village was the principle habitation site of its region. Second, mule deer, pronghorn, and bighorn sheep may all have been obtained relatively close to Wolf Village. I explore this possibility in the next chapter using strontium isotope analysis. Third, the low-caloric elements found at Wolf Village may have had social and economic importance to the Fremont there (i.e., these body parts and bones may have had utilities that Binford did not consider). The interpretation that some animal portions were collected for values other than as food will be explored in my concluding chapter.

My last research objective is to compare the results of the MGUI analysis at Wolf Village to the results of strontium isotope analysis on small artiodactyl teeth from Wolf Village. Strontium isotope analysis can help identity which small artiodactyl individuals were local to the region around Wolf Village and which come from areas far from the site. As stated, the interpretation that Wolf Village served as a kill-butchering site is unreasonable. Whether or not all mule deer, pronghorn, and bighorn sheep were obtained close to Wolf Village can be explored using strontium isotope analysis.

6 Strontium Isotope Analysis on Faunal Bones from Fremont Sites

In this chapter, I present the results of strontium isotope analysis on small artiodactyl and small mammal teeth recovered from Wolf Village. My research questions for this analysis include whether or not large game animals were obtained by Fremont hunters at locations close to Wolf Village or from areas distant from the site. The results of the MGUI analysis suggest that low-caloric elements were transported back to Wolf Village by Fremont hunters. The possible resource depression noted for Period II may have resulted in some large game being obtained by Fremont hunters at locations far from Wolf Village. Strontium isotope analysis will help identify whether any large game animals were non-local. A secondary objective of strontium isotope analysis is to determine whether the Fremont at Wolf Village obtained some animal portions or animal products (such as bone gaming pieces or awls) through trade with other Fremont communities.

To explore these research questions, I perform strontium isotope analysis on animal teeth. I examine differences in strontium values for the three small artiodactyl species identified at Wolf Village. I describe how strontium enters the archaeological record. Next, I review how strontium isotope analyses have been used in previous archaeological research, especially in Fremont archaeology. Third, I describe samples and methods for conducting strontium isotope analysis. I tested small artiodactyl teeth from Wolf Village, and small mammal teeth from Wolf Village and five other Fremont sites. Fourth, I present the results of the strontium isotope analysis. Finally, I analyze the results of the analysis in relation to my research objectives.

STRONTIUM IN THE ARCHAEOLOGICAL RECORD

Strontium isotope analysis has been used to examine prehistoric human migration and the source locations of plant and animals remains (Beard and Johnson 2000; Benson et al. 2006; Bentley 2006; Price et al. 2002). The technique measures the ^{87}Sr to ^{86}Sr ratio of strontium isotopes in organic materials, including human and non-human bone or tooth enamel. The ratio of strontium found in bones and teeth is directly influenced by the strontium isotope chemistry in the local geology.

Of the four isotopes of strontium (Sr), ^{87}Sr and ^{86}Sr provide information about the environment (Malainey 2011:42). Strontium occurs naturally in igneous bedrock and is passed on into the local ecosystem through erosional processes and soil formation. Strontium in water and soil passes on to herbivores as they eat plants and drink water. Carnivores obtain strontium by eating herbivores and drinking water (Figure 6.1). Strontium values do not fractionate as they transfer through the environment and food chain. Therefore, animals, plants, water, and sediment from any given region will have similar strontium values (Fisher and Valentine 2013). The ^{87}Sr and ^{86}Sr ratio values of an individual's bone or tooth can be compared to the biologically local ^{87}Sr and ^{86}Sr values. This allows researchers to determine whether an individual is local or non-local to an area. The term "local" in this research, refers to animals that lived and died in the general vicinity of Wolf Village or other archaeological sites. "Non-local" animals are those that originated from areas outside Wolf Village.

Strontium isotopic composition in bedrock, soils, and water varies by region. The ^{87}Sr and ^{86}Sr values depend on the geology of an area, and each area gives a distinct geochemical signature (Malainey 2011:188). The range of ^{87}Sr/^{86}Sr values is usually between 0.702 and 0.750. In general, recently formed basalt rocks have low ^{87}Sr/^{86}Sr values and extremely old granitic

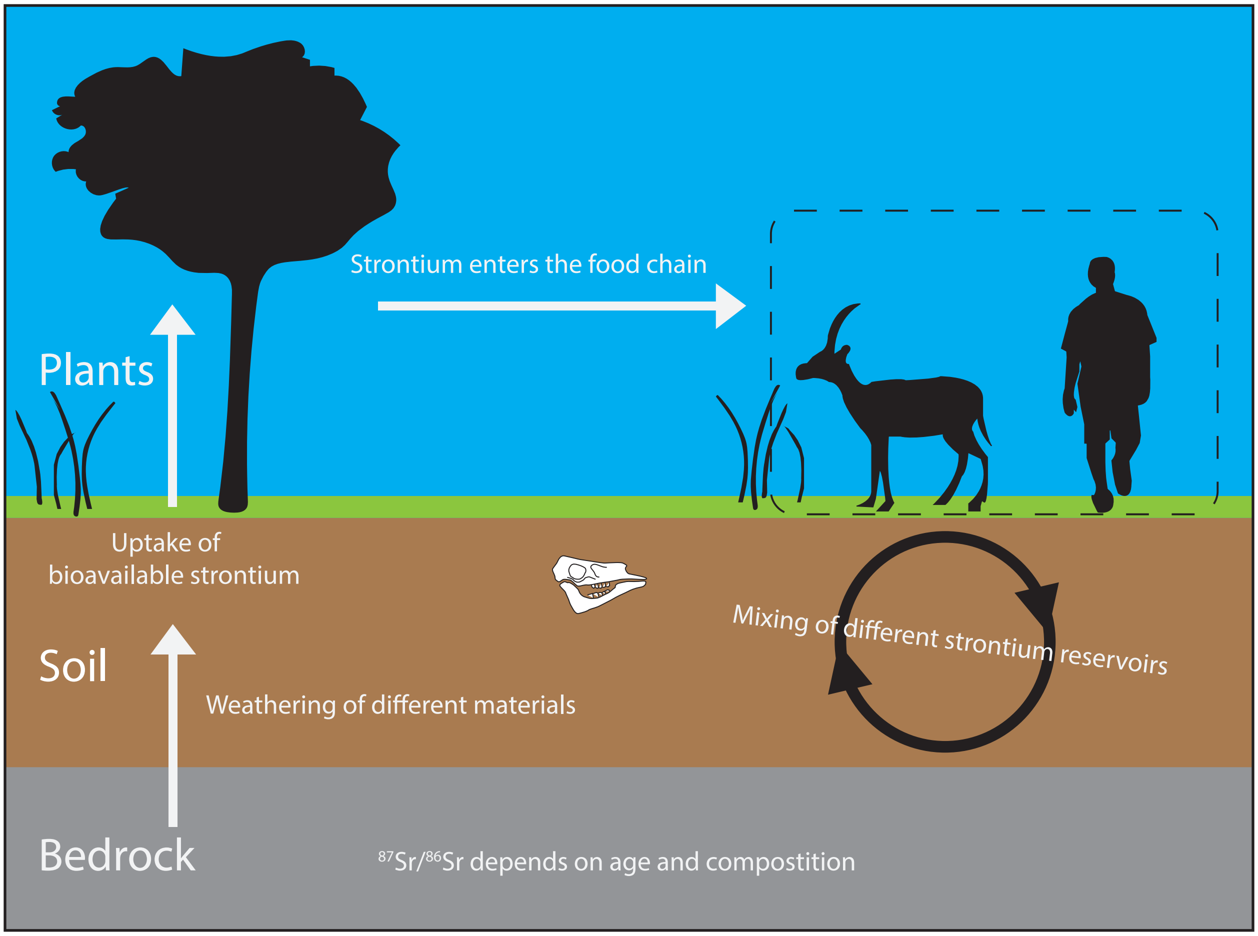

Figure 6.1. Strontium entering the archaeological record.

rocks have high values (Malainey 2011:42). If geologic regions have heterogeneous isotopic values, then strontium signatures can be used to identify different populations of animals or peoples on the landscape (Fisher and Valentine 2013). In essence, “strontium isotopes serve as geochemical signatures that can be used to ‘source’ a prehistoric skeleton to a geologic area” (Bentley 2006:136).

In my research, I tested animal teeth to determine their strontium values. For large game, I tested strontium values on tooth enamel. Tooth enamel is the preferred way of measuring strontium values since enamel is harder, denser, and less susceptible to contamination than more porous bone (Bentley et al. 2004:366; see also Malainey 2011:190). Contamination by local groundwater would reflect local strontium values (Bentley et al. 2004:366). This is not a problem when determining strontium values of local animals, but could skew data obtained from large game not local to a specific region. In addition, strontium is incorporated into skeletal material during formation and remodeling. Bones remodel completely every six to ten years. In contrast, tooth enamel forms only once during childhood and does not undergo remodeling after its development. Therefore, the $^{87}Sr/^{86}Sr$ ratio in tooth enamel is comparable to the specific region where an individual spent its adolescence. In this research, I examine strontium values from large game tooth enamel to determine whether individuals were local or non-local to the region around Wolf Village.

To be fully effective, the utility of strontium isotope analysis is dependent on identifying a regional baseline of $^{87}Sr/^{86}Sr$ values. Identifying the strontium baseline for the region around Wolf Village is important for comparing the strontium ratios in large game teeth. The baseline is also important to determine whether some large game individuals were local or non-local to Wolf Village. In summation, the purpose of the strontium baseline is to measure the $^{87}Sr/^{86}Sr$ ratios of small mammal teeth, in order to provide a background against which $^{87}Sr/^{86}Sr$ ratios from large game teeth can be compared. Before this research, no strontium baselines had been identified in the Fremont culture area.

PREVIOUS RESEARCH

Strontium isotope analysis has been used by archaeologists for many research projects. This technique has been used to track movements of prehistoric groups and individuals (Bentley 2006; Bentley et al. 2004; Price et al. 2002; Valentine et al. 2008). Strontium isotope analysis has been used in studies around the world, including Iceland (Price and Gestsdóttir 2006), Grasshopper Pueblo in Arizona (Ezzo et al. 1997), Teotihuacan (Price et al. 2000), and prehistoric Europe (Bentley et al. 2002).

A more recent example of strontium isotope analysis in archaeological research is presented by Thornton (2011). Her technique and research is similar to my own. She explores the trading of large mammals between ancient Maya communities. Strontium isotope analysis is an under-utilized method for examining animal transport and trade. Many archaeologists assume that when local species are recovered from archaeological sites, they are local resources (Thornton 2011:3254). Recent research from Mesoamerica suggests that some animal individuals with broad habitats were not always local to an area. Thornton (2011) compares strontium values from white-tailed deer (*Odocoileus virginianus*) and collared peccary (Tayassuidae) to strontium baselines. She determines that at least some individuals were not local to the area. She speculates that some non-local individuals entered archaeological sites through the prehistoric trade of animals (Thornton 2011:3261–3262). Thornton (2011:3262) concludes that traditional zooarchaeology methods cannot source animals to a specific region. Despite some taxa being common at Fremont sites, archaeologists should not assume that all individuals were obtained locally.

Very few Fremont archaeologists have incorporated strontium isotope analysis into their research, with a few exceptions (Fisher 2010; Fisher and Valentine 2013). Fisher (2010) performed strontium isotope analysis on mule deer and bighorn sheep mandibles from Five Finger Ridge. He wanted to determine whether hunters traveled farther than their local regional area for large game. It is assumed that hunters do not always hunt optimally based on local resource abundance and caloric return. Some researchers have argued that hunters sometimes base their decisions on costly-signaling (Fisher 2010; Hildebrandt and McGuire 2002). Fisher (2010:170–171) argues that if some animals are valued for their rarity and some hunters select them based on this rarity, then the archaeological record cannot be trusted to determine local resource abundance. Likewise, skeletal frequencies cannot be adequately used to determine transport practices since the MGUI is only based on caloric returns. The MGUI cannot consider all hunting decisions, including the number of individuals in a hunting party, the condition of the animal, and other factors (Fisher 2010:171). I also add that the MGUI cannot consider social and economic conditions when selecting animal portions.

Since the MGUI and optimal foraging theory cannot always be trusted to determine where animals were obtained by prehistoric hunters, Fisher (2010) advocates the use of strontium isotope analysis to resolve these issues. He determined that the relative abundance of mountain sheep declined at areas around Five Finger Ridge from A.D. 1200 to 1250 when compared to deer. He makes this assumption because strontium values in the mountain sheep changed over time. The analysis suggests that bighorn sheep were obtained from different locations than in previous periods at Five Finger Ridge (Fisher and Valentine 2013). Fisher (2010) did not attempt to identify the source of each artiodactyl analyzed at death. Instead, he identified different source populations of animals. In other words, he was not attempting to source animals to specific geographic locations. Similar to Fisher (2010), I use strontium isotope analysis on teeth from large game from Wolf Village to determine whether some large game were hunted far away from the site. While I will not specify the source of each large game individual at the time of their death, I will determine whether some were local to the area around Wolf Village.

MATERIALS AND METHODS

Baseline Sample Description

I tested 60 baseline samples from seven Fremont sites, including animal bones from Wolf Village (42UT273), the Nephi Mounds (42JB02), the Hinckley Mounds (42UT111), Woodard Mound (42UT102), Nawthis Village (42SV633), and sites from the Parowan Valley (42IN43 and 42IN100) (Figure 6.2). Most of the sites are major habitation sites. I refer to all samples used to identify site strontium baselines as “baseline samples.” All 60 baseline samples were from small mammals with restricted home ranges, presumed to be local.

To identify strontium baselines, I took the average $^{87}Sr/^{86}Sr$ values from small wild

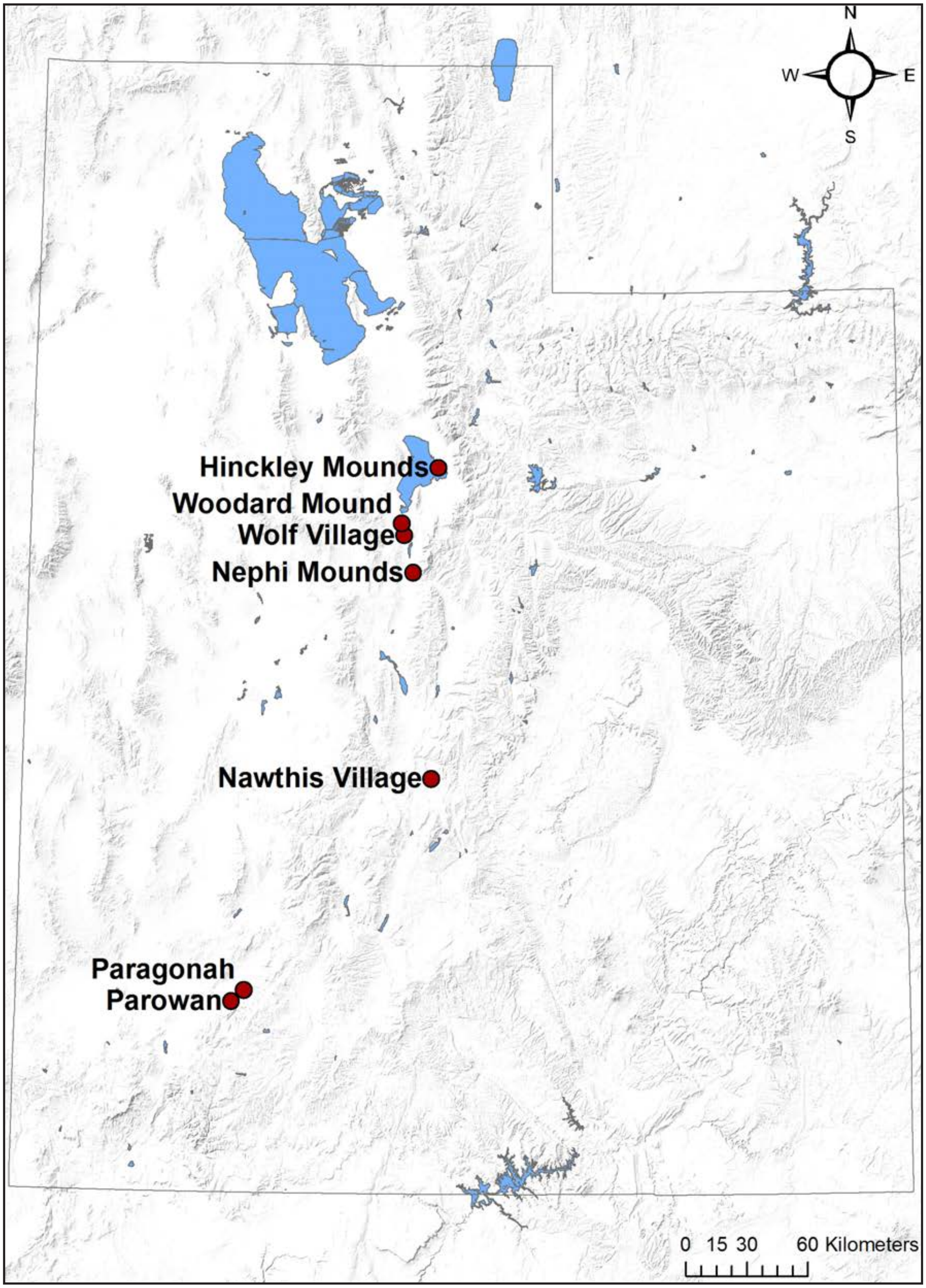

Figure 6.2. Map of Utah showing the location of the Fremont sites included in this study.

animals that lived in the vicinity around each Fremont site mentioned. Although geological, botanical, and hydrologic samples can also be used to measure ^{87}Sr/^{86}Sr values, low mobility animals more accurately reflect local ^{87}Sr/^{86}Sr ranges for larger animals (Thornton 2011:3256; see also Price et al. 2002). Bentley et al. (2004:366) suggest that the best way to identify a local strontium baseline is to measure strontium from local animal species at the site being tested (see also Bentley 2006:155). Small wild animals do not migrate far, so their ^{87}Sr/^{86}Sr ratios should reflect local vegetation (Malainey 2011:190). Bentley et al. (2004:366) explain that rodents and rabbits from the archaeological record are ideal for measuring ^{87}Sr/^{86}Sr ratios in their local area (see also Bentley 2006 and Price et al. 2002). This is because modern fertilizers and air pollution contribute strontium to the modern environment, which can affect the strontium baseline for an area (Malainey 2011:189). In addition, modern animals may consume imported foods (Bentley 2006:158).

To identify the strontium baseline for Wolf Village, I tested ten teeth from ten different muskrat individuals found in archaeological contexts. I avoided using rabbit teeth to identify the strontium baseline because there is a possibility that some rabbits may have been obtained during rabbit drives or trade. Archaeological evidence for communal jackrabbit drives has been noted in the Southwest (Driver and Wouderski 2008, Schmidt 1999). Modern Great Basin tribes, such as the Ute (Callaway 1986), Washo (d'Azevedo 1986), and Owens Valley Paiute (Liljeblad and Fowler 1986), also engaged in communal jackrabbit drives. Jackrabbits were useful not only as food, but their fur was used to make blankets. Rabbit fur blankets were used by early Holocene peoples in the Great Basin (Connolly et al. 2016). It is possible the Fremont also engaged in communal rabbit drives and obtained jackrabbits from diverse geologic locations. Jackrabbits may also have been obtained through trade. Muskrats may also have been obtained through trade at times, but I suspect that most came from marshlands near Wolf Village. Either way, jackrabbits may not be a good indicator of local strontium values.

In addition to samples from Wolf Village, I also tested teeth from ten small mammal individuals from six other Fremont sites (see Figure 6.2). I identified strontium baselines at these sites to determine whether some large game individuals recovered from Wolf Village originated from those regions, either through long distance hunting or trade. I included these sites for several reasons. The Nephi Mounds site is south of Wolf Village, and the natural travel route through Goshen Canyon may have allowed for easy travel between the two sites. It is possible that the Fremont at Wolf Village may have been in contact with Fremont at the Nephi Mounds. The Nephi Mounds site is also close enough that hunters from Wolf Village may have obtained large game in the broad area around the Nephi Mounds. I selected the Hinckley Mounds and Woodard Mound for similar reasons as the Nephi Mounds. I also wanted to determine whether there are differences in ^{87}Sr/^{86}Sr ratios within Utah Valley. The Nawthis Village and the Parowan Valley sites were selected to test Fremont sites from several locations across the Fremont region. Both are habitation sites and may have engaged in trading relationships with other Fremont communities, including Wolf Village. I would have preferred to also analyze small mammal specimens from Five Finger Ridge to compare to previous isotope research (see Fisher 2010; Fisher and Valentine 2013), but obtaining the necessary permissions proved to be difficult considering my timeline.

I attempted to keep my sample selection consistent across all sites in this study. I selected teeth from small mammals since they had minimal foraging ranges. Species with minimal foraging range can help identify the strontium baseline for each local area (Bentley et al. 2004:366; see also Bentley 2006:155; Price et al. 2002). I assume that small mammals were not likely traded or obtained from different locations. For my sample, I removed a tooth from each of the ten mandibles from each site to ensure that the teeth came from separate mandibles. In addition, I also ensured that teeth were removed from mandibles of the same side. For example, at Wolf Village I only selected teeth from the left mandibles of ten muskrats (Table 6.1). This

Table 6.1. Strontium ($^{87}Sr/^{86}Sr$) Results for Baseline Samples from Wolf Village (42UT273) with the Non-Local Specimen Bolded.

Sample ID	Taxa	$^{87}Sr/^{86}Sr$	Standard Error	Provenience
1494-57	*Ondatra zibethicus*	0.70949	0.000004	Str. 8 Ventilation tunnel
1494-58	*Ondatra zibethicus*	0.70891	0.000004	Str. 6 Lower fill of ventilation tunnel
1494-59	*Ondatra zibethicus*	0.70928	0.000004	Str. 2 Antechamber
1494-60	*Ondatra zibethicus*	0.70971	0.000004	Str. 8 Floor zone
1494-61	*Ondatra zibethicus*	0.70951	0.000003	Str. 8 Floor zone
1494-62	*Ondatra zibethicus*	0.70948	0.000003	Str. 8 Floor zone
1494-63	*Ondatra zibethicus*	0.70970	0.000003	Str. 8 Fill
1494-64	***Ondatra zibethicus***	**0.71071**	**0.000003**	**Str. 8 Storage pit**
1494-65	*Ondatra zibethicus*	0.70915	0.000004	Str. 2 Roof fall/Floor zone
1494-66	*Ondatra zibethicus*	0.71001	0.000004	Str. 6 Upper fill of ventilation tunnel

procedure ensures that teeth analyzed from each site originated from different individuals of the same species. Muskrat home ranges are very small compared to artiodactyl species. They average to about 15 m^2 of their primary dwelling place. Most activities occur within a 5 to 10 m radius of the dwelling (Willner et al. 1980:4).

I had hoped to select teeth from the same species for each Fremont site in this study; however, that proved to be impossible. While muskrat was abundant at Wolf Village and the Hinckley Mounds, other sites considered had very little. Therefore, I tested teeth from cottontail, jackrabbit, and squirrels from these sites. When possible, I tried to use only one small mammal species at each site, but the Nephi Mounds site had few mandibles with teeth still intact. Therefore, for Nephi Mounds, I analyzed teeth from muskrat, cottontails, and jackrabbits. Sites from the Parowan Valley also had a limited number of suitable specimens, so I analyzed a combined total of ten mandibles from the Paragonah and Parowan sites. I assumed that the sites shared similar strontium baseline values since they are close in proximity. In all cases, I made sure that all teeth came from either distinct species or from different individuals of the same species. The provenience of each mandible was not a primary concern, as long as it

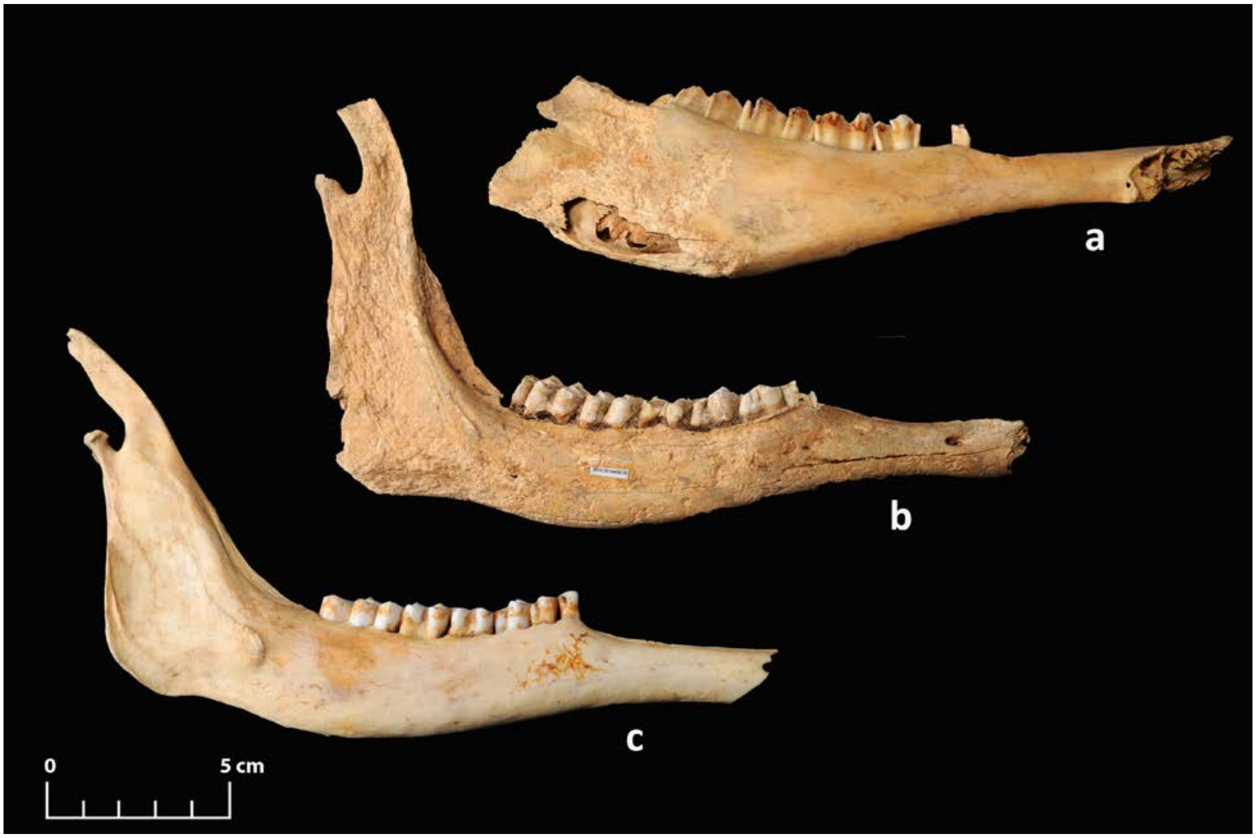

Figure 6.3. Large game mandibles from Wolf Village: (a) bighorn sheep, (b) mule deer, and (c) pronghorn. Mandibles “a” and “c” were recovered from the ventilation tunnel in Structure 9.

was recovered from prehistoric contexts on the site. I did not select mandibles collected from modern ground surface in this analysis. The strontium baseline data from these sites are listed in Appendix E. All tested teeth were completely destroyed as a result of the analysis.

Primary Sample Description

I tested 25 teeth from large game at Wolf Village, including 13 mule deer specimens, 8 bighorn sheep specimens, and 4 pronghorn specimens. I refer to all samples from large game teeth or bone gaming pieces as “primary samples.” All primary samples were compared to the strontium baseline data for each Fremont site in this study. I used a similar method in selecting primary samples as that for the baseline samples. First, I made sure that analyzed teeth were extracted from intact mandibles (Figure 6.3). Loose teeth were not considered in my analysis.

Second, in the case of the mule deer specimens, all teeth were extracted from only right mandibles. I selected right mandibles because they provided me with the most teeth to analyze. Pronghorn and bighorn sheep mandibles are not as plentiful in the Wolf Village assemblages. Therefore, I analyzed one tooth from each of the eight bighorn sheep mandibles with teeth and one from all four pronghorn mandibles with teeth. These mandibles came from a variety of contexts (Table 6.2), and it is possible that some mandibles came from the same individual. Lastly, I also tested five worked bone gaming pieces to determine whether these objects were exchanged between Fremont habitation sites (Figure 6.4) (see Janetksi 2002, 2017; Hall 2008, 2009; Robbins and Lambert 2016).

The context for the primary samples varied across Wolf Village (see Table 6.2). All of the large game mandibles came from architectural fill, floor zones, or ventilation tunnels. There were no large game mandibles with teeth recovered from Period I contexts at Wolf Village; all were recovered from Structures 1, 2, 6, 8, or 9. The five gaming pieces came from two contexts; four came from the midden-fill over Structure 2. Most of the Wolf Village bone gaming pieces were recovered from this midden (Robbins and Lambert 2016). The fifth gaming piece was recovered from a concentration of gaming pieces located in Activity Area 4 (Figure 6.5; see also Figure 2.10). The presence of unfinished gaming pieces and red ochre recovered from Activity Area 4 suggest the activity area was used in part to manufacture gaming pieces.

If funding had allowed, I would measure strontium isotope values from the mandible bone of each large game individual. The values from the enamel show the local strontium values for the location in which the large game individuals lived in their youth. In theory, if the teeth and bone strontium values have varying strontium signatures, then the individual spent its last years in a different geological area than that of its youth (Bentley 2006:161). In this research, I presume that the large game individuals did not migrate outside their home ranges. Therefore, my analysis can only suggest rather than confirm whether or not large game individuals were

Table 6.2. Strontium (^{87}Sr/^{86}Sr) Results for Primary Samples from Wolf Village (42UT273) with Local Specimens Bolded.

Sample ID	Taxon	Provenience	Tooth	Side	^{87}Sr/^{86}Sr
1494-01	*Odocoileus hemionus*	Str. 8 Floor zone	M_3	Right	0.71022
1494-02	*Odocoileus hemionus*	Str. 2 Midden/Fill	M_3	Right	0.71014
1494-03	***Odocoileus hemionus***	**Str. 1 Room 3**	**M_2**	**Right**	**0.70990**
1494-04	*Odocoileus hemionus*	Str. 2 Roof fall/Floor zone	M_3	Right	0.71047
1494-05	*Odocoileus hemionus*	Str. 8 Fill	M_1	Right	0.71020
1494-06	*Odocoileus hemionus*	Str. 2 Midden/Fill	PM_2	Right	0.71025
1494-07	***Odocoileus hemionus***	**Str. 6 Ventilation tunnel**	**PM_2**	**Right**	**0.70999**
1494-08	***Odocoileus hemionus***	**Str. 6 Ventilation tunnel**	**M_2**	**Right**	**0.70986**
1494-09	*Odocoileus hemionus*	Str. 2 Midden/Fill	M_3	Right	0.71032
1494-10	*Odocoileus hemionus*	Str. 2 Midden/Fill	PM_2	Right	0.71020
1494-11	*Odocoileus hemionus*	Str. 2 Midden/Fill	M_1	Right	0.71040
1494-12	*Odocoileus hemionus*	Str. 2 Midden/Fill	M_2	Right	0.71060
1494-13	***Odocoileus hemionus***	**Str. 2 Midden/Fill**	**M_2**	**Right**	**0.71025**
1494-14	*Antilocapra americana*	Str. 8 Ventilation tunnel	M_3	Right	0.71014
1494-15	*Antilocapra americana*	Str. 2 Midden/Fill	M_1	Right	0.71140
1494-16	*Antilocapra americana*	Str. 9 Ventilation tunnel	M_3	Left	0.71022
1494-17	*Antilocapra americana*	Str. 2 Midden/Fill	M_1	Right	0.71013
1494-18	*Ovis canadensis*	Str. 9 Ventilation tunnel	M_3	Right	0.71021
1494-19	*Ovis canadensis*	Str. 2 Midden/Fill	M_3	Left	0.71074
1494-20	***Ovis canadensis***	**Str. 2 Fill of eastern tunnel**	**M**	**Right**	**0.71001**
1494-21	*Ovis canadensis*	Str. 2 Midden/Fill	M	−	0.71071
1494-22	*Ovis canadensis*	Str. 2 Roof fall/Floor zone	M_2	Right	0.71057
1494-23	*Ovis canadensis*	Str. 1 Main habitation room	M	−	0.71025
1494-24	*Ovis canadensis*	Str. 8 Floor zone	M	−	0.71021
1494-25	*Ovis canadensis*	Str. 2 Midden/Fill	M_2	Left	0.71055
1494-26	Small Artiodactyl	Str. 2 Midden/Fill	N/A	−	0.71024
1494-27	Small Artiodactyl	Str. 2 Midden/Fill	N/A	−	0.71012
1494-28	Small Artiodactyl	Activity Area #4	N/A	−	0.71021
1494-29	Small Artiodactyl	Str. 2 Midden/Fill	N/A	−	0.71021
1494-30	Small Artiodactyl	Str. 2 Midden/Fill	N/A	−	0.71011

Figure 6.4. Five Wolf Village gaming pieces tested using strontium isotope analysis.

local to the region around Wolf Village. The weight and raw isotope data of each primary sample are provided in Appendix E.

Laboratory Methods

The samples in this study were analyzed at the Strontium Isotope Geochemistry Laboratory at the University of Utah. The samples were analyzed by Dr. Diego Fernandez, who was assisted by Stephanie Aswad. I did the sample pretreatment myself at the Biogeochemistry

Figure 6.5. Cache of gaming pieces at Activity Area 4 at Wolf Village. Courtesy of the Brigham Young University 2016 Field School.

Lab at the University of Utah. I first extracted a tooth from each large game mandible, then removed dentine and discoloration from each primary sample using a Dremel Lithium-Ion cordless drill (10.8 volt, Model 800). Each primary sample was then examined under a Bausch & Lomb StereoZoom 5 (zoom range 0.8×–4.0×) microscope to ensure each primary sample contained as much tooth enamel as possible (at least 0.05 g). Small mammal teeth are too small to manually separate the enamel from the dentine, so each baseline sample included both enamel and dentine. At least 0.05 g from each gaming piece sample was removed using the Dremel Lithium-Ion cordless drill.

All samples were pre-treated with 5 percent acetic acid (CH_3COOH) to remove post-depositional contaminants. Each sample was then rinsed three times with quadruple de-ionized water (4 × H_2O). Some scholars (e.g., Price et al. 1992; Sillen and Sealy 1995; Thornton 2011; Valentine et al. 2008) say this method is effective in removing contaminants. Samples were digested in sterile Teflon vials with cold nitric acid (HNO_3). The digested samples were run in a quadrupole inductively coupled plasma mass spectrometer (ICP-MS) (Agilent 7500ce, Santa Clara, CA) to determine the Sr concentration. A portion of the digest (200 ng) was purified using column chromatography with resin Sr-Spec (Eichrom, Lisle, IL) in an automated system (PrepFAST MC, Elemental Scientific, Omaha, NE). This was done to isolate strontium from other ions. The purified Sr fraction was dried down and rehydrated in 1 mL of 5 percent HNO_3, and analyzed on a Neptune Plus multi-collector ICP-MS (Thermo Scientific, Bremen, Germany). Certified reference material NIST (National Institute of Standard and Technology, Gaithersburg, MD) SRM 987 goowas run every three samples, and a blank was run after each sample or standard. The SRM value ($^{87}Sr/^{86}Sr = 0.71028$) is around the acceptable value of other analysts (e.g., Copeland et al. 2008).

RESULTS

Baseline Samples

The results of the analysis include the $^{87}Sr/^{86}Sr$ baseline for all Fremont sites included in this study. Strontium values are presented to five decimal digits, as advised by Bentley (2006:136). As advised by Thornton (2011), the local strontium range for each site is defined as two standard deviations above and below the site's mean baseline $^{87}Sr/^{86}Sr$ value. Samples that fall outside the baseline ranges are isotopic outliers, and suggest a specimen came from a non-local individual. Therefore, isotopic outliers are not calculated into the baseline. Likewise, primary samples that fall outside baseline ranges are considered non-local in this study.

Several of the baseline sites had $^{87}Sr/^{86}Sr$ values that overlapped with those of other sites (Figure 6.6). The overlapping strontium baselines make tracking the trade of gaming pieces and

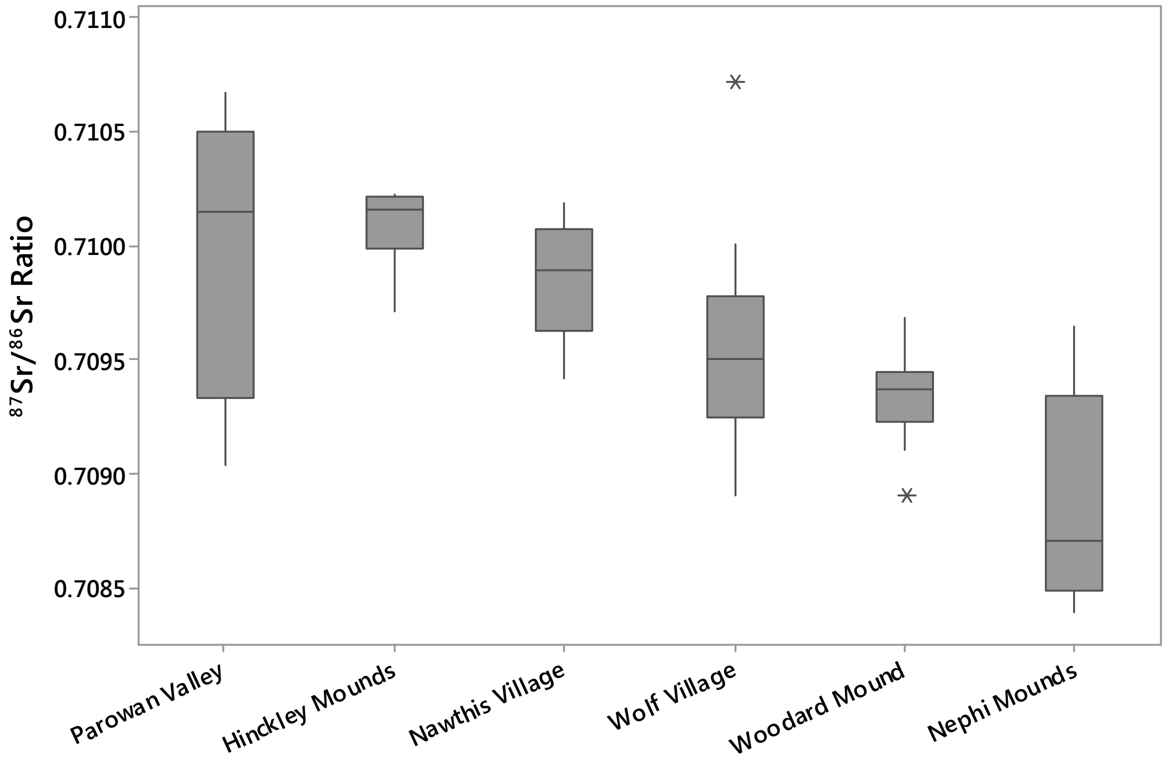

Figure 6.6. Boxplot of ^{87}Sr/^{86}Sr ratios for six locations in Utah, showing one muskrat from Wolf Village as an outlier.

large game difficult. The sites in Utah Valley have similar ^{87}Sr/^{86}Sr ranges, with some overlap (Figure 6.7). The highest values come from the Hinckley Mounds (^{87}Sr/^{86}Sr = 0.70975–0.71039, x̄ = 0.71007). Wolf Village (^{87}Sr/^{86}Sr = 0.70885–0.71009, x̄ = 0.70947) has slightly lower ^{87}Sr/^{86}Sr values than those of the Hinckley Mounds. Woodard Mound (^{87}Sr/^{86}Sr = 0.70893–0.70974, x̄ = 0.70934) and Nephi Mounds (^{87}Sr/^{86}Sr = 0.70802–0.70973, x̄ = 0.70888) also have slightly similar ^{87}Sr/^{86}Sr ranges. Nawthis Village (^{87}Sr/^{86}Sr = 0.70935–0.71034, x̄ = 0.70984) is far from Wolf Village, but has similar ^{87}Sr/^{86}Sr values as Wolf Village. The two regions may have similar geology making tracking trade between the two sites complicated. The Parowan Valley (^{87}Sr/^{86}Sr = 0.70885–0.71118, x̄ = 0.71002) range overlaps nearly all the baseline ranges in this study. However, if the Parowan Valley sites are considered separately (Figure 6.8), then the ^{87}Sr/^{86}Sr values at Parowan (^{87}Sr/^{86}Sr = 0.71002–0.71080, x̄ = 0.71041) and Paragonah (^{87}Sr/^{86}Sr

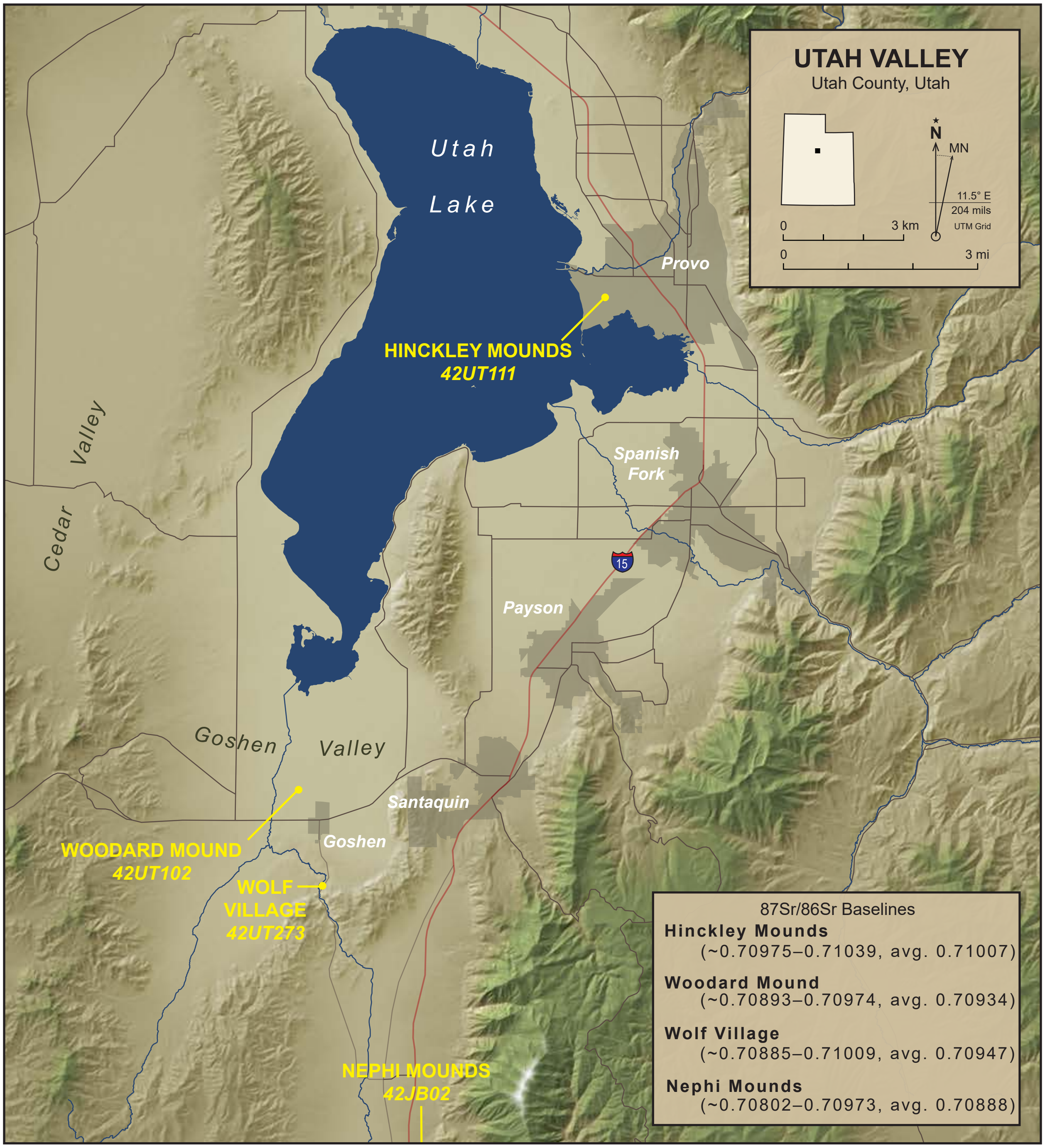

Figure 6.7. Map of the Utah Valley showing strontium baselines at four Fremont sites. Map courtesy of Scott Ure.

= 0.70895–0.70951, $\bar{x}$ = 0.70923) are highly variable (Figure 6.9). Contrary to my expectations, Parowan and Paragonah have differing strontium baselines; probably due to each site having different water sources (i.e., the Parowan Creek and the Red Creek – see Figure 6.9) passing

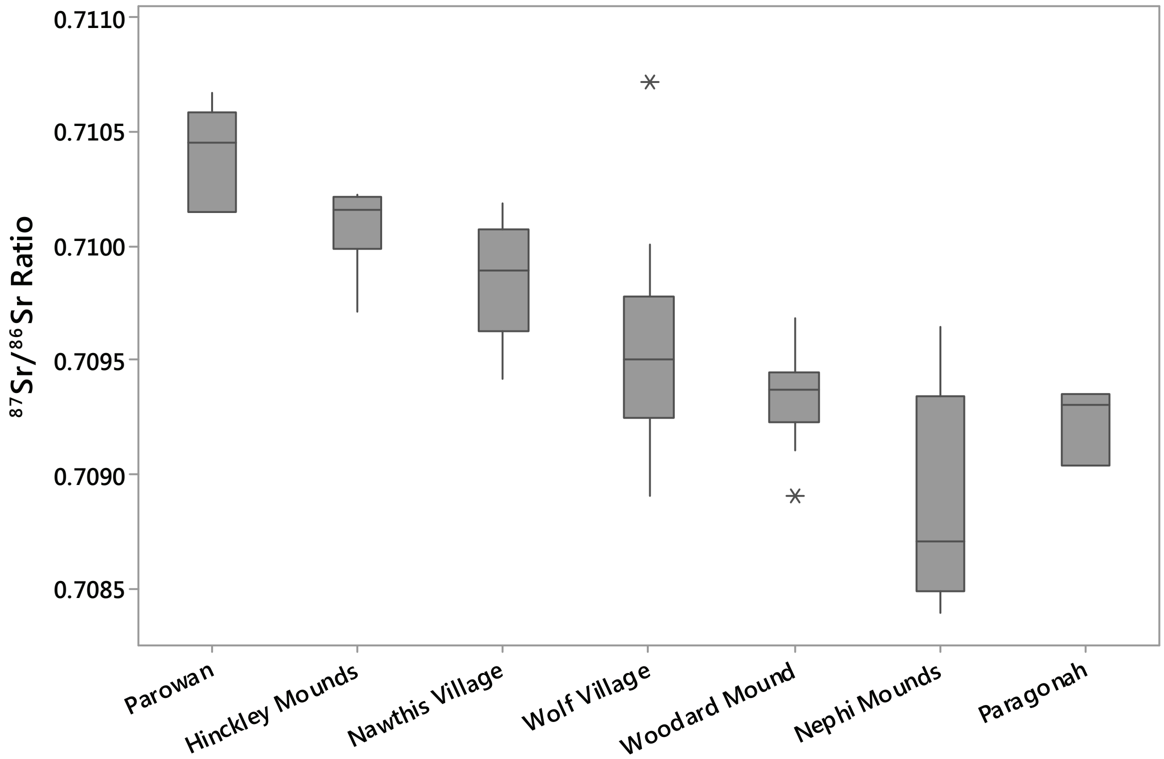

Figure 6.8. Boxplot of ^{87}Sr/^{86}Sr ratios for Fremont sites in Utah, showing the variation between Parowan and Paragonah baselines.

through varying geological formations in the nearby mountains.

One of the Wolf Village muskrat teeth is an outlier (see Figure 6.6; Table 6.1). Whether this outlier is included in the ^{87}Sr/^{86}Sr baseline at Wolf Village determines which large game individuals are considered local or non-local. If the outlier is included, the ^{87}Sr/^{86}Sr baseline for Wolf Village (^{87}Sr/^{86}Sr = 0.70865–0.71054, $\bar{x}$ = 0.70960) is different than the one previously presented. For this research, I compare the large game ^{87}Sr/^{86}Sr values to baselines that exclude the muskrat sample (Lab ID 1494-64). There are at least two reasons why the muskrat sample could be excluded from the Wolf Village strontium baseline. First, the ^{87}Sr/^{86}Sr value is much higher than all the other Wolf Village baseline samples. Second, when considered in the baseline, the sample falls outside the baseline range, suggesting that the muskrat from which the sample was collected was not local to the area around Wolf Village (Figure 6.10).

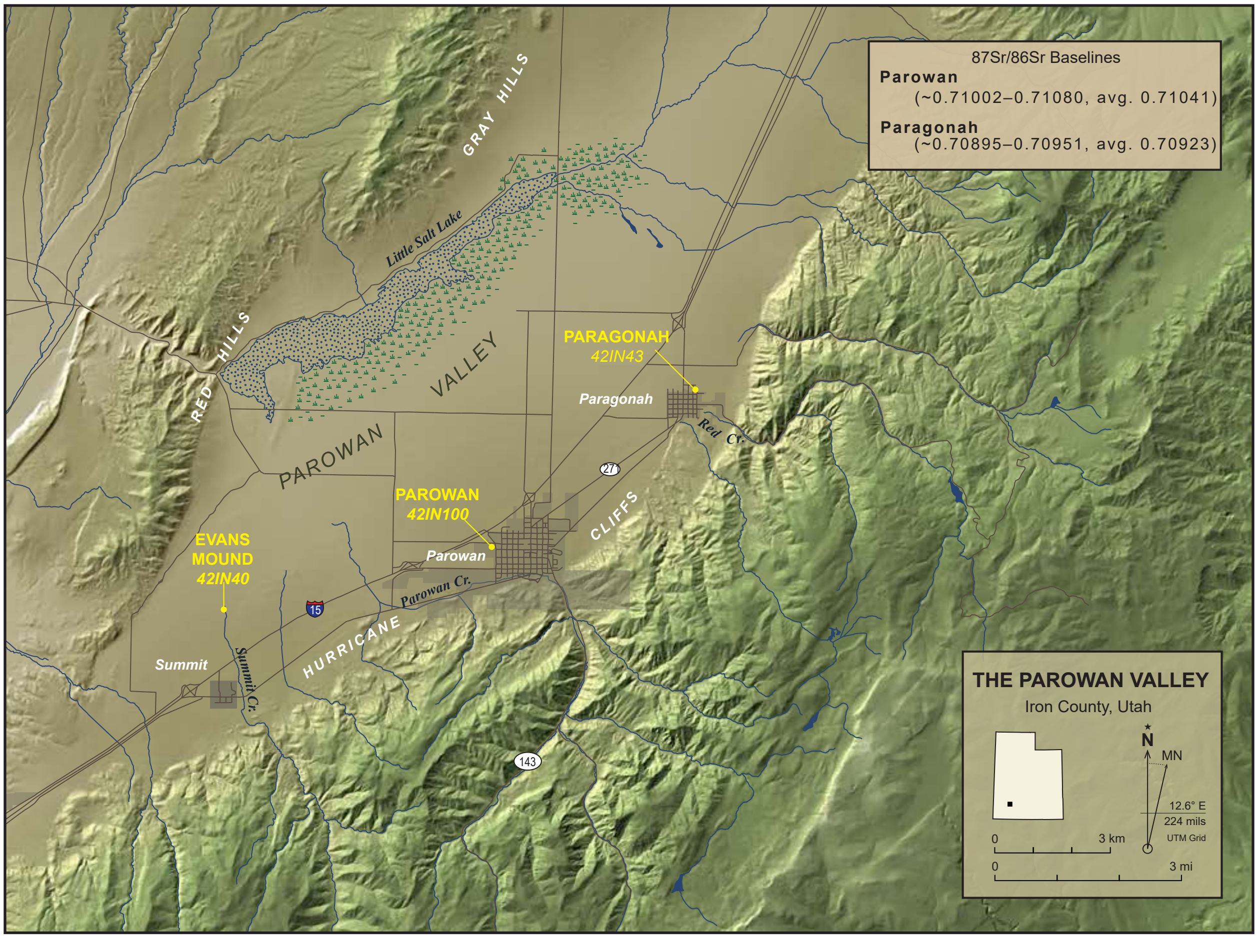

Figure 6.9. Map of the Parowan Valley showing strontium baselines at two Fremont sites. Map courtesy of Scott Ure.

Primary Samples

I compare the 30 primary samples from Wolf Village to the strontium baseline that excludes the muskrat outlier. A comparison of primary samples from pronghorn, bighorn sheep, and mule deer to the Wolf Village baseline suggests that most large game individuals were non-local to Wolf Village (see Figure 6.10). All pronghorn samples came from individuals that were non-local to Wolf Village. Seven of the eight bighorn sheep samples were of non-local individuals, while all but three of the 13 mule deer samples were from individuals that were non-local to Wolf Village. Of the four pronghorn mandibles, one was recovered in the Structure 8 ventilation tunnel, one in the Structure 9 ventilation tunnel, and two from the Structure 2 midden. Of the eight bighorn sheep mandibles, one was from the Structure 1 main habitation

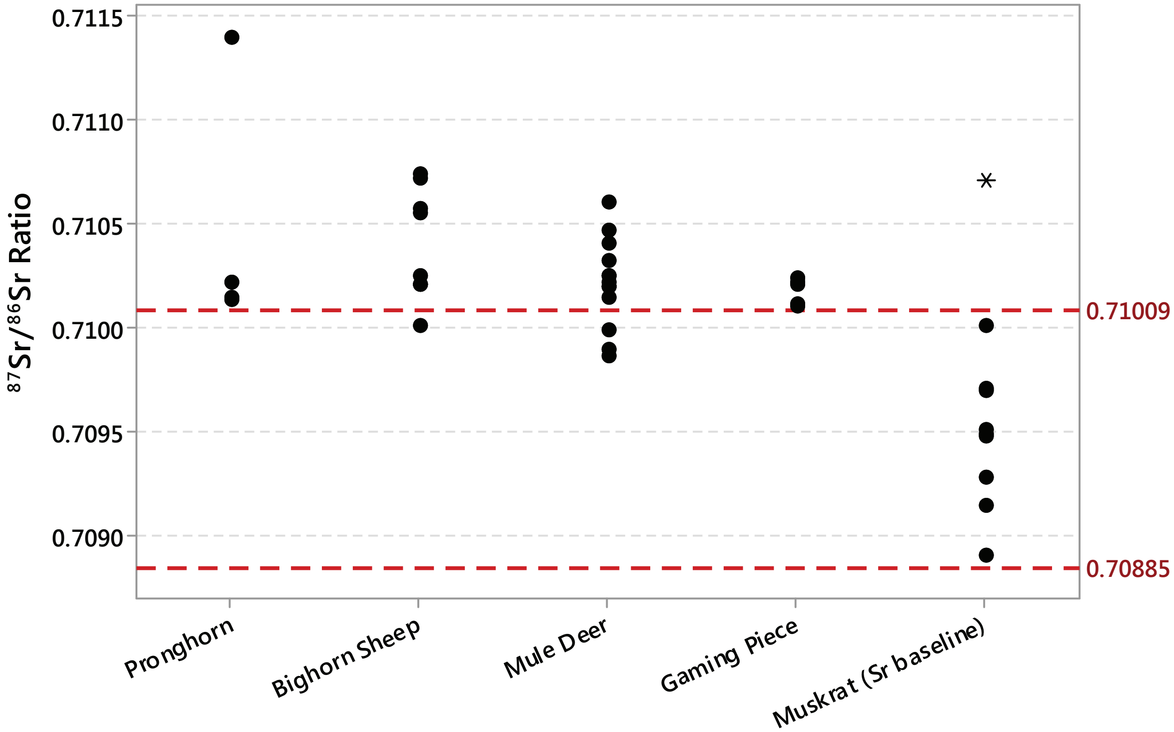

Figure 6.10. Individual value plot of Wolf Village $^{87}Sr/^{86}Sr$ ratios for large game, gaming pieces, and muskrat, compared to Wolf Village baseline values. Baseline range calculated with 2 standard deviations.

room, one from the floor zone of Structure 8, one from the Structure 9 ventilation tunnel, and the remaining five from the floor zone and midden overlying Structure 2 (see Table 6.2). Despite varying contexts, it is possible that some of the pronghorn and bighorn sheep samples came from the same individuals. Regardless, all pronghorn samples were non-local and all but one bighorn sheep samples were from non-local individuals. If the baseline is an accurate reflection of the strontium values around Wolf Village, then almost all large game was obtained at locations away from Wolf Village. This suggests that low-caloric elements (i.e., the mandibles) were transported from kill sites back to Wolf Village.

The five gaming pieces show similar patterns as the large game samples (see Figure 6.10). It is noteworthy that the five gaming pieces included in this study, have strontium values similar to pronghorn, bighorn sheep, and mule deer samples recovered from Wolf Village. This suggests that gaming pieces were manufactured at Wolf Village and constructed from all three artiodactyl species. In addition, some gaming pieces were likely constructed from large game obtained at similar locations as some of the large game individuals tested in this study.

Sourcing Non-Local Large Game

Attempting to track the trading of gaming pieces and large game portions between Fremont communities is complicated. As previously discussed, many of the strontium baseline ranges at Fremont sites in this study overlap with those of other sites (see Figures 6.6 and 6.8). This makes comparing strontium values from gaming pieces and large game samples to strontium baselines complicated. None of the gaming pieces or large game primary samples from Wolf Village appears to have been traded or obtained from nearby Woodard Mound or Nephi Mounds (Figure 6.11). In contrast, the Hinckley Mounds site shares a similar strontium baseline range with Wolf Village. Theoretically, it is possible that the Fremont from Wolf Village traded large game, fish, and other supplies with the Fremont along the Provo River delta. It is also possible that Wolf Village hunters traveled around Utah Lake to hunt some large game animals.

The two sites in this study that are farthest from Wolf Village share similar strontium baselines to one another. These sites are Nawthis Village and Parowan. According to their baseline data, it is possible that some large game and bone gaming pieces recovered from Wolf Village were obtained from Nawthis Village or the Parowan Valley (see Figure 6.11). Both sites share similar baseline ranges as Wolf Village; however, the sheer distance from Wolf Village to these two sites suggests that the Fremont from Wolf Village probably did not travel to these sites to obtain large game, especially if large game was plentiful in regions around Wolf Village. While some large game or gaming pieces may have been traded between Wolf Village, Parowan, and Nawthis Village, it is difficult to tell. It is probably more likely that at least most of the Wolf Village large game was obtained relatively close to the site.

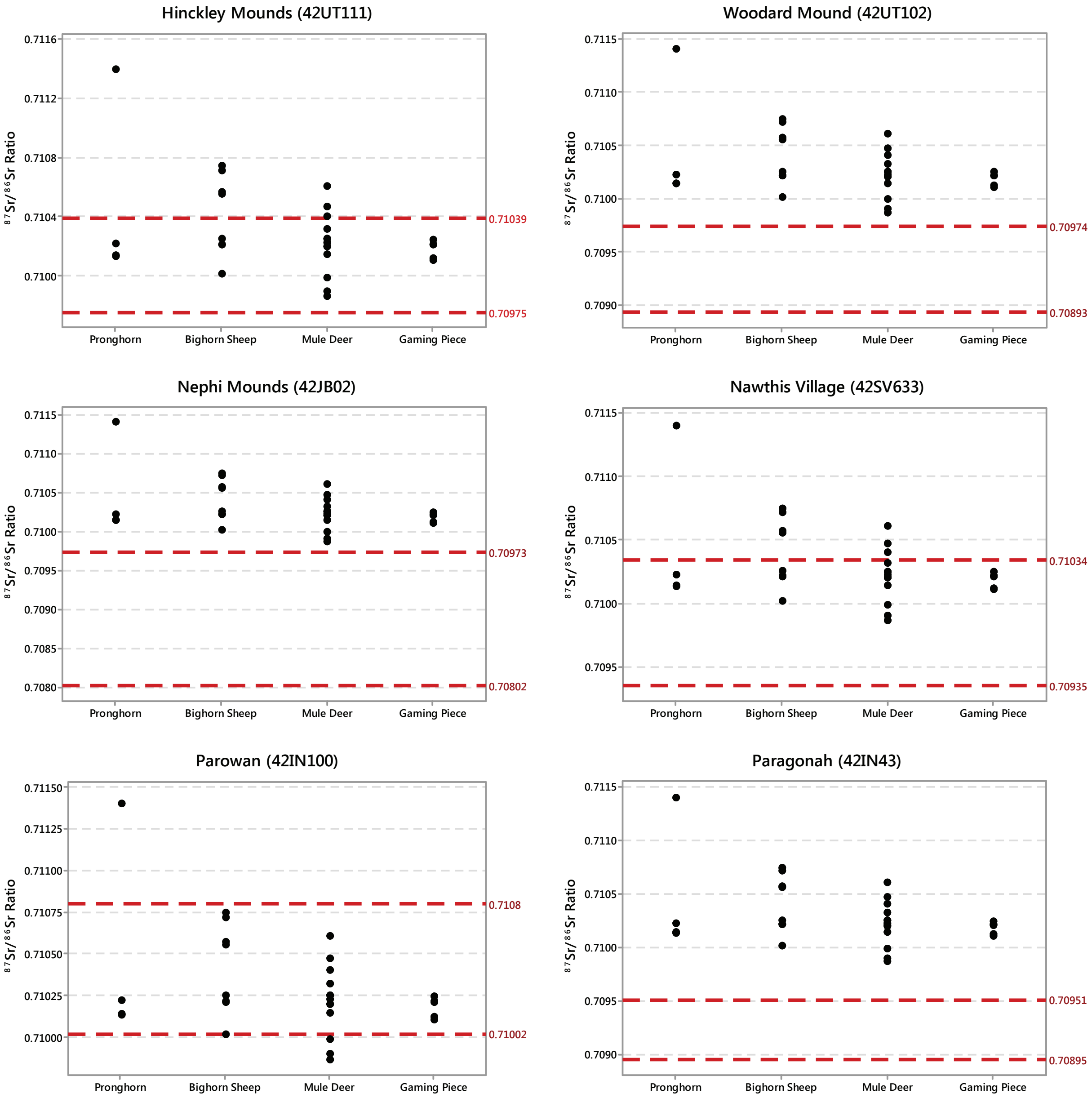

Figure 6.11. Individual value plot of Wolf Village $^{87}Sr/^{86}Sr$ ratios for large game and gaming pieces, compared to baseline values from several Fremont sites: Hinckley Mounds, Woodard Mound, Nephi Mounds, Nawthis Village, Parowan, and Paragonah. Baseline ranges calculated with 2 standard deviations.

As with tracking trade, isolating the source of origin for each large game individual is also complicated. Most artiodactyl species have predictable annual migratory patterns between seasonal home ranges (Anderson and Wallmo 1984; Fisher 2010; Valdez and Krausman1999). For example, the home range for mule deer is rather small, from 0.25 to 3.5 km^2 (Anderson and

Wallmo 1984). Mule deer migrate to lower elevations for the winter, with the migration taking up to four weeks and spanning up to 29.8 km (Anderson and Wallmo 1984; Nowak and Walker 1991). Deer of all species occupy a wide range of habitats, including grasslands, desert, and tundra (Broughton and Miller 2016:123).

Male bighorn sheep home ranges can be as great as 37 km^2, while female bighorn sheep have home ranges averaging 16.9 ± 3.4 km^2 (Shackleton 1985; see also Fisher 2010). Sheep populations usually utilize two home ranges (winter and summer), although some populations have as many as five home ranges (Shackleton 1985). The maximum distance between winter and summer ranges is approximately 48 km. Bighorn sheep are widely distributed in western North America and prefer treeless mountain regions with nearby cliffs to escape predators (Broughton and Miller 2016:126).

Pronghorn are native to North America and are the only surviving member of their taxonomic family. Pronghorns are active both day and night and live in open grasslands or sagebrush deserts. Environment zones or habitats of both types are located near Wolf Village. Pronghorns can run as fast as 70 mph and are the fastest land mammal in the Western Hemisphere (Broughton and Miller 2016:123–124). Home range sizes depend on the size of the pronghorn, habitat quality, population and group sizes, and season. The home-range for adult pronghorns have varied based on each study, but has been estimated at between 0.2 to 2,873 km^2 (Bates 2000; Canon 1993; Clemente et al. 1995; Hervert et al. 2005; Kitchen 1974). A recent study by Jacques et al. (2009) calculated 204 home ranges and 17 seasonal movements of pronghorn in western South Dakota, and determined that the average home range for pronghorn varies depending on seasons and the size and sex of the populations. The maximum calculation for pronghorn home ranges is approximately 127.2 km^2 (Jacques et al. 2009).

There is thus variation in the home range sizes among the three types of small artiodactyl species identified at Wolf Village. Using strontium isotope analysis to determine the source of each large game individual would be extremely complicated, and is beyond the scope of this thesis research. However, strontium isotope analysis is useful for determining which individuals are local or non-local in a specific region. The results of strontium isotope analysis on large game samples from Wolf Village suggests which individuals were local to the area around the site. Regardless of which Wolf Village baseline is compared to the large game primary samples, low-caloric elements from at least some non-local large game individuals were transported to Wolf Village.

RESEARCH OBJECTIVES READDRESSED

The purpose of strontium isotope analysis in this study was to determine which large game individuals at Wolf Village were local to the area. A secondary objective was to identify the trading of gaming pieces and large game between Wolf Village and other Fremont communities. Unfortunately, the second objective could not be realized. The strontium baselines at the Fremont sites in this study overlap. Based on the strontium data, I presume that at least some large game individuals and gaming pieces at Wolf Village did not come from Nephi Mounds, Woodard Mound, or Paragonah; however, Parowan, Hinckley Mounds, and Nawthis Village all have similar baseline ranges as that for Wolf Village. This suggests that large game and gaming pieces could have been transported from those areas either through hunting or trade. Following Occam's razor, I would suggest that most, if not all, large game probably came from close to Wolf Village. Large game individuals from Wolf Village probably were not hunted by Fremont hunters near Nawthis Village or Parowan due to the sheer distance from Wolf Village. The Hinckley Mounds site is close enough to Wolf Village that Fremont between the two sites may have traveled for hunting and fishing excursions, or trade.

Despite the complications with using strontium isotope analysis to identify trade among Fremont communities, my data suggest that at least some mule deer, pronghorn, and bighorn sheep were obtained in areas away from Wolf Village. It is possible that the area around Wolf Village has highly variable strontium values. If more funding is obtained, it would be valuable to test whether the strontium baseline remains similar in the immediate area around Wolf Village. Either way, Fremont hunters brought many low-caloric elements back to Wolf Village. This act is not consistent with the assumptions associated with Binford's MGUI, since Binford would expect hunters to only transport high-caloric elements over long distances.

The results of strontium isotope analysis on large game teeth from Wolf Village suggests that low-caloric elements from non-local individuals were frequently transported back to the site. This suggests that Fremont hunters transported low-caloric elements over distances whether large game individuals were local or non-local to an area. It is also possible that some non-local large game was obtained through trade. Whichever mode of transportation, low-caloric elements seem to have had utility among the Fremont beyond caloric value.

In my concluding chapter, I examine some possible uses for low-caloric elements by the Fremont. I argue that some low-caloric elements had value as raw materials for making tools, gaming pieces, and other bone objects. I also explore the utility of some low-caloric elements as possible symbolic objects.

7 Discussion and Conclusions

In this concluding chapter, I discuss the utility of low-caloric bone elements to the Fremont and describe some complications that archaeologists have noted in using the MGUI to determine site function and examine transport practices. Next, I discuss the concept of "utility" and redefine the term in relation to human behavioral ecology. I also describe non-caloric uses for faunal bones, including as raw material to make tools and gaming pieces and as possible symbolic objects. I conclude this thesis by reconsidering my research objectives and provide suggestions for future faunal bone and isotope research.

THE MODIFIED GENERAL UTILITY INDEX

According to the strontium isotope data presented in this thesis, some non-local large game was carried back to Wolf Village, at least part of the time. An analysis of large game skeletal material from both occupation periods at Wolf Village resulted in reverse utility patterns. These patterns suggest that hunters from Wolf Village and other Fremont sites regularly returned home from hunting with low-caloric elements of animals killed and processed elsewhere. The reverse utility patterns in the Wolf Village faunal bone assemblages also suggest that the MGUI is not an accurate indicator of site function since Wolf Village is a habitation site. For the MGUI to be useful, archaeologists must be aware of its limitations.

Reverse utility patterns for habitation sites have been noted by archaeologists studying within and outside the Fremont culture area (Marean and Frey 1997). As discussed in Chapter 1, reverse utility patterns have also been noted at several Fremont habitation sites, including Five Finger Ridge (42SV1686) (Janetski 2000; Talbot et al. 2000), Round Spring (42SV23) (Rood and Butler 1993; Todd 1993), and Nawthis Village (42SV633) (Sharp 1989, 1992). Stauffer (2012) also noted reverse utility patterns for sites in the Parowan Valley (42IN40, 42IN42, 42IN100) and provided me with updated data from her thesis research. In addition, I identified reverse utility patterns for several Fremont sites with unpublished faunal bone data, including the Bee sites, the Hinckley Mounds (42UT111), Baker Village (26WP63), and Seamons Mound (42UT271).

The Bee sites are approximately 200 sites recorded by James and Robert Bee in the early 1930s. Mooney (2014) describes several of the Bee sites in detail and offers information about the faunal bone assemblage. For this analysis, I only used data from sites on the Provo River delta that dated to the Fremont time period (Mooney 2014:114) (Bee sites 6, 11, 13, 17, and 18). For the Hinckley Mounds, I combined faunal bone data from three sites associated with the Hinckley farm (42UT110, 42UT111, and 42UT112). The faunal bone analysis of the 1940s and 1960s excavations at the Hinckley Mounds sites was done by Lindsay Johansson (see Mooney 2014). Faunal bones recovered from the 2015 excavations was done by Robert Nash and myself. When referring to the combined Hinckley Mounds sites, I use the site designation 42UT111. In addition to the Hinckley Mounds and the Bee sites, I also identified a reverse utility pattern at Baker Village (26WP63) and a reverse utility curve at Seamons Mound (42UT271) (Figure 7.1). Faunal analyses for Baker Village, Seamons Mound, and the Bee sites was done by Lindsay Johansson and, in the case of Seamons Mound and the Bee sites, is presented in Mooney (2014). Published and unpublished MNE and MAU data for each of the above sites are included in Appendix F. The results of these analyses show that reverse utility patterns are a common trend at Fremont habitation sites. The scatterplots displaying the comparison between

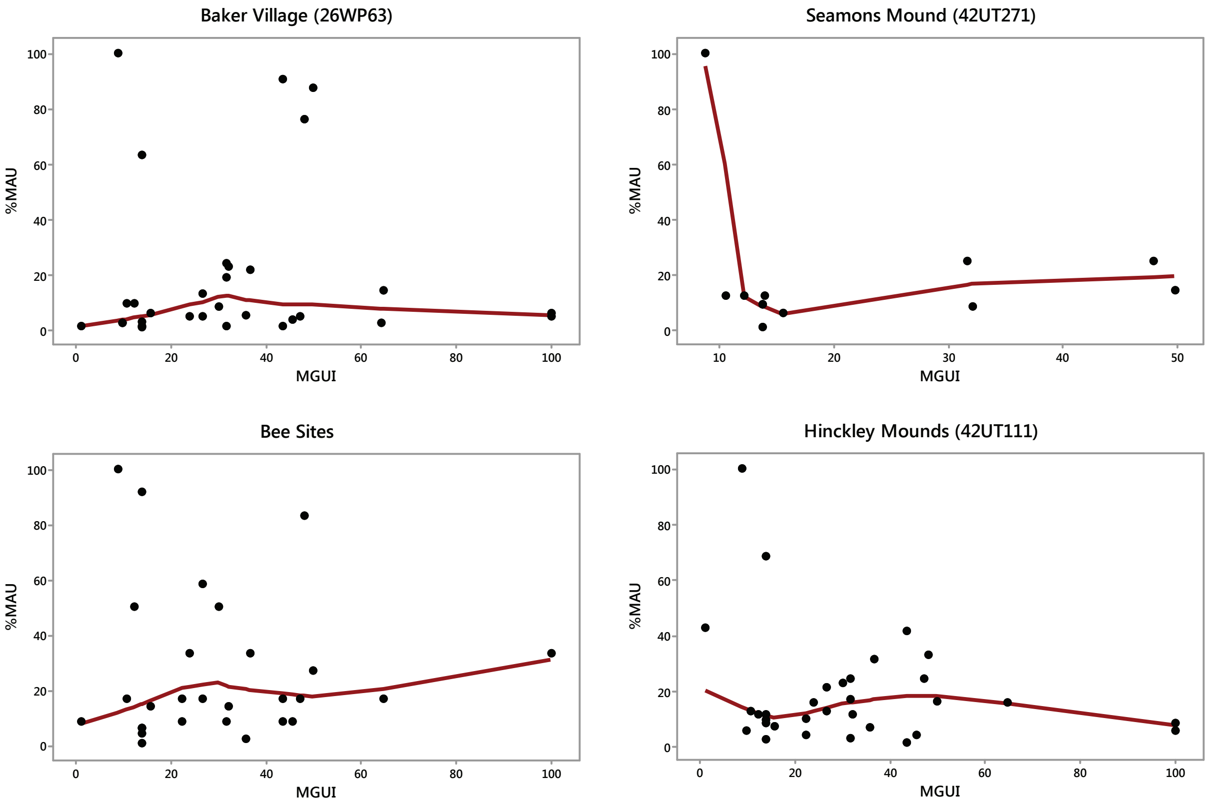

Figure 7.1. Reverse utility patterns from four Fremont habitation sites: Baker Village ($r^2 = 0.000$), Seamons Mound ($r^2 = 0.044$), the Bee sites ($r^2 = 0.001$), and the Hinckley Mounds ($r^2 = 0.049$).

MGUI values and the %MAU from 11 Fremont sites suggest that low-caloric skeletal elements are more common than high-caloric skeletal elements. LOWESS curves helps to visualize the reverse utility patterns at the 11 Fremont sites (Figure 7.2). The reverse utility patterns suggest the possibility of interesting differences between the 11 Fremont sites. These differences deserve more attention than this thesis provides, and should be examined in future research.

Unfortunately, faunal bone raw data from Fremont campsites was unavailable to compare to data from Fremont habitation sites. While Gilsen (1968) claimed to identify several Fremont campsites around Goshen Valley, as far as I can determine, no one has excavated at these other sites. Baker and Janetski (2004:39) explain that identifying Fremont campsites can be problematic on survey, since some sites without ceramics could also be Archaic rather than Fremont. Regardless, a recent publication on Fremont hunting complexes in the

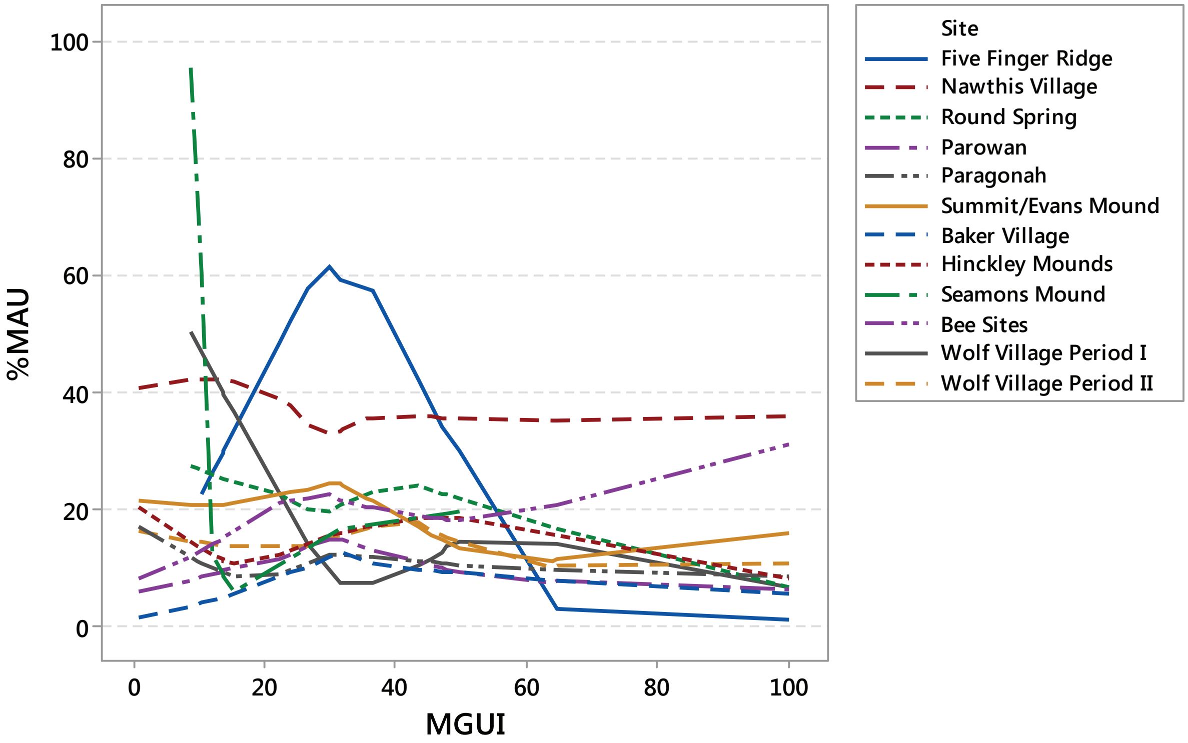

Figure 7.2. LOWESS regression of %MAU for 11 Fremont sites compared to the MGUI.

Wasatch Mountains in Weber County, Utah describes hunting activities at Fallen Rocks Shelter (42WB288) and the associated rock art sites, Running Warrior (42WB278) and Six Fingers (42WB280) (Stuart 2016). Burned mammal bone from a fire pit in Fallen Rocks Shelter date the site to approximately A.D. 1160 – 1300, contemporary with Period II at Wolf Village. Stuart (2016:139) argues the site was used "as a base camp for small groups of Fremont hunting big game." The faunal bone material contained mostly mule deer and bighorn sheep specimens, although elk, pronghorn, cottontails, jackrabbits, marmots, and grouse were also processed and/or consumed at the hunting site. Many of the bone specimens at Fallen Rocks Shelter were small, calcined fragments (Stuart 2016:131), suggesting marrow processing occurred at the site, and some meat was probably dried and consumed at the site prior to the hunters returning to their home base (Stuart 2016:143–144). Stuart (2016:132) argues that the high degree of bone fragmentation and burning at Fallen Rocks Shelter is evidence for "complete and careful utilization of each animal for hide, meat, bone, and marrow." Fallen Rocks Shelter, an example of a Fremont hunting complex, provides information about possible hunting practices of Wolf Village hunters. Fremont hunters from Wolf Village were probably processing and consuming some high-caloric animal body parts at hunting complexes, which affected which parts of the animal were carried back to Wolf Village.

I am not the first archaeologist to note complications with the MGUI. Chase (1985) states that the MGUI (and other indices proposed by Binford) are predictive models that seek to predict the behavior of butchers. He argues that the use of the MGUI and other predicative models are inappropriate for measuring prehistoric behavior. Many of Binford's indices (including the MGUI) are predicative, explanatory models not based on descriptive, empirical fact. Chase (1985) examines Nunamiut behavioral data, and he argues that the Nunamiut do not conform to Binford's models. In essence, Chase (1985:299) argues that if Nunamiut hunting practices do not validate the indices, then the MGUI does not predict Nunamiut behavior. It follows that the MGUI cannot be used to predict accurate hunting behavior by prehistoric peoples if it does not work for the original case it was designed for. He concludes that Binford's MGUI and other indices are "of little use in analyzing a prehistoric site" (Chase 1985:299).

Another critique of the MGUI comes from Metcalfe and Jones (1988). They explain that Binford (1978) created his utility models based on a Nunamiut faunal bone assemblage comprised of multiple kill events. Metcalfe and Jones (1988) argue that multiple kill events are the result of multiple hunters or hunting groups under varying conditions. These conditions include the number of carriers, the mode of transport, the number and size of animals killed, and the transport distance. For example, when the Nunamiut transported certain animal body parts, they used dog sled and snowmobiles (Metcalfe and Jones 1988:501–502). Therefore, it would be unreasonable to compare Nunamiut transport practices to prehistoric hunters who likely transported large game by foot. Metcalfe and Jones (1988) argue that comparing a faunal bone assemblage made up of multiple kill events to one made up of only one kill event could result in spurious utility models. Varying conditions of Fremont hunting groups could also affect faunal bone assemblages from Fremont sites.

Several archaeologists have used the MGUI to some effect. Lupo (2001) evaluates the usefulness of skeletal utility indices by examining Hadza butchering, hunting, and residential sites. She argues that transport practices are more accurately reflected by small-sized faunal bone assemblages from small-scale, single-event sites (Lupo 2001:374). In contrast, large faunal assemblages may be influenced by the situational variation discussed by Metcalfe and Jones (1988). The study by Lupo (2001) suggests that the MGUI may have some value when examining small assemblages from single-event sites but that the MGUI is not often accurate when compared to large assemblages from residential sites. She further argues that butchering and transport decisions are complex and that zooarchaeologists can build more accurate models to account for variability in prehistoric butchering and transport decisions by gathering ethnographic data from contemporary hunters (Lupo 2006:57).

Some archaeologists still consider the MGUI as a useful way to measure utility but argue that methods need to change. Marean and Frey (1997) note that reverse utility curves are present at several prehistoric residential sites around the world, including the Gatecliff Shelter Horizon 2 site in Nevada (Thomas and Mayer 1983), the Last Supper Cave site in Nevada (Grayson 1988), the Middle Paleolithic site of Combe Grenal in France (Chase 1986), the Middle Stone Age site of Klasies River Mouth in South Africa (Klein 1989), Kobeh Cave in Iran (Marean and Frey 1997), and the Iron Age site of `Ain Dara in Aleppo, Syria (Marean and Frey 1997).

For Gatecliff, Thomas and Mayer (1983) argued that the reverse utility curve was the result of hunters discarding low-caloric elements at the site and carrying back only high-caloric elements to habitation sites. Marean and Frey (1997:700) state that reverse utility curves are often present at many rock shelter habitation sites and many habitation sites in general, a phenomenon also noted in this thesis. Marean and Frey (1997) have argued that bone survivorship is a main contributor to the reverse utility curve phenomenon. They note that many reverse utility curves are the result of faunal bone analysts not considering long bone shafts in the MGUI (Marean and Frey 1997:709; see also Broughton 1999). They believe that the MGUI can be more reflective of human butchering and transport behavior when considering long bone shafts and proximal and distal ends. I disagree with the conclusion offered by Marean and Frey (1997). While there may be some value to considering long bone shafts in the MGUI analysis (see Chapter 5), the argument presented by Marean and Frey (1997) still assumes that hunters only make transport decisions based on caloric value. I argue that humans are complex and also consider the non-caloric utility of animal body parts (i.e., utility not measured by the MGUI).

To Binford's credit, he did attempt to measure the utility of large game animal portions using a systematic approach. He dissected caribou and sheep to determine numeric values based on caloric utility in which archaeologists could compare faunal bone assemblages. I believe that Binford's systematic methods for assigning the caloric values are why the MGUI is so attractive an index for determining site function. I disagree with Binford's assumption that hunters only consider caloric utility when transporting large game body parts. Even modern hunters collect large game body parts for non-caloric purposes. An example would be hunters who collect deer heads for mounting, or antlers for displaying in their homes. As with modern hunters, it is likely that the Fremont did not consider only food value when making transport decisions. Some large game body parts were useful to the Fremont hunters as raw materials and symbolic objects.

REDEFINING UTILITY

The Fremont likely considered artiodactyls as an important resource. Artiodactyls were undoubtedly hunted for their food value. Large game provides a high abundance of meat, grease, and marrow. During the course of this project, I learned how to butcher elk and deer legs using obsidian flakes. John Clark of Brigham Young University and Joseph Bryce of the Natural History Museum of Utah supervised my progress. The metapodial region of artiodactyls does not contain a significant amount of meat, grease, or marrow. The term "utility" should not be limited to only food or caloric value. The hide of the metapodial was valuable to the Fremont. While butchering artiodactyl metapodials, I ensured that the hide and hoof were preserved in such a way for someone to create Fremont-style moccasins. Other potential value of the metapodial was the large Achilles tendons and other smaller sinew which could be dried and used as cordage (Bryce 2016:81). Moccasins and cordage are perishable artifacts and would not preserve in the Wolf Village archaeological record; however, they were almost certainly created and used by the Fremont of Wolf Village. Artiodactyl cranial elements were probably important in creating headdresses, such as a deer-scalp headdress from Mantle's Cave made from the crown of a doe (Sommer 2013:218). In summation, artiodactyls were important to the Fremont as a food source and a resource for making craft items. Despite the assumptions of the MGUI, low-caloric elements had utility to the Fremont.

Before discussing the Fremont concept of utility in relation to animal bones, I should redefine the term. The term "utility" according to Binford and some archaeologists with theoretical leanings towards human behavioral ecology (HBE), would probably consider only products and actions that maximize caloric energy. For example, under the assumptions of the MGUI and HBE, Fremont hunters should have selected high-caloric large game elements over low-caloric elements since the former provides more food value. According to HBE, human change and behavior is based on the costs and benefits of different actions (Shennan 2012:16). Humans are equated to other animals and are assumed to maximize the ratio of costs and benefits. Models are tools to understand past human behavoir, but not the reason for specific behavoir. Codding and Bird (2015:10–11) state that HBE models are research tools and not rules that all past humans are expected to have followed. This is the position that I take on HBE models. While some HBE models have value in how to view and understand the past (e.g., the Artiodactyl Index), they should be used with the understanding that people are complex and do not make all their decisions based on costs and benefits. Social theory is a promising lens in which to view Fremont practices, and some current Fremont research has focused more on social theory (see Allison 2008, 2010; Janetski and Talbot 2014; Lekson 2014; Searcy and Talbot 2016; Ure 2009).

Since human behavior is complex, the concept of "utility" should not be limited to factors relating only to food value, caloric energy, or cost and benefits that are easily measurable. There could be social or spiritual benefits associated with some low-caloric large game body parts, as well as non-food economic benefits of animal parts as raw materials. For example, large game body parts are useful for their food value, while their bones are valuable as a raw material for constructing bone objects, hides are useful to create moccasins and headdresses, and tendons are valuable for drying to use as cordage. Some low-caloric body parts may have been associated with Fremont rituals. To summarize, utility should be defined as something that is useful for any reason, either in part or in its entirety. In the case of large game body parts, utility encompasses the food resource, raw bone material, sinew for cordage, and symbolic value associated with some faunal bones.

FREMONT UTILITY OF BONES

According to the MGUI and the results of the strontium isotope data, Fremont hunters possibly transported at least some non-local large game animals to habitation sites in their entirety. Some long bones were probably destroyed by the Fremont while processing for grease and marrow. It is also likely that some dense low-caloric elements were transported to habitation sites to be processed for non-food resources, such as bones for tools and bone gaming pieces.

High-Caloric Bones

Reverse utility patterns at Fremont habitation sites may not be caused completely by social and economic reasons. As previously explained, many low-caloric elements (e.g., mandibles, tarsals, metapodials, etc.) are easier to identify to genus and species than some high- and mid-caloric elements (e.g., vertebra, ribs, and innominate bones) (see Talbot et al 2000; Sharp 1992; Stauffer 2012). It is also possible that some reverse utility patterns are the result of preservation rather than transport behavior. In other words, high-caloric portions were brought back to habitation sites, but they were not preserved in the archaeological record (see Talbot et al 2000; Rood and Butler 1993; Sharp 1992). As with Hadza hunters in Africa (Bunn 1993:164), Fremont hunters may have pulverized some high-caloric elements to make soups or to extract bone marrow. Indeed, this may be at least part of the reason of why there are so few high-caloric elements at Fremont sites compared to low-caloric elements. It does not however, explain the large number of low-caloric elements.

The concept of "riders" was a possible explanation promoted by Binford (1978:74) to explain why some low-caloric elements are found at habitation sites. A "rider" is a low-caloric bone that was transported by hunters not for its food value, but due to its relationship with high-caloric body parts. Many of the small tarsal and carpal bones found at Wolf Village and other Fremont sites fit the definition of "riders." However, metatarsals and metacarpals may have been valuable to the Fremont for non-caloric reasons, specifically as a raw material for making bone tools and gaming pieces.

The lack of butchering marks on Wolf Village artiodactyl bones, in addition to the higher counts of low-caloric elements to high-caloric elements, suggests how the Fremont may have transported large game. Ethnographic data from Great Basin groups, including the Washo and the Northern Paiute (d'Azevedo 1986 and Fowler and Liljeblad 1986; see also S. Fowler 1986:82), state that Great Basin hunters hunted large game as individuals or in small groups. Skinning and butchering were activities that occurred on the spot and the meat divided among the hunters (d'Azevedo 1986:478). The Fremont may also have hunted as individuals or in small groups. In order to carry more meat, high-caloric animal body parts may have been butchered at the kill site and the meat transported without the bones, at least part of the time. Lupo (2006:21) explains that this technique is used by Hadza hunters in Africa some of the time (see also O'Connell et al. 1988, 1990). Special care may have been taken by Fremont hunters to collect artiodactyl feet in order to construct moccasins, bones tools, and other bone objects. This proposed butchering practice could explain the lack of butchered bones and high-caloric bones at Wolf Village.

Bones as a Raw Material

Some high-caloric bone elements were probably destroyed by the Fremont when extracting marrow or bone grease. Another reason that some low-caloric elements outnumber high-caloric elements could be the usefulness of some low-caloric bones as a raw material. Binford (1978:72) acknowledged that hunters may be interested in animal parts that provide "the greatest variety of potential uses." Unfortunately, he only considered caloric uses despite bones being an excellent raw material for making bone objects. Bone is a plentiful and useful substance for making objects. For the Fremont, low-caloric elements were important in the construction of worked bone objects, including bone awls (Bryce 2016:56–58), worked bone gaming pieces (Janetski 2017; Robbins 2013; Robbins and Lambert 2016), and antler pipes (Bryce 2018; Gillin 1941). While Binford classified metapodials and antlers as "low utility" elements among the Nunamiut, the Fremont likely viewed these elements as useful for making bone objects.

Bone Awls

Artiodactyl long bones were commonly used by the Fremont to make objects. Bryce (2016) recently analyzed 135 bone awls from Wolf Village (Figure 7.3). I assisted Bryce in

Figure 7.3. An assortment of worked bone awls recovered from Wolf Village (see Bryce 2016: Figures 3.6–3.10).

identifying some of the awls to species or skeletal element. Of the 135 bone awls analyzed by Bryce, 125 were identified to at least the taxonomic order of Artiodactyla, suggesting that bones from large game were important for making bone awls (Table 7.1). Seven of the awls were identified to species, including pronghorn (n=2), mule deer (n=2), and bighorn sheep (n=3) (Bryce 2016:58). Bryce (2016:70) reports that metapodials are the most commonly reported skeletal element used by the Fremont for making bone awls (see also Dalley 1976; Loosle and Koerner 1998; Shields 1967; Taylor 1957; Wormington 1955). Of the 135 Wolf Village bone awls, 43 were identified to specific elements. Of those 43 awls identified to specific elements, 97 percent (n=42) were metapodials; however, there was at least one awl made from an artiodactyl tibia (Table 7.2). The remaining awls (n=92) were unidentified long bones or unidentified to an element type (Bryce 2016:58). The high numbers of metapodials used in constructing bone awls

Table 7.1. Wolf Village Bone Awls Analyzed by Bryce (2016:56–58) and Identified to Order and Species by Bryce and the Author.

Taxon	NISP	%NISP
Antilocapra americana	2	1.5
Odocoileus hemionus	2	1.5
Ovis canadensis	3	2.2
Small Artiodactyla	118	87.4
Unidentified Mammal	10	7.4
Total	135	100.0

Table 7.2. Skeletal Frequencies of Wolf Village Bone Awls Identified to Element (see Bryce 2016:58).

Element	NISP	%NISP
Metacarpal	5	11.6
Metapodial	34	79.1
Metatarsal	3	7.0
Tibia	1	2.3
Total	43	100.0

suggests the Fremont valued some low-caloric elements as an important raw material for bone objects.

At Five Finger Ridge, 18 small artiodactyl distal metapodials were found that had been cut above the juncture of the diaphysis and epiphysis. Talbot et al. (2000:418) state that this was done to obtain the dense, long portion of the bone. Dense parts of bones were used to create bone awls and other objects (see also Madsen and Lindsay 1977:72). Cut and worked metapodials have also been found at Median Village (Dalley 1970), Backhoe Village (Madsen and Lindsay 1977), and Evans Mound (Berry 1972).

Besides metapodials, scapulae were common for constructing bone awls (Dalley 1972; Fry and Dalley 1979), as were ribs (Fowler 1963; Fry and Dalley 1979), ulnae (Talbot et al. 2000), and portions of femurs, fibulae, tibias, and humeri (Jones 1967). Sharp (1989:27) suggests that metapodials were selectively transported and possibly curated by the Fremont at Nawthis Village. Bryce (2016:70) states that the large quantities of metapodials found at Nawthis Village are possible evidence of the Fremont stockpiling bones to make tools. Large quantities of metapodials have also been identified at Median Village (Dalley 1970), Round Spring (Rood and McDonald 1993), Parowan, Paragonah, and Summit/Evans Mound (Stauffer 2012).

Bone Beads

Bones were also used in the construction of bone ornaments, especially pendants and beads. There are two types of bones beads represented at Wolf Village: disk beads and tubular beads (Figure 7.4). Bone beads are created by circumference sawing long bones. Dalley (1970:97) states that circumference sawing is done by sawing around the entire circumference of a bone. This technique can be used to create disk beads, tubular beads, and bone rings (Bryce 2016:74). Bone beads are usually small (~5–10 mm in diameter) and round in shape. In contrast, bone pendants are usually flat, trapezoidal, and drilled at the smaller end (Janetski et al. 2000:91). Bone and lignite beads are found throughout the Fremont area. A noteworthy find includes a bone and lignite bead necklace from a boulder-lined structure at Nawthis Village (Jennings 1978:4; see also Janetski et al. 2000:Figure 5.4).

There were 47 bone beads recovered in the Wolf Village excavations. I analyzed 39 of the bone beads. The remaining eight bone beads were returned to the Wolf family, so I supplemented my data with a former analysis by Lowry (2013). The purpose of this bone bead analysis was to determine which animals were used by the Fremont to make bone beads. I also recorded length, width, thickness, and diameter holes for disk beads and pendants, which data are irrelevant for my current research questions. These data are, however, presented in Appendix G. My analysis of the Wolf Village bone beads resulted in the identification of six pendants, seven disk beads, and 34 tubular beads (Table 7.3). All identified disk beads and pendants were from

Figure 7.4. An assortment of worked bone pendants (top row), disk beads (second row), and tube beads (third and fourth rows) from Wolf Village.

artiodactyls. Tubular beads were easier to identify to class and sometimes genus. Tubular beads were identified as coming from leporids and Anatidae; although at least one tubular bead appears to have been made from an artiodactyl phalanx as evidenced by its size and thickness. Recent experiments by Joseph Bryce (personal communication 2018) suggest that artiodactyl phalanges could have been useful for constructing some tubular beads. Approximately 47 percent (n=22) of the bone beads were constructed from bones from small mammals about the size of leporids and

Table 7.3. Bone Beads and Pendants from Wolf Village Identified by Class and Species.

Taxon	Disk	%Disk	Tube	%Tube	Pendant	%Pendant	Total NISP	%NISP
Artiodactyls	3	42.9	1	2.9	6	100.0	10	21.3
cf. *Lepus* sp.	–	–	4	11.8	–	–	4	8.5
cf. *Sylvilagus* sp.	–	–	1	2.9	–	–	1	2.1
Large Anatidae	–	–	1	2.9	–	–	1	2.1
Medium Anatidae	–	–	1	2.9	–	–	1	2.1
Small Mammals	–	–	17	50.0	–	–	17	36.2
Large Birds	–	–	5	14.7	–	–	5	10.6
Medium Birds	–	–	3	8.8	–	–	3	6.4
Unidentified	4	57.1	1	2.9	–	–	5	10.6
Total	7	100.0	34	100.0	6	100.0	47	100.0

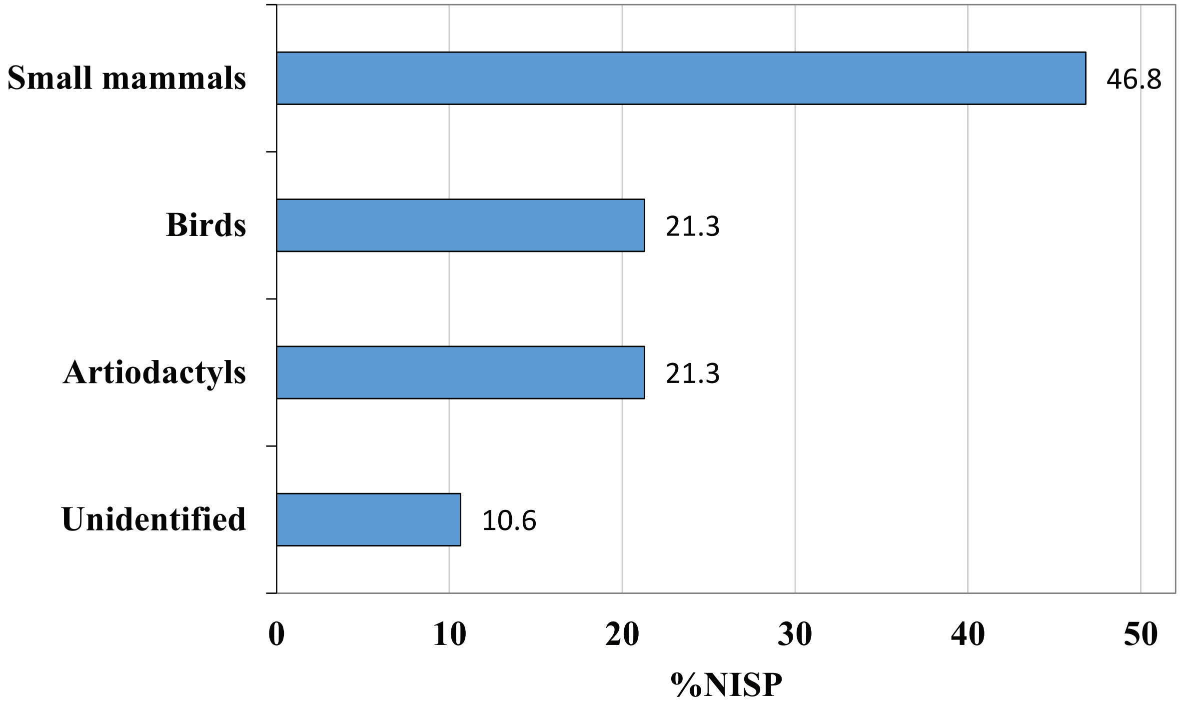

Figure 7.5. Percentage of Wolf Village bone beads by taxonomic class.

muskrats (Figure 7.5). Other identifiable classes include bird bones which made up 21 percent (n=10) of the bone beads, and artiodactyls which made up 21 percent (n=10). The remaining 10 percent (n=5) of the bone beads could not be identified to a taxonomic class. This analysis

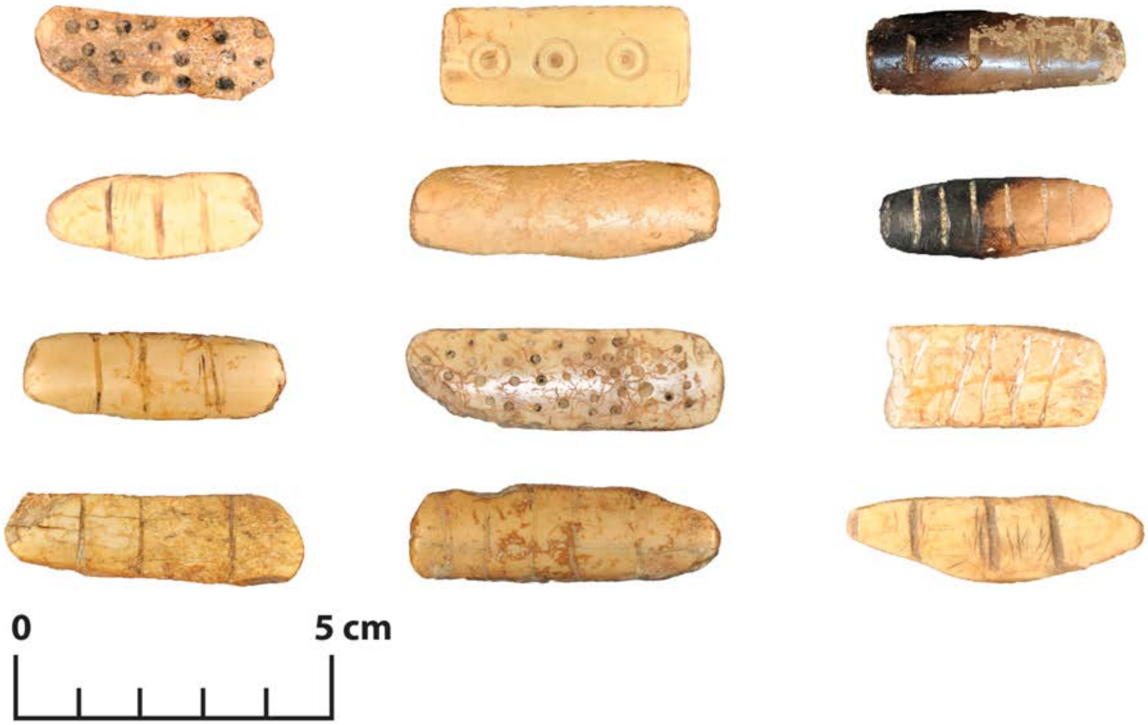

Figure 7.6. An assortment of worked bone gaming pieces recovered from Wolf Village.

suggests that small mammal (especially leporids) and bird long bones were important in making tubular bone beads, but artiodactyl bones were important for making some bone disk beads, tubular beads, and pendants.

Bone Gaming Pieces

In addition to bone awls and beads, faunal bones were used for making bone gaming pieces. Fremont gaming pieces are small, usually flat, rectangular pieces of worked bone often made from large mammal long bones (Figure 7.6). They are often smeared with red ochre on the concave surface (Janetski 2017:124; see also Hall 2008, 2009). Gaming pieces have been found at some of the earliest Fremont excavations (Judd 1919; Gunnerson 1969). Gunnerson (1969:141) noted the similarity between Fremont and Hopi gaming pieces. Gaming pieces are common in Fremont bone assemblages and are often the second most frequent worked bone artifact type after bone awls (Hall 2008:17–18; Gunnerson 1969:141; Janetski 2002:361), though this is not the case at Wolf Village.

The Wolf Village worked bone gaming pieces were analyzed by Brady Robbins and myself. There were 308 gaming pieces recovered from the Wolf Village excavations. About 42 percent (n=129) were classified as "unground" gaming pieces (Robbins 2013). In contrast to Wolf Village, only 10 gaming pieces were recovered from nearby Woodard Mound (42UT102) (Janetski 2017:136; Richens 1983:105). The Wolf Village gaming pieces were far too worked to identify which species the original bone came from; Robbins and Lambert (2016), however, note that 304 of the bone gaming pieces were made of artiodactyl long bones, probably metapodials. The remaining four Wolf Village gaming pieces were made from artiodactyl ribs (Robbins and Lambert 2016).

Over 1,000 gaming piece specimens have been identified at sites in the Parowan Valley (Hall 2008). The ubiquity of gaming pieces recovered from Wolf Village and other Fremont sites suggests that some low-caloric elements were an important raw material for constructing these objects. Janetski (2002) proposed that worked bone gaming pieces were potentially important for intense gaming activities, including gambling. Wolf Village and the Parowan Valley sites may have hosted annual trade festivities similar to other Southwest trade fairs, which drew in large populations of people (Janetski 2017:135; see also Janetski 2002). Fremont hunters at Wolf Village and other sites may have transported low-caloric elements back to habitation areas to create bone objects used in gaming or trade. The high quantity of bone awls and gaming pieces at Wolf Village and other sites suggests that the Fremont valued low-caloric elements of large game animals beyond their meat value.

Antler Pipes and Other Bone Objects

Lastly, the Fremont used antler to construct objects. Antler pipes are the most uncommon

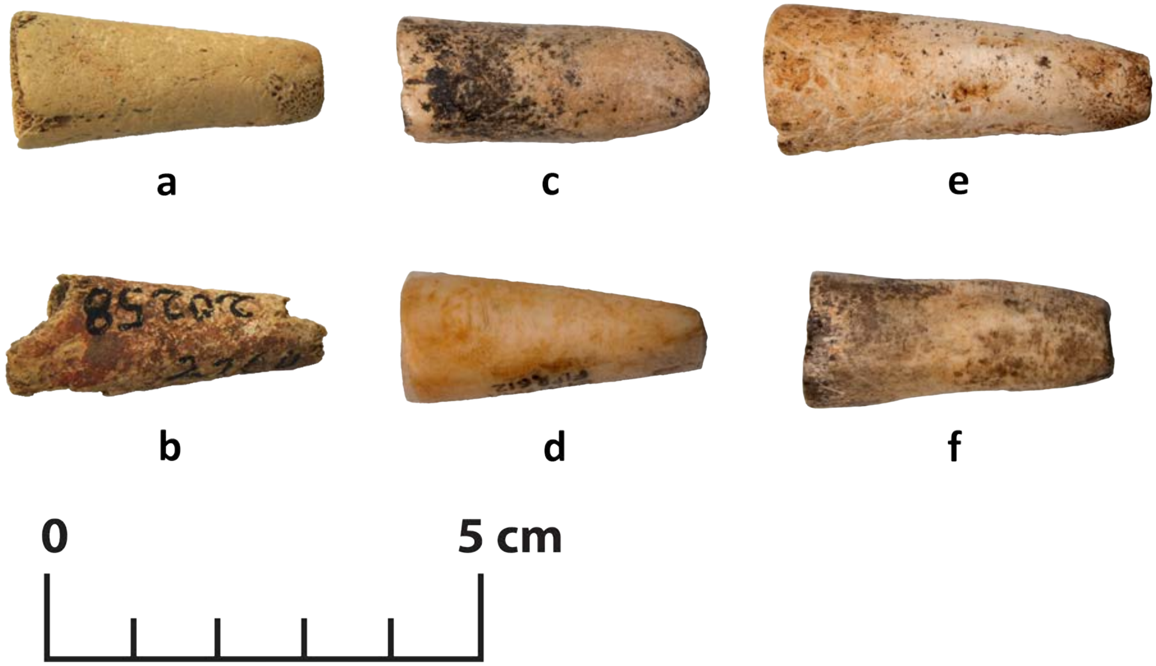

Figure 7.7. Antler pipes from Marysvale (a – b) and Five Finger Ridge (c – f). Photos by Joseph A. Bryce. Courtesy of the Natural History Museum of Utah and Fremont Indian State Park and Museum.

form of Fremont pipes (Bryce 2018a). Gillin (1941) notes that excavations at Marysvale (42PI02) in central Utah, recovered two worked pieces of antler (Figure 7.7). In his ongoing analysis of Fremont pipes, Bryce (2018a, 2018b) notes that these two pieces of antler are actually antler pipes with burned residue within them. In addition, the excavations at Five Finger Ridge recovered at least 15 antler pipes and nine mule deer antler flakers (Talbot et al. 2000:420). Johansson et al. (2014:51) state that a bone harpoon was found on the floor of Structure 8, which appears to have been made of antler. Bone harpoons have been found at several Fremont sites in Utah Valley, including three at Wolf Village (Figure 7.8). While antler pipes and flakers are rare, and none were recovered from the Wolf Village excavations, antler presumably had value to the Fremont beyond what the MGUI suggests.

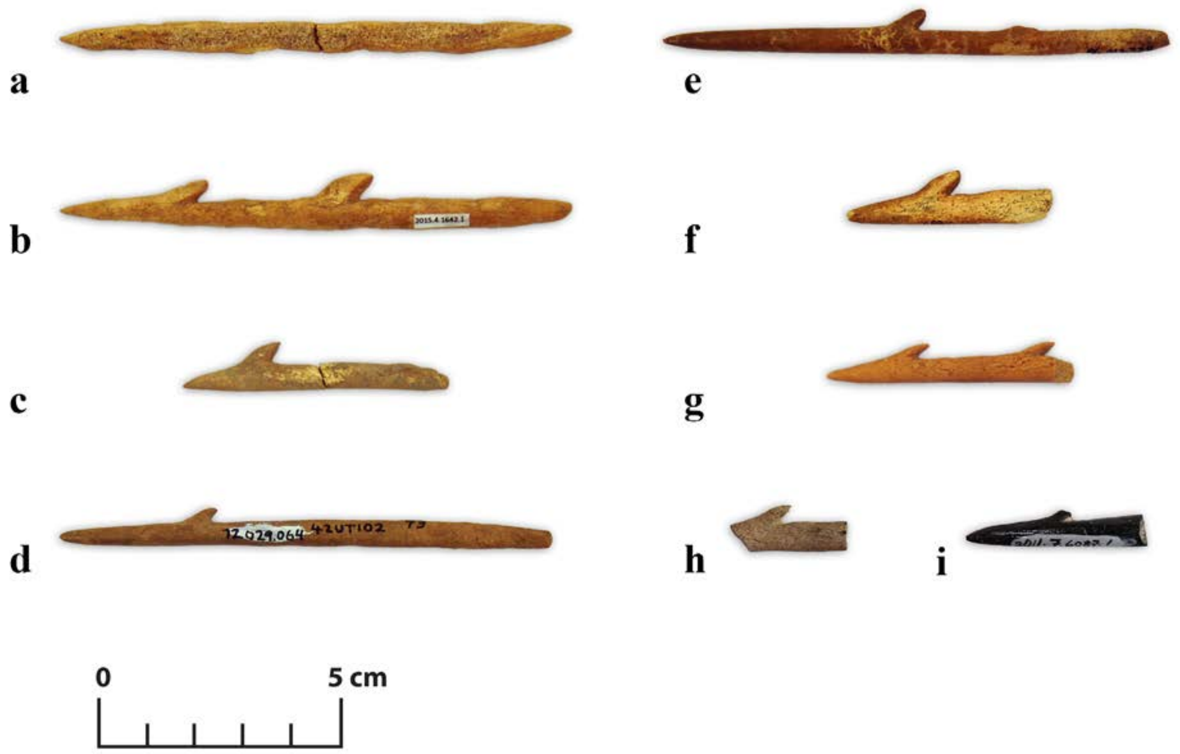

Figure 7.8. Antler harpoons from the Hinckley Mounds (a – c), Woodard Mound (d), Block 49 site (e, f), and Wolf Village (g – i). Photos by Joseph A. Bryce. Courtesy of the Museum of Peoples and Cultures.

Bones as Symbolic Objects

Some low-caloric elements, such as mandibles and cranial elements, may have had utility to the Fremont beyond their value as food or raw material. At Wolf Village, large game mandibles and cranial elements were found in ventilation tunnels and floors of at least three burned structures (Abo 2016). A mule deer skull with a corn cob in its center was recovered from the fill of the western tunnel of Structure 2. Other objects in this tunnel include corncobs, worked bone, worked ceramics, projectile points, and stone cores (Abo 2016:9–10). Fragments of at least three mule deer mandibles were recovered from within the southern antechamber of Structure 2.

The ventilation tunnel in Structure 6 contained at least 12 artiodactyl mandibles, four of which were articulated into two pairs (Wilson 2013:37–38; see also Abo 2016:10–13). According to Wilson (2013), based on the mandibles in Structure 6 there were at least seven mule deer

Figure 7.9. Deer mandible laying next to a mano found in the ventilation tunnel of Structure 6 at Wolf Village. Maize is visible in the profile of the fill of the ventilation tunnel. Courtesy of the 2010 Brigham Young University Field School.

individuals represented in the ventilation tunnel (Figure 7.9). All of these mandibles were from juveniles. Wilson (2013:38) theorizes that the location of deer mandibles in Structure 6 indicates possible “special treatment of mandibles in [Utah Valley].” In my own analysis, I determined that

Figure 7.10. Two artiodactyl mandibles found in the ventilation tunnel of Structure 9 at Wolf Village. Also included are antler, portions of a ceramic vessel, and a lump of red ochre. Courtesy of the 2016 Brigham Young University Field School.

at least seven of the Structure 6 mandibles were mule deer and the remaining were unidentifiable to a species. Johansson et al. (2014:46) state that the presence of the articulated mandibles and unusual artifacts in Structure 6 suggests the Fremont ritually abandoned the architectural feature.

The ventilation tunnel of Structure 9 contained a large concentration of artifacts, including one complete pronghorn mandible, one complete bighorn sheep mandible, an articulated cervical spine of a bighorn sheep, other artiodactyl bones, ceramic sherds, stone tools, and red ochre pieces (Figure 7.10) (Abo 2016:16–17; see also Holm 2017). Holm (2017:17–18) argues that the presence of mandibles, cervical vertebrae, ground stone, and ceramic vessels in the ventilation tunnel of Structure 9, suggests that the building was ritually abandoned. In addition to the mandibles, Structures 2, 6, and 9 appear to have been burned as part of the abandonment of each structure.

In addition to Wolf Village, mandibles have been found in ventilation tunnels at Kay's Cabin (42UT813) (Janetski 2016:49; see also Abo 2016:17–19). The context of these low-caloric mandibles and crania suggests they may have been symbolically important in Fremont abandonment practices, at least around Utah Valley. Like the bone awls at Wolf Village (Bryce 2016), the artiodactyl species represented by the low-caloric elements in abandonment contexts consist of mule deer, pronghorn, and bighorn sheep.

As stated, faunal bones have been used in the construction of bone tools and ornaments. Bone rings are not common at Fremont sites, and none were found at Wolf Village, but some have been recovered from Median Village (Dalley 1970: Table 2), Paragonah (Judd 1919), Round Spring (Metcalf et al. 1993), Evans Mound (Berry 1972), and Five Finger Ridge (Talbot et al. 2000: Figure 7.11). In addition, bones are used to construct bone beads, bone pendants, bone figurines, and other enigmatic worked bone objects (Figure 7.11). Some enigmatic bone objects from Five Finger Ridge may be pendant preforms (see Figure 7.11 a – i); however, some appear to have "eyes" or other anthropomorphic forms that suggest they are bone figurines (see Figure 7.11 j – l). Bone figurines are rare, but they have been found at Five Finger Ridge (Talbot et al. 2000:452–453) and Pharo Village (Marwitt 1968:53). Bone figurines may have been important symbols for the Fremont in ritual practices.

Lastly, worked bone gaming pieces may have served as symbolic objects. Large quantities of preform gaming pieces have been found at both the Parowan Valley sites (Hall 2008:63) and Wolf Village (Robbins 2013; Robbins and Lambert 2016). Wolf Village had a large number (n=232) of preform and expediently made gaming pieces found in the structural fill over Structure 2 (Janetski 2017:136; Robbins 2013). Janetski (2017:136) theorizes that the "expediently made specimens [at Wolf Village] were specifically created to be thrown into the

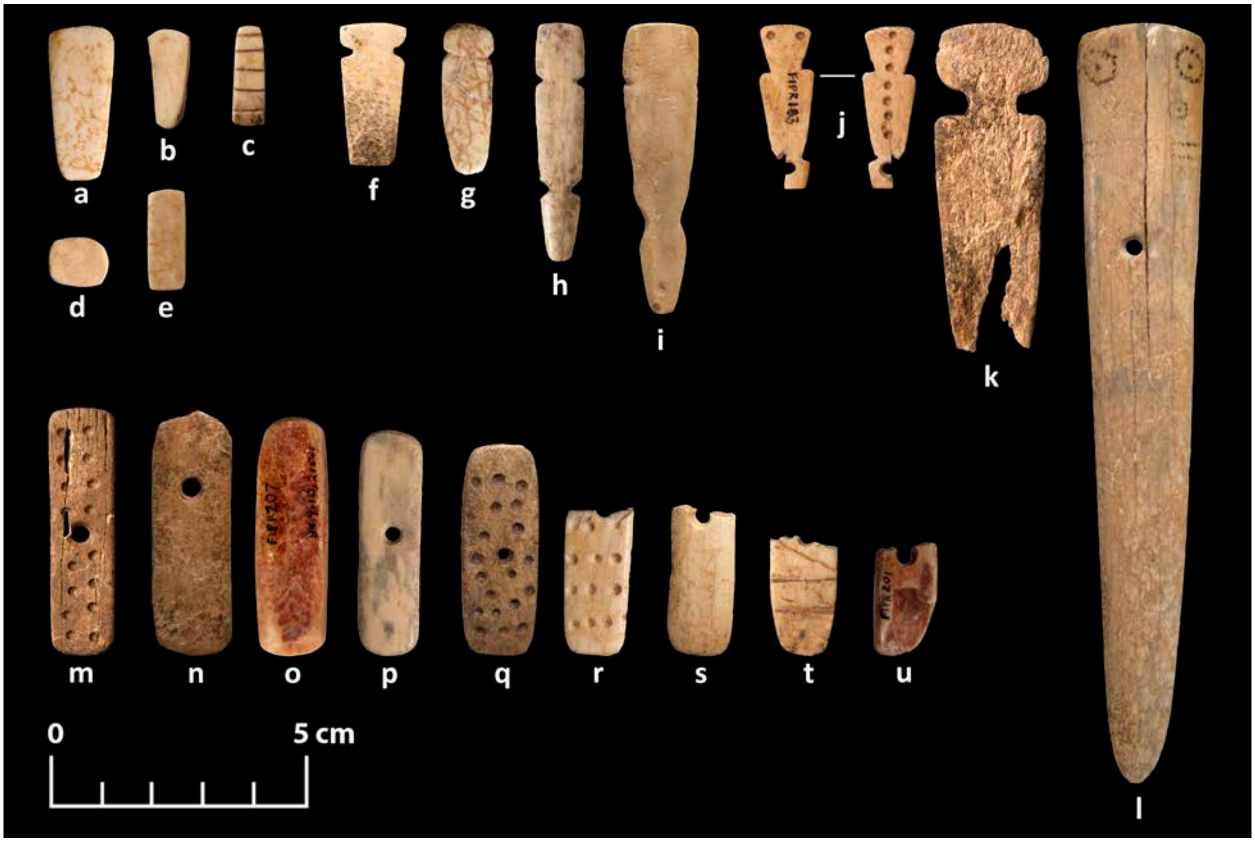

Figure 7.11. An assortment of bone objects from Five Finger Ridge, including bone pendants (a – e), enigmatic bone objects (f – i), bone figurines (j – l), and gaming pieces (m – u). Courtesy of Fremont Indian State Park and Museum.

structure fill as part of … a ritual." It is possible that worked bone gaming pieces were symbols used in Fremont abandonment practices. If true, this is further evidence that low-caloric elements were important to the Fremont despite having a low-caloric value.

FUTURE RESEARCH

Rather than just cautioning against using Binford's MGUI, I suggest a potential supplement to the MGUI. Strontium isotope analysis may be useful for examining transport practices of prehistoric hunters by determining which large game individuals are local to a specific region, though more research with this analysis is needed. Even with strontium isotope analysis, the MGUI is problematic when making assumptions that favor only caloric utility. I suggest that archaeologists also consider the non-caloric utility associated with prehistoric hunting and transport practices.

I have recently obtained further research grant money from the Charles Redd Center at Brigham Young University. I plan to identify the strontium baseline for Five Finger Ridge during the summer of 2018, to compare with data presented in Fisher (2010). I will also test teeth from at least five squirrel individuals from Wolf Village. The $^{87}Sr/^{86}Sr$ ratios obtained from these squirrels could be compared to the strontium baseline for Wolf Village. This would help determine whether the muskrat outlier is truly non-local to Wolf Village, as well as whether muskrat specimens provide different $^{87}Sr/^{86}Sr$ ratios than other non-wetland animals. I plan to present the results of this further strontium isotope analysis in a future publication.

I encourage Fremont researchers to incorporate isotope analyses into future research. Before Fremont archaeologists attempt to track human migrations using strontium isotope analysis, more strontium baselines must be identified at other Fremont sites. David Yoder from Weber State University, Michael Searcy from Brigham Young University, and I will continue to identify strontium baselines from regions around Wolf Village and Utah. During the summer of 2019, we plan on testing teeth from modern rodents to demonstrate whether strontium isotope analysis is a viable research tool in Utah. If regions far from one another share similar strontium baselines, then strontium isotope analysis may not be a viable way to track animal trade and migrations of humans and animals. Strontium isotope analysis may, however, be useful to distinguish local animals and humans from non-local animals and humans.

Lastly, if future funding is available, I suggest that further studies focus on identifying strontium baselines close to Wolf Village. Doing so would help determine whether there is variation in $^{87}Sr/^{86}Sr$ ratios around the site.

CONCLUSION

In all likelihood, the presence of most faunal bones at archaeological sites was primarily due to their role in holding meat. Undoubtedly, meat was important to prehistoric hunters; the Fremont, however, viewed bones as more than just bearers of meat. The MGUI is rarely useful in predicting the function of archaeological sites. The MGUI may be useful to infer site function for small, single use kill sites, but not habitation sites. Examining only one artifact type to determine the function of a habitation site is a shortsighted research method. Habitation sites are generally complex and contain more artifact types to consider than just bones.

I understand the attractiveness of the MGUI models. It is easy to compare skeletal frequencies to numeric values in hopes of understanding prehistoric transport decisions and site function, but I suggest that the complexity of human decisions needs closer attention. The MGUI is not a useful tool to study butchering and transport practices or to study utility in general, at least not without considering the social and economic value of bones. I would be skeptical of any argument that suggests any cultural group only considered the caloric value of large game while hunting and transporting animal portions. I argue that the MGUI should not be used without seriously considering other factors beyond calories. Archaeologists need to assume that past peoples were more complex in their hunting and other food practices, rather than assume that past peoples were calorie counters with no social or other economic influences.

Although the MGUI was designed by Binford (1978) as a means of understanding hunting, processing, and transport patterns, it fails to take into account the non-caloric utility of bones. While some low-caloric elements were likely brought back to habitation sites as "riders" (see Binford 1978), bones were more than just a means of transporting meat for later consumption. The low-caloric elements identified at Wolf Village and other Fremont sites are probably more abundant than high-caloric elements due to the destruction of the high-caloric elements for both food and other economic reasons. Some low-caloric elements were used to construct household items. Hides and sinew were useful for creating perishable artifacts such as moccasins, headdresses, and cordage. Bones were valuable as raw material to create bone objects such as gaming pieces, figurines, pendants, and enigmatic bone objects. In addition, some low-caloric elements were potential ritual objects. Low-caloric elements were a valuable resource that had a number of non-caloric uses for the Fremont.

References

Abo, Stephanie K. Y.

2016 Defining Fremont Abandonment Rituals. Manuscript of file, Department of Anthropology, Brigham Young University, Provo, Utah.

Adovasio, James M.

1975 Fremont Basketry. *Tebiwa* 17(2):67–73.

Aikens, C. Melvin, and David B. Madsen

1986 Prehistory of the Eastern Area. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 149–160. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Allison, James R.

2008 Human Ecology and Social Theory in Utah Archaeology. *Utah Archaeology* 21(1): 57–88.

2010 The End of Farming in the "Northern Periphery" of the Southwest. In *Leaving Mesa Verde: Peril and Change in the Thirteenth-Century Southwest*, edited by Timothy A. Kohler, Mark D. Varien, and Aaron Wright, pp. 128–155. University of Arizona Press, Tucson.

Anderson, Allen E., and Olof C. Wallmo

1984 Odocoileus Hemionus. *Mammalian Species* 219:1–9.

Baker, Colleen, and Joel C. Janetski

2004 Systematic Archaeological Survey Goshen Valley, Utah County, Utah. In *Archaeological Survey and Limited Excavations in Utah Valley*, by Joel C. Janetski, pp. 35–68. Museum of Peoples and Cultures Technical Series No. 04-19. Brigham Young University, Provo, Utah.

Bates, Steven

2000 Preliminary Results from a Radiotelemetry Study of Pronghorn Antelope at Dugway Proving Ground, Utah. *Proceedings of a Biennial Pronghorn Antelope Workshop* 17:42–44.

Bayham, Frank E.
1977 Analysis of Faunal Remains and Animal Exploitation in Copper Basin. In *Archaeology in Copper Basin, Yavapai County, Arizona: Model Building for the Prehistory of the Prescott Region*, edited by Marvin D. Jeter, pp. 339–367. Anthropological Research paper No. 11. Arizona State University, Tempe, Arizona.

Beard, Brian L., and Clark M. Johnson
2000 Strontium Isotope Composition of Skeletal Material Can Determine the Birth Place and Geographic Mobility of Humans and Animals. *Journal of Forensic Sciences* 45(5):1049–1061.

Bennyhoff, James A., and Richard E. Hughes
1987 Shell Bead and Ornament Exchange Networks Between California and the Western Great Basin. *Anthropological Papers of the American Museum of Natural History* 64(2):79–175.
2011 Fremont Period Shell Trade. *Journal of California and Great Basin Anthropology* 31(2):179–185.

Benson, Larry V., Eugene M. Hattori, Howard E. Taylor, Simon R. Poulson, and Ed A. Jolie
2006 Isotope Sourcing of Prehistoric Willow and Tule Textiles Recovered from Western Great Basin Rock Shelters and Caves – Proof of Concept. *Journal of Archaeological Science* 33(11):1588–1599.

Bentley, R. Alexander
2006 Strontium Isotopes from the Earth to the Archaeological Skeleton: A Review. *Journal of Archaeological Method and Theory* 13(3):135–187.

Bentley, R. Alexander, T. Douglas Price, Jens Lüning, Detlef Gronenborn, Joachim Wahl, and Paul D. Fullagar
2002 Human Migration in Early Neolithic Europe. *Current Anthropology* 43:799–804.

Bentley, R. Alexander, T. Douglas Price, and Elisabeth Stephan
2004 Determining the 'Local' ^{87}Sr/^{86}Sr Range for Archaeological Skeletons: A Case Study from Neolithic Europe. *Journal of Archaeological Science* 31:365–375.

Berry, Michael S.
1972 *The Evans Site*. Special Report, Department of Anthropology, University of Utah, Salt Lake City

Bettinger, Robert L.
1993 Doing Great Basin Archaeology Recently: Coping with Variability. *Journal of Archaeological Research* 1(1):43–66.

Binford, Lewis R.
1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

1981 *Bones: Ancient Men and Modern Myths*. Academic Press, Orlando.
1984 *Faunal Remains from the Klasies River Mouth*. Academic Press, Orlando.

Broughton, Jack M.
1999 *Resource Depression and Intensification during the Late Holocene, San Francisco Bay: Evidence for the Emery Shellmound Vertebrate Fauna*. University of California Publications, Anthropological Records Vol. 32. University of California Press, Berkeley.

Broughton, Jack M., Michael D. Cannon, Frank E. Bayham, and David A. Byers
2011 Prey Body Size and Ranking in Zooarchaeology: Theory, Empirical Evidence, and Applications from the Northern Great Basin. *American Antiquity* 76(3):403–428.

Broughton, Jack M., and Shawn D. Miller
2016 *Zooarchaeology & Field Ecology: A Photographic Atlas*. University of Utah Press, Salt Lake City.

Bryce, Joseph A.
2016 An Investigation of the Manufacture and Use of Bone Awls at Wolf Village (42UT273). Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.
2018a Emerging Patterns: Museum Collections in Archaeological Research. Paper presented at the 16th Biennial Southwest Symposium, Denver, Colorado.
2018b Fremont Smoking Pipes: Some Notes on Types and Manufacture. Paper presented at the 2018 Utah Professional Archaeological Council Winter Meeting, Ogden, Utah.

Bunn, Henry T.
1993 Bone Assemblages at Base Camps: A Further Consideration of Carcass Transport and Bone Destruction. In *From Bones to Behavior*, edited by Jean Hudson, pp. 156–168. Center for Archaeological Investigations, Occasional Paper No. 21. Southern Illinois University, Carbondale.

BYU Anthropology
2016 *Archaeology Field School Student Handbook*. Technical Series No. 16-1. Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Canon, Stephen K.
1993 Fawn Survival and Bed-Site Characteristics of Trans-Pecos Pronghorn. Unpublished PhD dissertation, Texas Tech University, Lubbock.

Callaway, Donald, Joel C. Janetski, and Omer C. Stewart
1986 Ute. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 336–367. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Castro, Mariana L. F.
2015 The Symbolic Value of Artifacts: The Case of Marine Shell Beads from Wolf Village, Utah. Unpublished Honors thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Castro, Mariana L. F., and Jerina E. M. Dement
2013 Shell Artifacts from Wolf Village: A Fremont Site in Utah County, Utah. *Utah Archaeology* 26(1):45–64.

Chase, Phillip G.
1985 On the Use of Binford's Utility Indices in the Analysis of Archaeological Sites. In *To Pattern the Past: Symposium Organized by the Commission IV of the International Union of Pre- and Protohistoric Sciences (UISPP), at the University of Amsterdam*, edited by Albertus Voorrips and Susan H. Loving, pp. 287–302. Council of Europe, Strasbourg.
1986 *The Hunters of Combe Grenal: Approaches to Middle Paleolithic Subsistence in Europe*. BAR International Series 286. British Archaeological Reports, Oxford.

Clason, Antje T.
1972 Some Remarks on the Use and Presentation of Archaeozoological Data. *Helinium* 12(2):139–153.

Clemente, Fernando, Raul Valdez, Jerry L. Holechek, Phillip J. Zwank, and Michel Cardenas
1995 Pronghorn Home Range Relative to Permanent Water in Southern New Mexico. *Southwestern Naturalist* 40:38–41.

Cleveland, William S.
1979 Robust Locally Weighted Regression and Smoothing Scatterplots. *Journal of the American Statistical Association* 74(368):829–836.
1981 LOWESS: A Program for Smoothing Scatterplots by Robust Locally Weighted Regression. *The American Statistician* 35(1):54.

Cleveland, William S., and Susan J. Devlin
1988 Locally Weighted Regression: An Approach to Regression Analysis by Locally Fitting. *Journal of the American Statistical Association* 83(403):596–610.

Codding, Brian F., and Douglas W. Bird
2015 Behavioral Ecology and the Future of Archaeological Science. *Journal of Archaeological Science* 56:9–20.

Coltrain, Joan B., and Steven W. Leavitt
2002 Climate and Diet in Fremont Prehistory: Economic Variability and Abandonment of Maize Agriculture in the Great Salt Lake Basin. *American Antiquity* 67(3):453–485.

Connolly, Thomas J., Pat Barker, Catherine S. Fowler, Eugene M. Hattori, Dennis L. Jenkins, and William J. Cannon
2016 Getting Beyond the Point: Textiles of the Terminal Pleistocene/Early Holocene in the Northwestern Great Basin. *American Antiquity* 81(3):490–514.

Cook, Clayton W.
1980 Faunal Analysis from Five Utah Valley Sites: A Test of a Subsistence Model from the Sevier Fremont Area. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Copeland, Sandi R., Matt Sponheimer, Petrus J. le Roux, Vaughan Grimes, Julia A. Lee-Thorp, Darryl J. de Ruiter, and Michael P. Richards
2008 Strontium Isotope Ratios (^{87}Sr/^{86}Sr) of Tooth Enamel: A Comparison of Solution and Laser Ablation Multicollector Inductively Couples Plasma Mass Spectrometry Methods. *Rapid Communications in Mass Spectrometry* 22:3187–3194.

Crandall, Amanda
2017 A Forensic Analysis of Animal Bones from Structure 1, Wolf Village. Senior thesis, manuscript on file, Department of Anthropology, Brigham Young University, Provo, Utah.

Dahle, Wendy C.
2011 Macrobotanical Evidence of Diet and Plant Use at Wolf Village (42UT273), Utah Valley, Utah. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Dalley, Gardiner F.
1970 Worked Bone and Antler. In *Median Village and Fremont Culture Regional Variation*, by John P. Marwitt, pp. 96–127. Anthropological Papers No. 95. University of Utah, Salt Lake City.
1972 Worked Bone and Antler. In *The Evans Site*, edited by Michael Berry, pp. 119–143. Special Report, Department of Anthropology, University of Utah, Salt Lake City.
1976 *Swallow Shelter and Associated Sites*. Anthropological Papers No. 96. University of Utah, Salt Lake City.

David, Bruno
1990 How Was this Bone Burnt? In *Problem Solving in Taphonomy: Archaeological and Palaeontological Studies from Europe, Africa, and Oceania*, Tempus Vol. 2, edited by Su Solomon, Iain Davidson, and Di Watson, pp. 65–79. Anthropology Museum, University of Queensland, St. Lucia, Australia.

d'Azevedo, Warren L.
1986 Washoe. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 466–498. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Dietler, Michael

2001 Theorizing the Feast: Rituals of Consumption, Commensal Politics, and Power in African Contexts. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by Michael Dietler and Brian Hayden, pp. 65–114. Smithsonian Institution Press, Washington, D.C.

Drennan, Robert D.

2009 *Statistics for Archaeologists: A Common Sense Approach*. Second Edition. Springer, New York.

Driver, Jonathan C.

2002 Faunal Variation and Change in the Northern San Juan Region. In *Seeking the Center Place*, edited by Mark D. Varien and Richard H. Wilshusen, pp. 143–160. University of Utah Press, Salt Lake City.

Driver, Jonathan C., and Joshua R. Woiderski

2008 Interpretation of the "Lagomorph Index" in the American Southwest. *Quarternary International* 185:3–11.

Ezzo, Joseph A., Clark M. Johnson, and T. Douglas Price

1997 Analytical Perspective on Prehistoric Migration: A Case Study from East-Central Arizona. *Journal of Archaeological Science* 24:447–466.

Fisher, Jacob L.

2010 Costly Signaling and Chaning Faunal Abundances at Five Finger Ridge, Utah. Unpublished PhD dissertation, Department of Anthropology, University of Washington, Seattle.

2015 Faunal Quantification and the Ascendance of Hunting Debate: Reevaluation of the Data from Southeastern California. *American Antiquity* 80(4):767–775.

Fisher, Jacob L., and Benjamin Valentine

2013 Resource Depression, Climate Change, and Mountain Sheep in the Eastern Great Basin of Western North America. *Archaeological and Anthropological Sciences* 5(2):145–157.

Fowler, Catherine S.

1986 Subsistence. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 64–97. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Fowler, Catherine S., and Sven Liljeblad

1986 Northern Paiute. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 435–465. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Fowler, Don D.
1963 *1961 Excavations: Harris Wash, Utah*. Anthropological Papers No. 64. University of Utah, Salt Lake City.
1986 History of Research. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 15–30. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

France, Diane L.
2009 *Human and Nonhuman Bone Identification: A Color Atlas*. CRC Press, Boca Raton, Florida.

Fry, Gary F., and Gardiner F. Dalley
1979 *The Levee Site and the Knoll Site*. Anthropological Papers No. 100. University of Utah, Salt Lake City.

Gilbert, B. Miles
1990 *Mammalian Osteology*. Second Edition. Missouri Archaeological Society, Columbia.

Gillin, John
1941 *Archaeological Investigations in Central Utah: Joint Expedition of the University of Utah and the Peabody Museum, Harvard University*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts.

Gilsen, Leland
1968 An Archaeological Survey of Goshen Valley, Utah County, Central Utah. Unpublished Master's thesis, Brigham Young University, Provo, Utah.

Grayson, Donald K.
1978 Minimum Numbers and Sample Size in Vertebrate Faunal Analysis. *American Antiquity* 43(1):53–65.
1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Academic Press, New York.
1988 *Danger Cave, Last Supper Cave, and Hanging Rock Shelter: The Faunas*. Anthropological Papers of the American Museum of Natural History, Vol. 66, Pt. 1. New York.
1989 Bone Transport, Bone Destruction, and Reverse Utility Curves. *Journal of Archaeological Science* 16(6):643–652.

Grayson, Donald K., and Michael D. Cannon
1999 Human Paleoecology and Foraging Theory in the Great Basin. In *Models for the Millennium: Great Basin Anthropology Today*, edited by Charlotte Beck, pp. 141–151. University of Utah Press, Salt Lake City.

Grimstead, Deanna N., and Frank E. Bayham

2010 Evolutionary Ecology, Elite Feasting, and the Hohokam: A Case Study from a Southern Arizona Platform Mound. *American Antiquity* 75(4):841–864.

Gunnerson, James H.

1969 *The Fremont Culture: A Study in Culture Dynamics on the Northern Anasazi Frontier*. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 59, No. 2. Harvard University, Cambridge, Massachusetts.

Hall, Molly A.

2008 Parowan Valley Gaming Pieces and Insights into Fremont Social Organization. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

2009 The Distribution of Gaming Pieces Across the Fremont Culture Area with a Focus on the Parowan Valley. *Utah Archaeology* 22(1):31–50.

Heckman, Richard A., Charles Thompson, and David A. White

1981 Fishes of Utah Lake. In *Utah Lake Monographs*, pp. 107–127. Memoirs No. 5. Great Basin Naturalist, Provo, Utah.

Hegmon, Michelle

1995 *The Social Dynamics of Pottery Style in the Early Puebloan Southwest*. Occasional Paper No. 5. Crow Canyon Archaeological Center, Cortez, Colorado.

Herrmann, Robert

2001 Macrobotanical Remains. In *Fremont Site Complexity at Backhoe Village: Results of Discovery Excavations and Data Analysis at the Utah Army National Guard Vehicle Maintenance Facility within Backhoe Village (42SV662) in Richfield, Sevier County, Utah*, edited by Matthew T. Seddon, pp. 141–153. SWCA Archaeological report No. 00-27. Report prepared for Paul Graham, Utah National Guard, Environmental Resource Management.

Hervert, John J., Jill L. Bright, Robert S. Henry, Linden A. Piest, and Mark T. Brown

2005 Home-range and Habitat-Use Patterns of Sonoran Pronghorn in Arizona. *Wildlife Society Bulletin* 33:8–15.

Hildebrandt, William R., and Kelly R. McGuire

2002 The Ascendance of Hunting During the California Middle Archaic: An Evolutionary Perspective. *American Antiquity* 67(2):231–256.

Hockett, Bryan S.

1998 Sociopolitical Meaning of Faunal Remains from Baker Village. *American Antiquity* 63(2):289–302.

Holm, Kevin

2017 Killing a Home: Termination Rituals at Wolf Village Structure 9. Senior thesis, manuscript on file, Department of Anthropology, Brigham Young University, Provo, Utah.

Jacques, Christopher N., Jonathan A. Jenks, and Robert W. Klaver

2009 Seasonal Movements and Home-Range Use by Female Pronghorns in Sagebrush-Steppe Communities of Western South Dakota. *Journal of Mammalogy* 90(2):433–441.

Janetski, Joel C.

1990 Utah Lake: Its Role in the Prehistory of Utah Valley. *Utah Historical Quarterly* 58(1):4–31.

1997a 150 Years of Utah Archaeology. *Utah Historical Quarterly* 65:100–133.

1997b Fremont Hunting and Resource Intensification in the Eastern Great Basin. *Journal of Archaeological Science* 24:1075–1088.

2000 Faunal Remains. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde, pp. 67–81. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo, Utah.

2002 Trade in Fremont Society: Contexts and Contrasts. *Journal of Anthropological Archaeology* 21:344–370.

2004 *Archaeological Survey and Limited Excavations in Utah Valley*. Museum of Peoples and Cultures Technical Series No. 04-19. Brigham Young University, Provo, Utah.

2008 The Enigmatic Fremont. In *The Great Basin: People and Place in Ancient Times*, edited by Catherine S. Fowler and Don D. Fowler, pp. 105–115. School for Advanced Research Press, Santa Fe, New Mexico.

2016 Fremont Occupation of the Utah Valley Uplands: The View from Jay's Place and Kay's Cabin. *Utah Archaeology* 29(1):29–58.

2017 Gaming in Fremont Society. In *Prehistoric Games of North American Indians: Subarctic to Mesoamerica*, edited by Barbara Voorhies, pp. 119–138. University of Utah Press, Salt Lake City.

Janetski, Joel C., and Richard K. Talbot

2000 Project Overview and Context. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde, pp. 1–7. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo, Utah.

2014 Fremont Social Organization: A Southwestern Perspective. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski. University of Utah Press, Salt Lake City.

Janetski, Joel C., Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde

2000 *Clear Creek Canyon Archaeological Project: Results and Synthesis*. Occasional Papers No. 7. Museum of Peoples and Cultures, Brigham Young University, Provo.

Janetski, Joel C., Cady B. Jardine, and Christopher N. Watkins
2011 Interaction and Exchange in Fremont Society. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin*, edited by Richard E. Hughes, pp. 22–54. University of California, Berkley.

Jennings, Jesse D., and Edward Norbeck
1955 Great Basin Prehistory: A Review. *American Antiquity* 21(1):1–11.

Johansson, Lindsay D.
2013 Promontory Culture: The Faunal Evidence. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Johannsson, Lindsay D., Katie K. Richards, and James R. Allison
2014 Wolf Village (42UT273): A Case Study in Fremont Architectural Variability. *Utah Archaeology* 27(1): 33–56.

Jones, Carl H.
1961 An Archaeological Survey of Utah County, Utah. Unpublished Master's thesis, Brigham Young University, Provo, Utah.

Jones, George T., Charlotte Beck, and Donald K. Grayson
1989 Measures of Diversity and Expedient Lithic Technologies. In *Quantifying Diversity in Archaeology*, edited by R. D. Leonard and G. T. Jones, pp. 69–78. Cambridge University Press, Cambridge.

Jones, William A.
1967 Report on the G. M. Hinckley Mound (42UT110). Unpublished manuscript, Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Jones, Kevin T., and Duncan Metcalfe
1988 Bare Bones Archaeology: Bone Marrow Indices and Efficiency. *Journal of Archaeological Science* 15(4):415–423.

Judd, Neil M.
1919 *Archaeological Investigations at Paragonah, Utah*. Smithsonian Miscellaneous Collections, Vol. 70, No. 3. Smithsonian Institution, Washington, D.C.

Julian, Sadie
2017 Evidence for Communal Activity in Structure 8: A Comparative Analysis of Faunal Bone from Three Different Structures at Wolf Village. Senior thesis, manuscript on file, Department of Anthropology, Brigham Young University, Provo, Utah.

Kelly, Robert L.
1995 *The Foraging Spectrum*. Smithsonian Institution Press, Washington, D.C.

Kidder, Alfred V.
1962 *An Introduction to the Study of Southwestern Archaeology*. Yale University Press, New Haven, Connecticut.

Kintigh, Keith W.
1989 Sample Size, Significance, and Measures of Diversity. In *Quantifying Diversity in Archaeology*, edited by R. D. Leonard and G. T. Jones, pp. 25–36. Cambridge University Press, Cambridge.

Kitchen, David W.
1974 Social Behavior and Ecology of the Pronghorn. *Wildlife Monographs* 38:1–96.

Klein, Richard G.
1989 Why Does Skeletal Element Abundance Differ between Smaller and Larger Bovids at Klasies River Mouth and Other Archaeological Sites? *Journal of Archaeological Science* 16:363–381.

Lambert, Spencer F. X., and Joseph A. Bryce
2016 A Comparison of Faunal Use at Residential Structures at Two Fremont Sites in Utah Valley. Paper presented at the 2016 Utah Professional Archaeological Council Winter Meeting, Salt Lake City, Utah.

Lambert, Spencer F. X., Joseph A. Bryce, and Robert J. Bischoff
2016 An Analysis of the Early Occupation of Wolf Village. Paper presented at the 35th Great Basin Anthropological Conference, Reno, Nevada.
2017 Feathered Fauna: A Look at Bird Use among the Fremont. Paper presented at the 82nd Society for American Archaeology Annual Meeting, Vancouver, B.C., Canada.

Lekson, Stephen H.
2014 Thinking about the Fremont: The Later Prehistory of the Great Basin and the Southwest. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski, pp. 109–117. University of Utah Press, Salt Lake City.

Liljeblad, Sven, and Catherine S. Fowler
1986 Owens Valley Paiute. In *Great Basin*, edited by Warren L. d'Azevedo, pp. 412–434. Handbook of North American Indians, Vol. 11, W. C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Loose, Byron, and Darlene Koerner.
1998 42UN1816-Merkley Butte. *Utah Archaeology* 11(1):43–68.

Lowry, Chris
2013 Decorated in Death: Fremont Bone Beads. Senior thesis, manuscript on file, Department of Anthropology, Brigham Young University, Provo, Utah.

Lupo, Karen D.

2001 Archaeological Skeletal Part Profiles and Differential Transport: An Ethnoarchaeological Example from Hadza Bone Assemblages. *Journal of Anthropological Archaeology* 20:361–378.

2006 What Explains the Carcass Field Processing and Transport Decisions of Contemporary Hunter-Gatherers? Measures of Economic Anatomy and Zooarchaeological Skeletal Part Representation. *Journal of Archaeological Method and Theory* 13(1):19–66.

Lupo, Karen D., and Joel C. Janetski

1994 Evidence of Domesticated Dogs and Some Related Canids in the Eastern Great Basin. *Journal of California and Great Basin Anthropology* 16(2):199–220.

Lyman, R. Lee

1984 Bone Density and Differential Survivorship of Fossil Classes. *Journal of Anthropological Archaeology* 3(4):259–299.

1987 Archaeofaunas and Butchery Studies: A Taphonomic Perspective. In *Advances in Archaeological Method and Theory*, edited by Michael B. Schiffer, pp. 249–337. Academic Press, San Diego.

1994 *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

2005 Zooarchaeology. In *Handbook of Archaeological Methods*, edited by Herbert D. G. Maschner and Christopher Chippindale, pp. 835–870. Alta Mira Press, New York City.

Madsen, David B.

1979 The Fremont and the Sevier: Defining Prehistoric Agriculturalists North of the Anasazi. *American Antiquity* 44(4):711–722.

Madsen, David B., and Lar Mar W. Lindsay

1977 *Backhoe Village*. Antiquities Section Selected Papers Vol. IV, No. 12. Utah State Historical Society, Salt Lake City.

Madsen, David B., and Steven R. Simms

1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12(3):255–336.

Magnussen, Steen, and Timothy J. B. Boyle

1995 Estimating Sample Size for Inference about the Shannon-Weaver and the Simpson Indices of Species Diversity. *Forest Ecological Management* 78:71–84.

Maguire, Don

1894 Report of the Department of Ethnology, Utah World's Fair Commission. In *Utah at the World's Columbian Exposition*, by E.A. McDaniel, pp. 105–110. Salt Lake Lithographing, Salt Lake City, Utah.

Malainey, Mary E.
2011 *A Consumer's Guide to Archaeological Science: Analytical Techniques*. Springer Science+Business Media, LLC, New York City.

Marean, Curtis W., and Carol J. Frey
1997 Animal Bones from Caves to Cities: Reverse Utility Curves as Methodological Artifacts. *American Antiquity* 62(4):698–711.

Marwitt, John P.
1968 *Pharo Village*. Anthropological Papers No. 91. University of Utah, Salt Lake City.
1970 *Median Village and Fremont Culture Regional Variation*. Anthropological Papers No. 95. University of Utah, Salt Lake City.

Metcalf, Michael D., Kelly J. Pool, Kae McDonald, and Anne McKibben
1993 *The Round Spring Site, 42SV23*, vol. III. Hogan Pass: Final Report on Archaeological Investigations Along Forest Highway 10 (State Highway 72), Sevier County, Utah. 3 vols. Metcalf Archaeological Consultants Eagle, Colorado. Report prepared for Interagency Archaeological Services, U.S. Department of the Interior, National Park Service, Lakewood, Colorado. Contract No. CX-1200-6-BO52

Metcalfe, Duncan, and Kevin T. Jones
1988 A Reconsideration of Animal Body Part Indices. *American Antiquity* 53(3):486–504.

Miller, George J.
1975 A Study of the Cuts, Grooves, and Other Marks on Recent and Fossil Bone: II Weathering Cracks, Fractures, Splinters, and Other Similar natural Phenomena. In *Lithic Technology*, edited by Earl Swanson, pp. 211–226. Mouton Publishers, The Hague.

Mock, James M.
1971 The Archaeology of Spotten Cave, Utah County, Central Utah. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Mooney, Adrien
2014 A Synthesis of 20th-Century Archaeological Work at Fremont Sites in the Provo River Delta, Utah. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Morss, Noel
1931 *The Ancient Culture of the Fremont River in Utah: Report on the Explorations under the Claflin-Emerson Fund, 1928-29*. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 12, No. 3. Harvard University, Cambridge, Massachusetts.

Museum of Peoples and Cultures
2010 Museum of Peoples and Cultures Handbook for Faunal Analysis. Manuscript on file, Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Newbold, Bradley A.
2009 Paleoindian Lifeways of Paleoarchaic Peoples: A Faunal Analysis of Early Occupations at North Creek Shelter, Utah. Unpublished Master's thesis, Brigham Young University, Provo, Utah.

Noe-Nygaard, Nanna
1975 Bone Injuries Caused by Human Weapons in Mesolithic Denmark. In *Archaeozoological Studies*, edited by A. T. Clason, pp. 151–159. North-Holland Publishing Company, Amsterdam.

Nowak, Ronald M., and Ernest P. Walker
1991 *Walker's Mammals of the World*. 5th ed. John Hopkins University Press, Baltimore, Maryland.

O'Connell, James F., Kristen Hawkes, and N. Blurton Jones
1988 Hadza Hunting, Butchering, and Bone Transport and their Archaeological Implications. *Journal of Anthropological Research* 44:113–161.

O'Connell, James F., Kristen Hawkes, and N. Blurton Jones
1990 Reanalysis of Large Mammal Body Part Transport among the Hadza. *Journal of Archaeological Science* 17(3):301–316.

O'Connell, James F., Kevin T. Jones, and Steven R. Simms
1982 Some Thoughts on Prehistoric Archaeology in the Great Basin. In *Man and Environment in the Great Basin*, edited by David B. Madsen and James F. O'Connell, pp. 227–241. SAA Papers No. 2. Society for American Archaeology, Washington, D.C.

O'Connell, James F., and Brendan Marshall
1989 Analysis of Kangaroo Body Part Transport among the Alyawara of Central Australia. *Journal of Archaeological Science* 16(4):393–405.

Palmer, Edward
1877 A Review of the Published Statements Regarding the Mounds at Payson, Utah, with an Account of their Structure and Origin. *Proceedings of the Davenport Academy of Natural Sciences* 2:167–172.

Parmalee, Paul W.
1980 Utilization of Birds by the Archaic and Fremont Cultural Groups of Utah. *Contributions in Science: Natural History Museum of Los Angeles County* 330:237–250.

Potter, James M.
1997 Communal Ritual and Faunal Remains: An Example from the Dolores Anasazi. *Journal of Field Archaeology* 24(3):353–364.
2000 Pots, Parties, and Politics: Communal Feasting in the American Southwest. *American Antiquity* 65(3):471–492.

Price, T. Douglas, Jennifer Blitz, James H. Burton, and Joseph A. Ezzo
1992 Diagenesis in Prehistoric Bone: Problems and Solutions. *Journal of Archaeological Science* 19:513–529.

Price, T. Douglas, Linda Manzanilla, and William D. Middleton
2000 Residential Mobility at Teotihuacan: A Preliminary Study using Strontium Isotopes. *Journal of Archaeological Science* 27:903–914.

Price, T. Douglas, James H. Burton, and R. Alexander Bentley
2002 The Characterization of Biologically Available Strontium Isotope Ratios for the Study of Prehistoric Migration. *Archaeometry* 44(1):117–135.

Price, T. Douglas, and Hildur Gestsdóttir
2006 The First Settlers of Iceland: An Isotopic Approach to Colonisation. *Antiquity* 80:130–144.

Prichett, Clyde L., Herbert H. Frost, and Wilmer W. Tanner
1981 Terrestrial Vertebrates in the Environs of Utah Lake. In *Utah Lake Monographs*, pp. 125–169. Memoirs No. 5. Great Basin Naturalist, Provo, Utah.

Pyper, Laura M.
2011 Geochemical Analysis of Ancient Fremont Activity Areas at Wolf Village, Utah. Unpublished Master's thesis, Department of Plant and Wildlife Sciences, Brigham Young University, Provo, Utah.

Reitz, Elizabeth, and Elizabeth Wing
2008 *Zooarchaeology*. 2nd Edition. Cambridge University Press, Cambridge.

Renfrew, Colin
1977 Alternative Models for Exchange and Spatial Distribution. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp. 71–90. Academic Press, New York City.

Richards, Katie K.
2014 Fremont Ceramic Designs and Their Implications. Unpublished Master's thesis, Brigham Young University, Provo, Utah.

Richards, Katie K., James R. Allison, Lindsay D. Johansson, Richard K. Talbot, and Scott M. Ure

2018 Houses, Public Architecture, and the Organization of Fremont Communities. In *Communities and Households in the Greater Southwest: New Perspectives and Case Studies*, edited by Robert Stokes. University Press of Colorado, Boulder. In Press.

Richens, Lane D.

1983 Woodard Mound: Excavations at a Fremont Site in Goshen Valley, Utah County, Utah 1980-1981. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

2000 Ceramics. In *Clear Creek Canyon Archaeological Project: Results and Synthesis*, edited by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde, pp. 47–65. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo, Utah.

Robbins, Brady L.

2013 Rejects, Refuse, and Ritual: The Life History of Fremont Worked Bone Gaming Pieces. Senior thesis, manuscript on file, Department of Anthropology, Brigham Young University, Provo, Utah.

Robbins, Brady L., and Spencer F. X. Lambert

2016 Rejects, Refuse, and Ritual: The Life History of Fremont Worked Bone Gaming Pieces. Paper presented at the 35th Great Basin Anthropological Conference, Reno, Nevada.

Rood, Ronald J., and Virginia Butler

1993 Round Springs Faunal Remains. In *The Round Spring Site, 42SV23*, vol. III. Hogan Pass: Final Report on Archaeological Investigations Along Forest Highway 10 (State Highway 72), Sevier County, Utah, edited by Michael D. Metcalf, Kelley J. Pool, Kae McDonald, and Anne McKibbin, pp. 165–192. 3 vols. Metcalf Archaeological Consultants Eagle, Colorado. Report prepared for Interagency Archaeological Services, U.S. Department of the Interior, National Park Service, Lakewood, Colorado. Contract No. CX-1200-6-BO52.

Rood, Ronald J., and Kae McDonald

1993 Round Spring Modified Bone, Antler, and Shell. In *The Round Spring Site, 42SV23*, vol. III. Hogan Pass: Final Report on Archaeological Investigations Along Forest Highway 10 (State Highway 72), Sevier County, Utah, edited by Michael D. Metcalf, Kelley J. Pool, Kae McDonald, and Anne McKibbin, pp. 77–91. 3 vols. Metcalf Archaeological Consultants Eagle, Colorado. Report prepared for Interagency Archaeological Services, U.S. Department of the Interior, National Park Service, Lakewood, Colorado. Contract No. CX-1200-6-BO52.

Rudy, Jack R.
1953 *Archaeological Survey of Western Utah*. Anthropological Papers No. 12. University of Utah, Salt Lake City.

Schaafsma, Polly
1971 *The Rock Art of Utah: A Study from the Donald Scott Collection*. Harvard University Papers No. 65. Peabody Museum of American Archaeology and Ethnology, Cambridge, Massachusetts.
2014 Rock Art's Century and More: Encounters in the Great Basin and the Northern Southwest. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski, pp. 163–176. University of Utah Press, Salt Lake City.

Schiffer, Michael B.
1987 *Formation Processes of the Archaeological Record*. University of New Mexico Press, Albuquerque.

Schmidt, Kari M.
1999 The Five Feature Sites (AZ CC:7:55[ASM]): Evidence for a Prehistoric Rabbit Drive in Southeastern Arizona. *Kiva* 65(2):103–124.

Searcy, Michael T., and Richard K. Talbot
2016 Late Fremont Cultural Identities and Borderland Processes. In *Late Holocene Research on Foragers and Farmers in the Desert West*, edited by Barbara J. Roth and Maxine E. McBrinn, pp. 234–264. University of Utah Press, Salt Lake City.

Shackleton, David M.
1985 Ovis Canadensis. *Mammalian Species* 219:1–9.

Shannon, Claude E., and Warren E. Weaver
1949 *The Mathematical Theory of Communication*. University of Illinois Press, Urbana.

Sharp, Nancy D.
1989 Redefining Fremont Subsistence. *Utah Archaeology* 1989 2(1):19–31.
1992 Fremont Farmers and Hunters: Faunal Resource Exploitation at Nawthis Village, Central Utah. Unpublished Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Shennan, Stephen
2012 Darwinian Cultural Evolution. In *Archaeological Theory Today*, edited by Ian Hodder, pp. 15–36. Second edition. Polity Press, Cambridge.

Shields, Wayne F.

1967 1966 Excavations: Uinta Basin. In *Miscellaneous Collected Papers 15-18*, edited by Jesse Jennings, pp. 1–31. Anthropological Papers No. 89. University of Utah, Salt Lake City.

Sillen, Alain, and Judith C. Sealy

1995 Diagenesis of Strontium in Fossil Bone: A Reconsideration of Nelson et al. (1986). *Journal of Archaeological Science* 22:313–320.

Simms, Steven R.

1986 New Evidence for Fremont Adaptive Diversity. *Journal of California and Great Basin Anthropology* 8(2):204–206.

2008 *Ancient Peoples of the Great Basin & Colorado Plateau*. Left Coast Press, Walnut Creek, California.

Sommer, Caitlin A.

2013 Animacy, Symbolism, and Feathers from Mantle's Cave, Colorado. Unpublished Master's thesis, Department of Anthropology, University of Colorado, Denver.

Stauffer, Sara E.

2012 Parowan Fremont Faunal Exploitation: Resource Depression or Feasting? Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Stauffer, Sara E., and Lindsay D. Johansson

2016 Where's the Party? An Investigation of Communal Feasting Among the Fremont. Paper presented at the 81st Society for American Archaeology Annual Meeting, Orlando, Florida.

Steward, Julian H.

1933 *Archaeological Problems of the Northern Periphery of the Southwest*. Museum of Northern Arizona Bulletin No. 5. Northern Arizona Society of Science and Art, Flagstaff.

1941 *Culture Element Distributions XIII: Nevada Shoshoni*. Anthropological Records Vol. 4, No. 2. University of California, Berkeley.

Stewart, Omer C.

1942 *Culture Element Distributions XVIII: Ute-Southern Paiute*. Anthropological Records Vol. 6, No. 4. University of California, Berkeley.

Stiner, Mary C.

1991 Food Procurement and Transport by Human and Non-Human Predators. *Journal of Archaeological Science* 18(4):455–482.

Stuart, Mark E.

2016 Fallen Rocks Shelter and Associated Sites: A Fremont Hunting Complex in the Wasatch Mountain Foothills Weber County, Utah. *Utah Archaeology* 29(1):127–148.

Talbot, Richard K.

2000a Fremont Farmers: The Search for Context. In *The Archaeology of Regional Interaction: Religion, Warfare, and Exchange across the American Southwest and Beyond*, edited by Michelle Hegmon, pp. 275–293. University Press of Colorado, Boulder.

2000b Fremont Architecture. In *Clear Creek Canyon Archaeological Project: Results and Synthesis*, edited by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde, pp. 131–184. Museum of Peoples and Cultures Occasional Papers No. 7. Provo, Utah.

Talbot, Richard K., Lane D. Richens, James D. Wilde, Joel C. Janetski, and Deborah E. Newman

2000 *Excavations at Five Finger Ridge, Clear Creek Canyon, Central Utah*. Occasional Papers No. 5. Museum of Peoples and Cultures, Brigham Young University, Provo.

Taylor, Dee C.

1957 *Two Fremont Sites and Their Position in Southwestern Prehistory*. Anthropological Papers No. 29. University of Utah, Salt Lake City.

Thomas, David H.

1969 Great Basin Hunting Patterns: A Quantitative Method for treating Faunal Remains. *American Antiquity* 34(4):392–401.

Thomas, David H., and Deborah Mayer

1983 Behavioral Faunal Analysis of Selected Horizons. In *The Archaeology of Monitor Valley 2. Gatecliff Shelter*, edited by David H. Thomas, pp. 353–380. Anthropological Papers Vol. 59, Pt. 1. American Museum of Natural History, New York City.

Thornton, Erin K.

2011 Reconstructing Ancient Maya Animal Trade through Strontium Isotope (^{87}Sr/^{86}Sr) Analysis. *Journal of Archaeological Science* 38:3254–3263.

Todd, Lawrence C.

1993 Body Parts, Butchery, and Postdepositional Processes at Round Spring: Formation Analysis of Body Size III (Brain) Bovids. In *The Round Spring Site, 42SV23*, vol. III. Hogan Pass: Final Report on Archaeological Investigations Along Forest Highway 10 (State Highway 72), Sevier County, Utah, edited by Michael D. Metcalf, Kelley J. Pool, Kae McDonald, and Anne McKibbin, pp. 165–192. Report prepared for Interagency Archaeological Services, U.S. Department of the Interior, National Park Service, Lakewood, Colorado. Contract No. CX-1200-6-BO52.

Ure, Scott M.
2009 The Social Side of Subsistence: Examining Food Choice at the Seamons Mound Site (42UT271) using Sociocultural Perspectives. *Utah Archaeology* 22(1): 75–100.
2013 Parowan Valley Potting Communities: Examining Technological Style in Fremont Snake Valley Corrugated Pottery. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Ure, Scott M., and Sara E. Stauffer
2010 The Function of the Central Structure in Fremont Community Organization. Paper presented at the 32nd Great Basin Anthropological Conference, Layton, Utah.

Valdez, Raul, and Paul R. Krausman
1999 Description, Distribution, and Abundance of Mountain Sheep in North America. In *Mountain Sheep of North America*, edited by Raul Valdez and Paul R. Krausman, pp. 3–22. University of Arizona Press, Tucson.

Valentine, Benjamin, George D. Kamenov, John Krigbaum
2008 Reconstructing Neolithic Groups in Sarawak, Malaysia through Lead and Strontium Isotope Analysis. *Journal of Archaeological Science* 35:1463–1473.

VanDerwarker, Amber M.
1999 Feasting and Status at the Toqua Site. *Southeastern Archaeology* 18(1):24–34.

Watkins, Christopher N.
2006 Parowan Pottery and Fremont Complexity: Late Formative Ceramic Production and Exchange. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo, Utah.
2009 Type, Series, and Ware: Characterizing Variability in Fremont Ceramic Temper. *Journal of California and Great Basin Anthropology* 29(2):145–161.
2016 The Fremont Bird Cult. In *Dr. J's Legacy: Papers in Honor of Joel C. Janetski*, edited by Richard K. Talbot, James R. Allison, and Charmaine Thompson. In Preparation.

White, Theodore E.
1953 Observations on the Butchering Technique of Some Aboriginal Peoples No. 2. *American Antiquity* 19(2):160–164.

Willner, Gale R., George A. Feldhamer, Elizabeth E. Zucker, and Joseph A. Chapman
1980 Ondatra Zibethicus. *Mammalian Species* 141:1–8.

Wilson, Charles H.
2013 Artifacts and Architecture of Structure 6, Wolf Village, Goshen, Utah. Unpublished Honors thesis, Department of Anthropology, Brigham Young University, Provo, Utah.

Wormington, H. Marie
1955 *A Reappraisal of the Fremont Culture with a Summary of the Archaeology of the Northern Periphery*. Proceedings, No. 1. Denver Museum of Natural History. Denver, Colorado.

Yoder, David T.
2016 Gazing Back at You: Fremont Figurines. *Archaeology Southwest* 29(4):10–11.

Appendix A:

Descriptive Summary of the Wolf Village Faunal Material

PERIOD I (A.D. 650 – 800)

Class: Mammalia—Mammals

Unidentified Order:

Unidentified Mammals:
Material: 4 flat bones, 11 long bones, 866 unidentified fragments; **881 specimens**
Large Mammal:
Material: 3 cranial fragments, 1 femur, 181 flat bones, 17 long bones, 1 tibia, 3 tooth fragments, 14 unidentified fragments; **220 specimens**
Medium Mammal:
Material: 3 long bones; **3 specimens**
Small Mammal:
Material: 1 atlas fragment, 1 caudal fragment, 5 claws, 9 cranial fragments, 1 femur, 226 flat bones, 1 humerus, 279 long bones, 3 mandibles, 3 pelvises, 1 phalanx, 2 radii, 11 ribs, 4 scapulae, 1 thoracic vertebra, 8 tibias, 2 teeth, 4 vertebrae fragments, 14 unidentified fragments; **576 specimens**

Order: Artiodactyla—Even Toed Ungulates

Small Artiodactyl:
Material: 3 carpals, 8 cranial fragments, 11 femurs, 13 flat bones, 2 humeri, 6 incisor fragments, 272 long bones, 5 mandibles, 3 metacarpals, 5 metatarsals, 33 molar fragments, 3 pelvises, 1 phalanges, 11 radii, 18 ribs, 6 scapulae, 5 sesamoids, 1 tarsal, 1 thoracic vertebra, 30 tibias, 165 tooth fragments, 1 ulna, 1 vertebra; **604 specimens**

Family: Antilocapridae—antelope
Species: *Antilocapra americana*—pronghorn
Material: 2 calcaneus, 5 molar fragments, 1 tibia, 1 tooth fragment; **9 specimens**
Species: cf. *Antilocapra americana*—possible pronghorn
Material: 2 ribs; **2 specimens**

Family: Cervidae—elk and deer
Species: *Odocoileus hemionus*—mule deer
Material: 1 calcaneus, 1 carpal, 1 humerus, 8 incisors, 1 lumbar vertebra, 1 malar, 4 mandibles, 2 metacarpals, 2 metatarsals, 21 molar fragments, 1 occipital, 1 pelvis, 1 phalanx, 1 second phalanx, 3 radii, 2 ribs, 4 tarsals, 14 tooth fragments, 3 ulnae; **72 specimens**
Species: cf. *Odocoileus hemionus*—possible mule deer
Material: 1 carpal, 1 lateral metapodial, 1 maxilla, 1 metacarpal, 5 ribs, 2 scapulae, 2 tibias, 1 ulna; **14 specimens**

Family: Bovidae—cattle, bison, sheep, and goats
Species: *Ovis canadensis*—bighorn sheep
Material: 7 molar fragments, 1 third phalanx, 1 tibia; **9 specimens**
Species: cf. *Ovis canadensis*—possible bighorn sheep
Material: 1 costal, 1 rib, 1 scapula; **3 specimens**

<u>Order: Lagomorpha—Hares, Pikas, and Rabbits</u>

<u>Family:</u> Leporidae—hares and rabbits

Unidentified Species:

  Material: 8 long bones; **8 specimens**

Species: *Lepus townsendi*—white tailed jackrabbit

  Material: 1 rib, 1 scapula, 1 thoracic vertebra; **3 specimens**

Species: cf. *Lepus townsendi*—possible white tailed jackrabbits

  Material: 1 femur; **1 specimen**

Species: *Sylvilagus audubonii*—desert cottontail

  Material: 2 claws, 1 lacrimal, 1 mandible, 1 phalanx; **5 specimens**

Species: cf. *Sylvilagus audubonii*—possible desert cottontail

  Material: 1 scapula; **1 specimen**

<u>Order: Rodentia—Rodents</u>

Unidentified Rodent:

  Material: 2 femurs, 1 humerus, 2 long bones, 1 tibia; **6 specimens**

<u>Family:</u> Sciuridae—chipmunks and squirrels

Species: *Spermophilus armatus*—Uinta ground squirrel

  Material: 1 humerus, 2 radii; **3 specimens**

Species: cf. *Spermophilus armatus*—possible Uinta ground squirrel

  Material: 1 ulna; **1 specimen**

Species: cf. *Spermophilus variegatus*—possible rock squirrel

  Material: 1 humerus; **1 specimen**

Species: *Spermophilus* sp.—squirrel

  Material: 2 mandibles, 1 tibia, 1 thoracic vertebra; **4 specimens**

Species: *Marmota* sp.—large squirrels

  Material: 1 tibia; **1 specimen**

<u>Family:</u> Cricetidae—rats, mice, and voles

Species: cf. *Ondatra zibethicus*—muskrat

  Material: 2 ribs, 1 phalanx; **3 specimens**

Species: *Neotoma cinerea*—bushy-tailed woodrat

  Material: 1 fibula, 1 humerus, 1 scapula; **3 specimens**

Species: cf. *Neotoma cinerea*—possible bushy-tailed woodrat

  Material: 1 humerus; **1 specimen**

<u>Family:</u> Geomyidae—gophers

Species: *Thomomys bottae*—Botta's pocket gopher

  Material: 1 tibia; **1 specimen**

Class: Aves—Birds

<u>Unidentified Order:</u>

Large Bird:

  Material: 1 cranial fragment, 1 femur, 2 furculae, 5 humeri, 18 long bone fragments, 1 rib, 1 scapula, 4 tibias, 1 ulna; **34 specimens**

Medium Bird:
  Material: 6 long bones; **6 specimens**
Small Bird:
  Material: 3 humeri, 1 long bone; **4 specimens**

Order: Anseriformes—Waterfowl
Family: Anatidae—mallard and swan
Medium Anatidae:
  Material: 1 long bone; **1 specimen**
Species: *Anas platyrhynchos*—mallard
  Material: 1 humerus; **1 specimen**
Species: *Cygnus* sp.—swan
  Material: 1 carpal, 4 coracoids, 2 femurs, 2 furculae, 7 humeri, 2 occipitals, 1 radius, 9 vertebrae; **28 specimens**
Species: cf. *Cygnus* sp.—possible swan
  Material: 1 radius; **1 specimen**

Class: Actinopterygii—Ray-finned fishes

Unidentified Order:
Unidentified Fish:
  Material: 1 opercular, 1 parasphenoid, 13 ribs, 1 sphenotic, 1 vertebra; **17 specimens**

Order: Cypriniformes—Suckers and Minnows
Family: Catostomidae—suckers
Species: *Catostomus ardens*—Utah sucker
  Material: 1 parasphenoid; **1 specimen**

Family: Cyprinidae—chubs
Species: *Gila atraria*—Utah chub
  Material: 1 pelvic girdle, 3 pharyngeals, 1 tooth; **5 specimens**

PERIOD II (A.D. 1000 – 1150)

Class: Mammalia—Mammals

Unidentified Order:

Unidentified Mammals:

Material: 10 cranial fragments, 413 flat bones, 10 long bones, 3 ribs, 8 tooth fragments, 12,509 unidentified fragments; **12,953 specimens**

Large Mammal:

Material: 2 carpals, 14 cranial fragments, 1,366 flat bones, 27 incisors, 996 long bones, 7 mandibles, 1 pelvis, 1 phalanx, 9 ribs, 40 tooth fragments, 2 vertebrae, 3,501 unidentified fragments; **5,966 specimens**

Medium Mammal:

Material: 1 carpal, 1 cervical vertebra, 10 cranial fragments, 2 femurs, 67 flat bones, 1 humeri, 2 incisors, 183 long bones, 1 maxilla fragment, 1 metapodial, 1 metatarsal, 1 pelvis, 4 phalanges, 2 first phalanges, 1 second phalanx, 1 third phalanx, 1 radius, 61 ribs, 1 scapula, 2 tibias, 4 tooth fragments, 1 ulna, 5 vertebrae, 8 unidentified fragments; **362 specimens**

Small Mammal:

Material: 1 calcaneus, 3 caudal fragments, 3 cervical vertebrae, 4 claws, 172 cranial fragments, 1 episternum, 10 femurs, 1 fibula, 1,195 flat bones, 6 humeri, 143 incisors, 3,011 long bones, 2 lumbar vertebrae, 20 mandibles, 5 maxilla fragments, 8 metapodials, 1 molar, 10 pelvises, 42 phalanges, 2 first phalanges, 7 second phalanges, 9 third phalanges, 4 radii, 343 ribs, 4 sacra, 18 scapulae, 5 tarsals, 27 tibias, 200 tooth fragments, 1 tympanic bulla, 3 ulnae, 46 vertebrae, 1 zygomatic, 312 unidentified fragments; **5,620 specimens**

Order: Artiodactyla—Even Toed Ungulates

Large Artiodactyl:

Material: 12 long bones, 2 pelvises, 1 rib, 1 tibia, 1 vertebra; **17 specimens**

Small Artiodactyl:

Material: 4 antler fragments, 1 astragalus, 10 calcanei, 16 carpals, 31 cervical vertebrae, 17 costals, 113 cranial fragments, 1 episternum, 165 femurs, 1,563 flat bones, 100 humeri, 6 hyoids, 7 incisors, 6,145 long bones, 33 lumbar vertebrae, 86 mandibles, 5 maxilla fragments, 144 metacarpals, 128 metapodials, 139 metatarsals, 7 molars, 2 nasals, 2 patellae, 86 pelvises, 78 phalanges, 21 first phalanges, 19 second phalanges, 8 third phalanges, 98 radii, 684 ribs, 92 scapulae, 44 sesamoids, 1 sternum, 32 tarsals, 55 thoracic vertebrae, 211 tibias, 296 tooth fragments, 18 ulnae, 168 vertebrae, 229 unidentified fragments; **10,865 specimens**

Family: Antilocapridae—antelope

Species: *Antilocapra americana*—pronghorn

Material: 8 astragali, 10 calcanei, 2 carpals, 5 femurs, 8 humeri, 9 mandibles, 19 metacarpals, 1 metapodial, 14 metatarsals, 14 molars, 10 pelvises, 16 first phalanxes, 19 second phalanges, 11 third phalanges, 1 radius, 2 ribs, 2 scapulae, 2 tarsals, 5 thoracic vertebrae, 11 tibias, 13 tooth fragments, 7 ulnae; **188 specimens**

Species: cf. *Antilocapra americana*—possible pronghorn

Material: 2 femurs, 1 humeri, 3 lumbar vertebrae, 3 metatarsals, 1 phalanx, 2 second phalanges, 1 scapulae, 1 tibia; **14 specimens**

Family: Cervidae—elk and deer

Species: *Odocoileus hemionus*—mule deer

Material: 25 antler fragments, 15 astragali, 26 calcanei, 3 carpals, 6 cervical vertebrae, 10 cranial fragments, 16 femurs, 29 humeri, 4 hyoids, 1 incisor, 7 lumbar vertebrae, 1 malar, 92 mandibles, 32 maxilla fragments, 45 metacarpals, 3 metapodials, 70 metatarsals, 69 molar fragments, 2 occipitals, 1 patella, 25 pelvises, 2 phalanges, 36 first phalanges, 50 second phalanges, 54 third phalanges, 3 premolars, 35 radii, 23 ribs, 24 scapulae, 2 sesamoids, 18 tarsals, 11 thoracic vertebrae, 27 tibias, 41 tooth fragments, 1 tympanic bulla, 23 ulnae, 2 vertebrae; **834 specimens**

Species: cf. *Odocoileus hemionus*—possible mule deer

Material: 8 antler fragments, 1 calcaneus, 1 carpal, 1 cervical vertebra, 1 cranial fragment, 4 femurs, 1 flat bone, 3 humeri, 1 incisor, 1 mandible, 2 metacarpals, 3 metapodials, 5 metatarsals, 4 pelvises, 2 phalanges, 3 first phalanges, 3 second phalanges, 1 third phalanx, 2 radii, 1 rib, 4 scapulae, 4 tarsals, 3 thoracic vertebrae, 3 tibias, 1 tooth fragment, 2 ulnae, 1 vertebra; **66 specimens**

Family: Bovidae—cattle, bison, sheep, and goats

Species: *Ovis canadensis*—bighorn sheep

Material: 1 horn fragment, 8 astragali, 1 axis, 8 calcanei, 2 carpals, 7 cervical vertebrae, 3 cranial fragments, 7 femurs, 20 humeri, 2 lumbar vertebrae, 12 mandibles, 1 maxilla fragment, 8 metacarpals, 1 metapodial, 15 metatarsals, 12 molars, 1 occipital, 7 pelvises, 2 phalanges, 16 first phalanges, 8 second phalanges, 14 third phalanges, 15 radii, 3 ribs, 3 scapulae, 2 tarsals, 3 thoracic vertebrae, 17 tibias, 12 tooth fragments, 2 ulnae; **213 specimens**

Species: cf. *Ovis canadensis*—possible bighorn sheep

Material: 3 femurs, 2 humeri, 1 metacarpal, 3 metatarsals, 1 first phalanx, 1 second phalanx, 1 radius, 4 ribs, 1 scapula, 1 thoracic vertebra, 2 tibias, 1 tooth fragment; **21 specimens**

Species: *Bison bison*—bison

Material: 1 astragalus, 1 atlas, 1 cervical vertebra, 1 humerus; **4 specimens**

Order: Carnivora—Carnivores

Family: Canidae—dogs

Unidentified Species:

Material: 1 canine, 1 cranial fragment, 1 incisor, 1 long bone; **2 specimens**

Species: *Canis latrans*—coyote

Material: 1 humerus, 1 phalanx, 1 vertebra; **3 specimens**

Species: cf. *Canis latrans*—coyote

Material: 1 metapodial, 1 second phalanx; **2 specimens**

Species: *Canis* sp.—canines

Material: 1 cervical vertebra, 2 femurs, 1 mandible, 3 phalanges, 2 ribs, 2 scapulae, 1 tooth; **12 specimens**

Family: Procyonidae—small carnivores

Species: cf. *Procyon lotor*—common raccoon

Material: 1 humerus, 1 mandible, 1 scapula; **3 specimens**

Order: Lagomorpha—Hares, Pikas, and Rabbits

Family: Leporidae—hares and rabbits

Unidentified Species:

Material: 1 calcaneus, 1 caudal vertebra, 1 cranial fragment, 2 femurs, 5 humeri, 128 long bones, 1 lumbar vertebra, 1 metacarpal, 5 metapodials, 5 metatarsals, 16 phalanges, 4 first phalanges, 2 second phalanges, 1 third phalanx, 1 radius, 43 ribs, 6 tibias, 3 teeth, 6 vertebrae; **234 specimens**

Species: *Lepus californicus*—black tailed jackrabbit

Material: 4 calcanei, 2 cranial fragments, 6 femurs, 6 humeri, 2 lumbar vertebrae, 1 mandible, 1 maxilla, 1 metapodial, 4 metatarsals, 1 molar, 4 pelvises, 3 phalanges, 2 first phalanges, 4 radii, 2 ribs, 1 scapula, 1 sesamoid, 1 sternabra, 6 tibias, 4 ulnae; **57 specimens**

Species: cf. *Lepus californicus*—possible black tailed jackrabbit

Material: 1 mandible, 2 ribs; **3 specimens**

Species: *Lepus townsendi*—white tailed jackrabbit

Material: 1 astragalus, 5 calcanei, 1 cranial fragment, 7 femurs, 14 humeri, 5 lumbar vertebrae, 1 fifth lumbar vertebra, 7 mandibles, 1 maxilla, 2 metacarpals, 1 metapodial, 11 metatarsals, 7 pelvises, 2 phalanges, 1 first phalanx, 1 third phalanx, 20 radii, 6 ribs, 10 scapulae, 1 sternabra, 4 tarsals, 2 thoracic vertebrae, 12 tibias, 1 tooth, 15 ulnae, 1 vertebra; **139 specimens**

Species: cf. *Lepus townsendi*—possible white tailed jackrabbit

Material: 1 humerus, 2 tibias; **3 specimens**

Species: *Lepus* sp.—jackrabbit

Material: 4 astragali, 1 atlas, 16 calcanei, 4 cervical vertebrae, 3 cranial fragments, 37 femurs, 39 humeri, 23 long bones, 7 lumbar vertebrae, 6 mandibles, 4 maxillae, 8 metacarpals, 17 metapodials, 18 metatarsals, 15 pelvises, 27 phalanges, 16 first phalanges, 9 second phalanges, 1 third phalanx, 37 radii, 137 ribs, 21 scapulae, 5 sternums, 8 tarsals, 3 thoracic vertebrae, 43 tibias, 5 teeth, 12 ulnae, 41 vertebrae; **567 specimens**

Species: *Sylvilagus audubonii*—desert cottontail

Material: 2 atlases, 13 calcanei, 13 cervical vertebrae, 9 cranial fragments, 31 femurs, 1 fibula, 1 frontal, 30 humeri, 10 lumbar vertebrae, 1 malar, 35 mandibles, 3 maxillae, 31 metacarpals, 23 metapodials, 58 metatarsals, 38 pelvises, 29 phalanges, 26 first phalanges, 18 second phalanges, 6 third phalanges, 1 premaxilla, 23 radii, 101 ribs, 1 sacrum, 46 scapulae, 9 tarsals, 9 thoracic vertebrae, 42 tibias, 5 teeth, 1 tympanic bulla, 20 ulnae, 16 vertebrae; **652 specimens**

Species: cf. *Sylvilagus audubonii*—possible desert cottontail

Material: 1 calcaneus, 1 femur, 1 mandible, 1 metatarsal, 1 pelvis, 2 phalanges, 1 second phalanx, 10 ribs, 1 scapula, 1 tibia, 2 teeth; **22 specimens**

Species: *Sylvilagus* sp.—cottontail

Material: 3 astragali, 1 axis, 4 calcanei, 2 cervical vertebrae, 10 femurs, 1 frontal, 10 humeri, 1 long bone, 3 lumbar vertebrae, 2 malars, 10 mandibles, 33 metacarpals, 32 metapodials, 20 metatarsals, 5 pelvises, 24 phalanges, 16 first phalanx, 4 second phalanx, 11 radii, 54 ribs, 18 scapulae, 2 tarsals, 20 tibias, 1 tympanic bulla, 13 ulnae, 5 vertebrae; **305 specimens**

Species: cf. *Sylvilagus* sp.—possible cottontail

Material: 1 rib; **1 specimen**

<u>Order: Rodentia—Rodents</u>

Unidentified Rodent:

Material: 1 atlas, 1 axis, 1 calcaneus, 1 caudal vertebra, 8 cervical vertebrae, 3 claws, 68 cranial fragments, 27 femurs, 37 flat bones, 24 humeri, 53 incisors, 123 long bones, 1 lumbar vertebra, 52 mandibles, 8 maxillae, 6 metapodials, 7 metatarsals, 14 pelvises, 4 phalanges, 3 second phalanges, 2 third phalanges, 7 radii, 62 ribs, 8 scapulae, 1 sternum, 2 tarsals, 3 thoracic vertebrae, 30 tibias, 82 teeth, 12 ulnae, 40 vertebrae, 2 unidentified fragments; **692 specimens**

<u>Family:</u> Castoridae—beavers

Species: *Castor* sp.—beaver

Material: 1 long bone, 1 ulna; **2 specimens**

<u>Family:</u> Erethizontidae—porcupines

Species: *Erethizon dorsatum*—North American porcupine

Material: 1 mandible, 1 tooth; **2 specimens**

Species: cf. *Erethizon dorsatum*—possible North American porcupine

Material: 1 tibia; **1 specimen**

<u>Family:</u> Sciuridae—chipmunks and squirrels

Unidentified Species:

Material: 1 femur, 1 humerus, 1 mandible, 1 molar, 1 pelvis, 2 radii, 2 scapulae, 1 ulna; **10 specimens**

Species: *Spermophilus armatus*—Uinta ground squirrel

Material: 1 cervical vertebra, 1 cranial fragment, 9 femurs, 5 humeri, 1 lumbar vertebra, 15 mandibles, 2 maxillae, 5 pelvises, 1 phalanx, 3 radii, 2 sacra, 6 scapulae, 2 thoracic vertebrae, 5 tibias, 3 ulnae, 1 vertebra; **62 specimens**

Species: cf. *Spermophilus armatus*—possible Uinta ground squirrel

Material: 2 cranial fragments, 2 femurs, 2 humeri, 1 mandible, 1 metatarsal, 2 pelvises, 1 radius, 1 scapula, 2 tibias; **14 specimens**

Species: *Spermophilus variegatus*—rock squirrel

Material: 1 cervical vertebra, 4 cranial fragments, 2 femurs, 1 humerus, 8 mandibles, 1 metatarsal; **17 specimens**

Species: cf. *Spermophilus variegatus*—possible rock squirrel

Material: 1 femur, 1 pelvis; **2 specimens**

Species: *Spermophilus* sp.—squirrel

Material: 1 atlas, 1 axis, 2 calcanei, 8 cervical vertebrae, 7 cranial fragments, 20 femurs, 1 fibula, 14 humeri, 6 lumbar vertebrae, 37 mandibles, 4 maxillae, 2 metatarsals, 12 pelvises, 2 phalanges, 5 radii, 2 ribs, 3 sacra, 19 scapulae, 8 thoracic vertebrae, 12 tibias, 16 teeth, 7 ulnae, 13 vertebrae; **204 specimens**

<u>Family:</u> Cricetidae—rats, mice, and voles

Unidentified Species:

Material: 1 calcaneus, 1 caudal vertebra, 4 cranial fragments, 9 femurs, 8 humeri, 1 long bone, 16 mandibles, 1 maxilla, 1 metatarsal, 1 molar, 7 pelvises, 4 phalanges, 1 first phalanx, 1 second phalanx, 4 third phalanx, 2 radii, 2 ribs, 1 thoracic vertebra, 5 tibias, 2 ulnae, 4 vertebrae; **76 specimens**

Species: *Ondatra zibethicus*—muskrat

Material: 1 astragalus, 2 atlases, 1 axis, 12 calcanei, 1 carpal, 29 caudal vertebrae, 5 cervical vertebrae, 1 third cervical vertebra, 1 fourth cervical vertebra, 1 sixth cervical vertebra, 12 cranial fragments, 54 femurs, 47 humeri, 3 incisors, 4 lumbar vertebrae, 73 mandibles, 3 maxillae, 7 metacarpals, 7 metapodials, 66 metatarsals, 37 pelvises, 28 phalanges, 6 first phalanges, 27 second phalanges, 2 third phalanges, 31 radii, 87 ribs, 2 sacra, 34 scapulae, 5 tarsals, 8 thoracic vertebrae, 78 tibias, 13 teeth, 35 ulnae, 2 vertebrae, 1 zygomatic bone; **727 specimens**

Species: cf. *Ondatra zibethicus*—possible muskrat

Material: 1 caudal vertebra, 1 cranial fragment, 1 femur, 15 incisors, 1 long bone, 2 mandibles, 1 maxilla, 1 metatarsal, 5 pelvises, 1 phalanx, 1 premaxilla, 1 radius, 17 ribs, 2 teeth, 1 tibia; **51 specimens**

Species: *Neotoma cinerea*—bushy-tailed woodrat

Material: 1 femur, 6 humeri, 6 mandibles, 2 maxillae, 1 pelvis, 2 radii, 1 sacrum, 1 scapula, 3 tibias, 1 tooth, 4 ulnae; **28 specimens**

Species: *Neotoma stephensi*—Stephens' woodrat

Material: 2 femurs, 4 humeri, 1 tibia; **7 specimens**

Species: cf. *Neotoma stephensi*—possible Stephens' woodrat

Material: 1 mandible, 1 pelvis, 1 tibia; **3 specimens**

Species: *Neotoma* sp.—woodrat

Material: 1 calcaneus, 2 caudal vertebrae, 1 cervical vertebra, 10 femurs, 10 humeri, 5 mandibles, 1 maxilla, 1 metatarsal, 7 pelvises, 2 radii, 1 rib, 1 sacrum, 2 scapulae, 1 thoracic vertebra, 5 tibias, 1 tooth, 3 ulnae, 1 vertebra; **55 specimens**

Species: cf. *Neotoma* sp.—possible woodrat

Material: 1 rib; **1 specimen**

Species: *Microtus* sp.—vole

Material: 1 cervical vertebra, 6 cranial fragments, 2 femurs, 6 humeri, 10 mandibles, 3 maxillae, 1 metatarsal, 1 pelvis, 3 radii, 1 rib, 1 sacrum, 1 scapula, 3 tibias, 1 tooth, 3 ulnae, 10 vertebrae; **53 specimens**

Species: cf. *Microtus* sp.—possible vole

Material: 1 femur; **1 specimen**

Family: Muridae—mice

Species: *Mus musculus*—house mouse

Material: 2 cranial fragments, 5 femurs, 1 humerus, 7 mandibles, 2 pelvises, 1 sacrum, 2 scapulae, 3 tibias; **23 specimens**

Family: Geomyidae—gophers

Species: *Thomomys bottae*—Botta's pocket gopher

Material: 1 femur, 9 mandibles, 2 maxillae, 1 pelvis, 1 tibia; **14 specimens**

Species: cf. *Thomomys bottae*—possible Botta's pocket gopher

Material: 1 femur; **1 specimen**

Species: *Thomomys* sp.—pocket gopher

Material: 1 mandible, 1 pelvis, 1 rib, 2 tibias; **5 specimens**

Family: Heteromyidae—kangaroo rats and kangaroo mice
Species: *Dipodomys deserti*—possible desert kangaroo rat
Material: 1 cranial fragment; **1 specimen**
Species: *Dipodomys* sp.—kangaroo rats
Material: 1 mandible, 1 sacrum, 2 tibias; **4 specimens**

Class: Aves—Birds

Unidentified Order:
Unidentified Bird:
Material: 23 flat bones, 5 long bones, 12 unidentified bones; **40 specimens**
Large Bird:
Material: 1 atlas, 1 cranial fragment, 17 flat bones, 1 humerus, 38 long bones, 1 phalanx, 2 ribs, 1 tibia, 1 ulna, 4 unidentified bones; **67 specimens**
Medium Bird:
Material: 2 carpals, 1 cranial fragment, 1 femur, 19 flat bones, 4 humeri, 130 long bones, 1 mandible, 1 third phalanx, 1 radius, 2 ribs, 1 tibia, 1 ulna, 2 vertebrae, 1 unidentified bone; **167 specimens**
Small Bird:
Material: 4 carpals, 6 coracoids, 2 cranial fragments, 6 femurs, 44 flat bones, 5 humeri, 89 long bones, 1 mandible, 2 maxillae, 5 phalanges, 2 third phalanges, 1 premaxilla, 3 radii, 3 ribs, 2 sacra, 1 sternum, 6 tarsals, 2 tibias, 1 unidentified bone; **185 specimens**

Order: Podicipediformes—Grebes
Family: Podicipedidae—grebes
Species: *Aechmophorus occidentalis*—western grebe
Material: 1 femur; **1 specimen**

Order: Pelecaniformes—Pelicans, Herons, and Other Waterbirds
Family: Ardeidae—herons
Species: *Ardea alba*—great white heron
Material: 1 phalanx; **1 specimen**

Family: Pelecanidae—pelicans
Species: *Pelecanus erythrorhynchos*—American white pelican
Material: 1 carpal; **1 specimen**

Order: Anseriformes—Waterfowl
Family: Anatidae—mallard, ducks, and swan
Large Anatidae:
Material: 1 humerus; **1 specimen**
Small Anatidae:
Material: 2 femurs, **2 specimens**
Species: *Anas platyrhynchos*—mallard
Material: 9 carpals, 2 clavicles, 7 coracoids, 2 femurs, 4 furculae, 26 humeri, 1 maxilla, 2 pelvises, 6 phalanges, 4 first phalanges, 1 second phalanx, 14 radii, 2 sacra, 3 scapulae, 4 sternums, 5 tarsals, 9 tibias, 7 ulnae; **108 specimens**

Species: cf. *Anas platyrhynchos*—possible mallard
  Material: 1 carpal, 1 clavicle, 3 humeri, 1 tibia, 1 ulna; **7 specimens**
Species: *Anas crecca*—common teal
  Material: 1 tibia; **1 specimen**
Species: *Anas americana*—American wigeon
  Material: 1 carpal, 1 humerus; **2 specimens**
Species: *Anas* sp.—ducks
  Material: 1 clavicle, 2 coracoids, 2 femurs, 1 furcula, 4 humeri, 10 phalanges, 2 radii, 2 sacra, 4 tarsals, 3 tibias, 3 ulnae; **34 specimens**
Species: *Cygnus* sp.—swan
  Material: 2 coracoids, 1 humerus, 3 first phalanges, 2 radii, 1 tarsal, 2 tibias, 1 ulna; **12 specimens**
Species: cf. *Cygnus* sp.—possible swan
  Material: 1 humerus; **1 specimen**

Order: Falconiformes—Diurnal Birds of Prey
Family: Falconidae—falcons and kestrels
Species: *Falco mexicanus*—prairie falcon
  Material: 1 phalanx; **1 specimen**

Order: Galliformes—Ground-Feeding Birds
Family: Phasianidae—pheasants, grouse, and quail
Subfamily: Tetraoninae—grouse
Unidentified Species:
  Material: 2 tarsals; **2 specimens**
Species: *Dendragapus obscurus*—dusky grouse
  Material: 1 coracoid, 5 femurs, 1 fibula, 3 humeri, 1 pelvis, 1 scapula, 1 tarsal; **13 specimens**
Species: cf. *Dendragapus obscurus*—possible dusky grouse
  Material: 1 rib; **1 specimen**
Species: *Dendragapus* sp.—possible dusky grouse
  Material: 1 coracoid, 1 humerus; **2 specimens**

Order: Charadriiformes—Waders, Gulls, and Auks
Family: Recurvirostridae—avocets and stilts
Species: *Recurvirostra* sp.—avocet
  Material: 1 carpal; **1 specimen**

Family: Scolopacidae—snipes, sandpipers, and phalaropes
Species: *Gallinago gallinago*—common snipe
  Material: 1 coracoid; **1 specimen**
Species: cf. *Gallinago gallinago*—common snipe
  Material: 1 metacarpal; **1 specimen**

Order: Columbiformes—Pigeons and Doves
Family: Columbidae—pigeons and doves
Species: *Zenaida macroura*—mourning dove
  Material: 3 carpals, 9 coracoids, 3 femurs, 1 humerus, 1 pelvis, 1 phalanx, 1 ulna; **19 specimens**
Species: *Zenaida* sp.—dove
  Material: 1 tarsal; **1 specimen**

Order: Strigiformes—Nocturnal Birds of Prey
Family: Strigidae—owls
Unidentified Species:
  Material: 1 metacarpal; **1 specimen**

Order: Piciformes—Arboreal Birds
Family: Picidae—woodpeckers
Species: *Colaptes auratus*—northern flicker
  Material: 1 metatarsal, 1 tibia; **2 specimens**

Order: Passeriformes—Perching Birds
Family: Bombycillidae—waxwings
Species: *Bombycilla cedrorum*—cedar waxwing
  Material: 1 carpal, 1 coracoid, 1 humerus, 1 radius, 1 ulna; **5 specimens**
Species: cf. *Bombycilla cedrorum*—cedar waxwing
  Material: 1 humerus; **1 specimen**

Family: Corvidae—crows, ravens, magpies, jays, nutcrackers, etc.
Unidentified Species:
  Material: 1 ulna; **1 specimen**
Species: *Corvus brachyrhynchos*—American crow
  Material: 1 coracoid, 2 phalanges, 1 tarsal; **4 specimens**

Family: Turdidae—thrushes
Unidentified Species:
  Material: 1 tibia; **1 specimen**
Species: *Turdus migratorius*—American robin
  Material: 2 carpals, 4 femurs, 4 humeri, 2 radii, 2 ulnae; **14 specimens**
Species: cf. *Turdus migratorius*—possible American robin
  Material: 1 carpal, 1 coracoid, 2 humeri, 2 tibias, 1 ulna; **7 specimens**

Class: Actinopterygii—Ray-finned fishes

Unidentified Order:
Unidentified Fish:
  Material: 9 angulars, 1 atlas, 1 basioccipital, 1 basihyal, 7 caudal vertebrae, 42 ceratohyals, 3 clavicles, 3 dentary, 1 ethmoid, 992 flat bones, 1 frontal, 10 hyomandibulars, 4 parasphenoids, 2 pharyngeals, 2 post-temporal bones, 7 premaxillae, 77 ribs, 6 supraoccipitals, 7 ultimate vertebrae, 458 vertebrae, 14 Weberian apparatus bones, 96

unidentified bones; **1742 specimens**

Order: Cypriniformes—Suckers and Minnows

Family: Catostomidae—suckers

Species: *Catostomus ardens*—Utah sucker

Material: 4 angulars, 2 atlases, 8 basioccipitals, 3 branchiostegals, 13 ceratohyals, 23 clavicles, 1 epihyal, 14 hyomandibulars, 2 hypleurals, 4 hypercoracoid, 7 maxillae, 1 metapterygoid, 1 nasal, 15 operculars, 2 parasphenoids, 21 pharyngeals, 12 post-temporal bones, 3 preoperculars, 6 quadrate bones, 1 subopercular, 2 ultimate vertebrae, 3 vertebrae, 18 Weberian apparatus bones; **166 specimens**

Species: cf. *Catostomus ardens*—possible Utah sucker

Material: 2 hyomandibulars, 2 operculars, 12 post-temporal, 5 quadrate bones; **21 specimens**

Family: Cyprinidae—chubs

Species: *Gila atraria*—Utah chub

Material: 9 angulars, 1 atlas, 38 basioccipitals, 1 branchiostegal, 1 caudal vertebra, 14 ceratohyals, 33 clavicles, 3 dentary bones, 2 exoccipitals, 2 frontals, 17 hyomandibulars, 1 hypercoracoid, 22 operculars, 2 parasphenoids, 300 pharyngeals, 1 post-temporal, 1 preopercular, 10 pterygiophores, 2 quadrate bones, 10 ribs, 2 squamosal bones, 23 teeth, 2 ultimate vertebrae, 40 vertebrae, 9 Weberian apparatus bones; **551 specimens**

Species: cf. *Gila atraria*—possible Utah chub

Material: 1 branchiostegals, 1 ceratohyal, 9 clavicles, 1 hyomandibular, 1 parasphenoid, 1 pharyngeal, 1 pterygiophore, 1 vertebra; **17 specimens**

Species: *Gila* sp.—western chub

Material: 1 basioccipital, 64 pharyngeals, 1 vertebra; **66 specimens**

Class: Amphibia

Unidentified Order:

Unidentified Amphibian:

Material: 11 long bones; **11 specimens**

Appendix B:

Taxonomic Counts Per Wolf Village Provenience

The following tables depict the number of identified specimens (NISP) for each taxa. Only specimens identified to the taxonomic rank of order or lower are included in these tables. The provenience data is organized by each structure and activity area, and further categorized into “fill”, “floor zone”, and “subfloor.” Faunal bones recovered from the “fill” were recovered from above the structural floor zone. “Floor zone” is the 10 cm above a cultural floor or use surface. Faunal bones recovered from the surface of the floor are also included in this category. Faunal bones recovered from the “subfloor” are those recovered from subfloor pits, postholes, or other subfloor features. Worked bone specimens are not included in these tables. Identified artiodactyl specimens from the fill of Structure 2 (i.e., the shaded excavation units in Figure 3.1) are included in this appendix. Artiodactyl specimens identified outside of the shaded units in Figure 3.1 are not included in this appendix.

Table B1. NISP Counts from Activity Area 1 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Odocoileus hemionus	–	–	1	1
Small Artiodactyl	–	–	18	18
Lagomorpha				
Lepus townsendi	–	–	1	1
Leporidae	–	–	8	8
Rodentia				
Spermophilus armatus	–	–	2	2
Spermophilus sp.	–	–	4	4
cf. *Ondatra zibethicus*	–	–	1	1
Cypriniformes				
Catostomus ardens	–	–	1	1
Gila atraria	–	–	4	4
Total	–	–	40	40

Table B2. NISP Counts from Activity Area 2 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	–	–	3	3
cf. *Antilocapra americana*	–	–	2	2
Odocoileus hemionus	–	–	28	28
cf. *Odocoileus hemionus*	–	–	14	14
Ovis canadensis	–	–	2	2
cf. *Ovis canadensis*	–	–	3	3
Small Artiodactyl	–	1	382	383
Lagomorpha				
Lepus townsendi	–	2	–	2
cf. *Lepus townsendi*	–	–	1	1
Sylvilagus audubonii	–	1	4	5
cf. *Sylvilagus audubonii*	–	–	1	1
Rodentia				
Spermophilus armatus	–	–	1	1
cf. *Spermophilus armatus*	–	–	1	1
cf. *Spermophilus variegatus*	–	–	1	1
Marmota sp.	–	–	1	1
cf. *Ondatra zibethicus*	–	–	2	2
Neotoma cinerea	–	–	3	3
cf. *Neotoma cinerea*	–	–	1	1
Thomomys bottae	–	–	1	1
Anseriformes				
Anas platyrhynchos	–	–	1	1
Cygnus sp.	–	–	28	28
cf. *Cygnus* sp.	–	–	1	1
Medium Anatidae	–	–	1	1
Total	–	4	482	486

Table B3. NISP Counts from Structure 1 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	1	7	4	12
Odocoileus hemionus	12	21	3	36
Ovis canadensis	5	18	2	25
cf. *Ovis canadensis*	1	–	–	1
Bison bison	–	1	–	1
Small Artiodactyl	280	529	39	848
Carnivora				
Canis latrans	–	–	1	1
Lagomorpha				
Lepus californicus	2	3	1	6
cf. *Lepus californicus*	–	1	–	1
Lepus townsendi	3	2	–	5
Lepus sp.	3	22	2	27
Sylvilagus audubonii	13	22	4	39
cf. *Sylvilagus audubonii*	2	–	–	2
Leporidae	1	5	2	8
cf. Leporidae	1	–	–	1
Rodentia				
Spermophilus armatus	5	3	–	8
cf. *Spermophilus armatus*	1	12	–	13
Spermophilus variegatus	6	3	–	9
cf. *Spermophilus variegatus*	–	1	–	1
Spermophilus sp.	2	47	3	52
Sciuridae	–	4	–	4
Ondatra zibethicus	9	41	3	53
cf. *Ondatra zibethicus*	2	–	–	2
Neotoma cinerea	10	2	–	12
Neotoma stephensi	1	–	–	1
Neotoma sp.	4	8	–	12
Microtus sp.	1	2	–	3
Cricetidae	–	1	–	1
Thomomys bottae	2	–	–	2
Thomomys sp.	–	4	–	4
Dipodomys sp.	2	–	–	2

Table B3. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total
Anseriformes				
Anas platyrhynchos	–	2	–	2
cf. *Anas platyrhynchos*	1	–	–	1
Anas crecca	1	–	–	1
Anas sp.	–	1	–	1
Small Anatidae	–	2	–	2
Charadriiformes				
Gallinago gallinago	–	–	1	1
Columbiformes				
Zenaida macroura	1	–	–	1
Zenaida sp.	–	1	–	1
Passeriformes				
Bombycilla cedrorum	–	3	–	3
cf. *Turdus migratorius*	1	5	–	6
Cypriniformes				
Catostomus ardens	19	24	4	47
cf. *Catostomus ardens*	7	–	–	7
Gila atraria	18	27	8	53
Total	417	824	77	1,318

Table B4. NISP Counts from Structure 2 at Wolf Village.

Taxon	Fill*	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	41	2	–	43
cf. *Antilocapra americana*	2	–	1	3
Odocoileus hemionus	244	47	14	305
cf. *Odocoileus hemionus*	7	–	2	9
Ovis canadensis	55	6	1	62
cf. *Ovis canadensis*	6	–	–	6
Bison bison	1	–	–	1
Large Artiodactyl	7	3	–	10
Small Artiodactyl	4,345	1,283	233	5,861
Carnivora				
Canis latrans	1	–	–	1
cf. *Canis latrans*	2	–	–	2
Canis sp.	3	2	–	5
cf. *Procyon lotor*	1	–	–	1
Lagomorpha				
Lepus californicus	25	5	1	31
cf. *Lepus californicus*	1	–	–	1
Lepus townsendi	57	15	11	83
Lepus sp.	297	78	37	412
Sylvilagus audubonii	209	105	35	349
cf. *Sylvilagus audubonii*	–	1	–	1
Sylvilagus sp.	180	10	5	195
cf. *Sylvilagus* sp.	1	–	–	1
Leporidae	127	9	1	137
Rodentia				
Erethizon dorsatum	1	–	–	1
Spermophilus armatus	41	1	3	45
Spermophilus variegatus	2	–	–	2
cf. *Spermophilus variegatus*	–	–	1	1
Spermophilus sp.	35	20	–	55
Sciuridae	1	–	–	1
Ondatra zibethicus	247	53	25	325
cf. *Ondatra zibethicus*	2	–	–	2

Table B4. Continued.

Taxon	Fill*	Floor Zone	Subfloor	Total
Neotoma cinerea	2	–	–	2
Neotoma stephensi	5	–	–	5
Neotoma sp.	18	7	–	25
Microtus sp.	7	3	–	10
Cricetidae	30	1	1	32
Mus musculus	4	–	–	4
Thomomys bottae	6	2	–	8
Dipodomys sp.	–	–	2	2
Pelecaniformes				
Ardea alba	–	–	1	1
Anseriformes				
Anas platyrhynchos	69	13	1	83
cf. *Anas platyrhynchos*	2	2	–	4
cf. *Anas americana*	1	–	–	1
Anas sp.	26	–	2	28
Cygnus sp.	7	1	–	8
Large Anatidae	1	–	–	1
Galliformes				
Dendragapus obscurus	6	–	–	6
Dendragapus sp.	1	–	–	1
Charadriiformes				
Recurvirostra sp.	–	1	–	1
Columbiformes				
Zenaida macroura	5	5	1	11
Piciformes				
Colaptes auratus	1	–	–	1
Passeriformes				
Bombycilla cedrorum	1	–	–	1
cf. *Bombycilla cedrorum*	–	–	1	1
Corvus brachyrhynchos	–	–	4	4
Turdus migratorius	10	1	–	11
cf. *Turdus migratorius*	1	–	–	1
Turdidae	–	1	–	1

Table B4. Continued.

Taxon	Fill*	Floor Zone	Subfloor	Total
Cypriniformes				
Catostomus ardens	41	23	6	70
Gila atraria	226	38	7	271
Gila sp.	27	6	2	35
Total	6,438	1,744	398	8,580

*NISP counts only recorded for bones recovered from the gray shaded units in Figure 3.1.

Table B5. NISP Counts from Structure 3 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Ovis canadensis	1	–	–	1
Large Artiodactyl	1	–	–	1
Small Artiodactyl	4	3	–	7
Lagomorpha				
Sylvilagus audubonii	1	–	–	1
Leporidae	1	–	–	1
Rodentia				
Ondatra zibethicus	1	–	–	1
Total	9	3	0	12

Table B6. NISP Counts from Structure 4 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	1	–	–	1
Odocoileus hemionus	2	–	–	2
Small Artiodactyl	88	38	1	127
cf. Small Artiodactyl	13	3	–	16
Lagomorpha				
Lepus townsendi	2	–	–	2
cf. *Lepus townsendi*	1	–	–	1
Lepus sp.	1	1	–	2
Sylvilagus audubonii	14	5	–	19
cf. *Sylvilagus audubonii*	2	3	1	6
Leporidae	2	–	1	3
cf. Leporidae	2	–	–	2
Rodentia				
Spermophilus armatus	1	–	–	1
Spermophilus sp.	1	–	–	1
Ondatra zibethicus	17	5	2	24
cf. *Ondatra zibethicus*	1	2	–	3
Neotoma cinerea	1	–	–	1
Neotoma stephensi	1	–	–	1
cf. *Neotoma stephensi*	3	–	–	3
cf. *Thomomys bottae*	1	–	–	1
Anseriformes				
Anas platyrhynchos	1	–	–	1
cf. *Anas platyrhynchos*	1	–	–	1
Anas americana	1	–	–	1
Cypriniformes				
Catostomus ardens	2	–	1	3
Gila atraria	5	2	–	7
Total	164	59	6	229

Table B7. NISP Counts from Structure 5 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Small Artiodactyl	–	2	1	3
Rodentia				
Microtus sp.	3	–	–	3
Total	3	2	1	6

Table B8. NISP Counts from Structure 6 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	2	–	–	2
Odocoileus hemionus	46	1	–	47
Ovis canadensis	2	–	–	2
Large Artiodactyl	2	–	–	2
Small Artiodactyl	442	2	9	453
Carnivora				
Canis latrans	1	–	–	1
Canis sp.	3	–	–	3
Lagomorpha				
Lepus californicus	12	–	–	12
Lepus townsendi	14	–	–	14
Lepus sp.	81	–	–	81
Sylvilagus audubonii	151	–	3	154
Sylvilagus sp.	89	–	–	89
Leporidae	19	–	–	19
Rodentia				
Spermophilus armatus	3	–	–	3
Spermophilus variegatus	4	–	–	4
Spermophilus sp.	67	–	–	67
Sciuridae	4	–	–	4
Ondatra zibethicus	60	–	–	60
Neotoma cinerea	11	–	–	11
Neotoma sp.	3	–	–	3
Microtus sp.	9	–	–	9
Cricetidae	19	–	–	19
Mus musculus	3	–	–	3
Thomomys bottae	2	–	–	2
Thomomys sp.	1	–	–	1
Pelecaniformes				
Pelecanus erythrorhynchos	1	–	–	1
Anseriformes				
Anas platyrhynchos	10	–	–	10
Anas sp.	1	–	–	1
Cygnus sp.	3	–	–	3

Table B8. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total
Galliformes				
Dendragapus obscurus	7	–	–	7
Dendragapus sp.	1	–	–	1
Tetraoninae	1	–	–	1
Passeriformes				
Bombycilla cedrorum	1	–	–	1
Cypriniformes				
Catostomus ardens	14	–	–	14
Gila atraria	37	–	–	37
Gila sp.	28	–	–	28
Total	1,154	3	12	1,169

Table B9. NISP Counts from Structure 7 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Small Artiodactyl	1	1	16	18
Carnivora				
Canis sp.	–	–	1	1
Lagomorpha				
Sylvilagus audubonii	–	–	1	1
Leporidae	1	–	–	1
cf. Leporidae	–	–	1	1
Rodentia				
cf. Spermophilus armatus	–	–	1	1
Spermophilus sp.	–	–	2	2
Ondatra zibethicus	–	1	–	1
Galliformes				
cf. Dendragapus obscurus	–	–	1	1
Columbiformes				
Zenaida macroura	–	–	5	5
Cypriniformes				
Catostomus ardens	–	–	23	23
cf. Catostomus ardens	–	–	14	14
Gila atraria	–	–	81	81
cf. Gila atraria	–	–	9	9
Total	2	2	155	159

Table B10. NISP Counts from Structure 8 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	9	9	–	18
cf. *Antilocapra americana*	5	1	–	6
Odocoileus hemionus	37	65	3	105
cf. *Odocoileus hemionus*	15	15	–	30
Ovis canadensis	17	12	1	30
cf. *Ovis canadensis*	3	1	–	4
Large Artiodactyl	–	1	–	1
Small Artiodactyl	861	990	60	1,911
Carnivora				
Canis sp.	1	1	–	2
Canidae	–	1	–	1
cf. *Procyon lotor*	2	–	–	2
Lagomorpha				
Lepus californicus	3	2	–	5
Lepus townsendi	9	9	2	20
cf. *Lepus townsendi*	–	1	–	1
Lepus sp.	4	18	–	22
Sylvilagus audubonii	22	22	3	47
cf. *Sylvilagus audubonii*	4	–	–	4
Leporidae	15	11	4	30
cf. Leporidae	2	1	3	6
Rodentia				
cf. *Erethizon dorsatum*	1	–	–	1
Ondatra zibethicus	78	71	36	185
cf. *Ondatra zibethicus*	5	–	15	20
Microtus sp.	1	–	–	1
cf. *Microtus* sp.	–	–	1	1
Cricetidae	6	2	–	8
Thomomys bottae	1	–	–	1
Anseriformes				
Anas platyrhynchos	3	4	1	8
cf. *Anas platyrhynchos*	1	–	–	1
Cygnus sp.	–	1	–	1

Table B10. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total
Falconiformes				
Falco mexicanus	–	1	–	1
Columbiformes				
Zenaida macroura	–	2	–	2
Strigiformes				
Strigidae	–	1	–	1
Piciformes				
Colaptes auratus	–	–	1	1
Passeriformes				
Turdus migratorius	–	2	1	3
Cypriniformes				
Catostomus ardens	2	1	–	3
Gila atraria	25	12	2	39
cf. *Gila atraria*	3	2	–	5
Total	1,135	1,259	133	2,527

Table B11. NISP Counts from Structure 9 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total
Artiodactyla				
Antilocapra americana	15	1	5	21
cf. *Antilocapra americana*	3	–	1	4
Odocoileus hemionus	39	5	4	48
cf. *Odocoileus hemionus*	7	1	5	13
Ovis canadensis	17	2	17	36
cf. *Ovis canadensis*	5	1	–	6
Bison bison	1	–	–	1
Large Artiodactyl	3	–	–	3
Small Artiodactyl	624	111	56	791
Carnivora				
cf. Canidae	–	1	–	1
Lagomorpha				
Lepus californicus	1	–	1	2
cf. *Lepus californicus*	–	1	–	1
Lepus townsendi	7	5	2	14
cf. *Lepus townsendi*	1	–	–	1
Lepus sp.	17	1	–	18
Sylvilagus audubonii	25	8	4	37
cf. *Sylvilagus audubonii*	6	1	–	7
Sylvilagus sp.	21	–	–	21
Leporidae	20	2	–	22
Rodentia				
cf. *Castor canadensis*	2	–	–	2
Spermophilus armatus	5	–	–	5
Spermophilus variegatus	2	–	–	2
Spermophilus sp.	8	–	–	8
Ondatra zibethicus	55	6	1	62
cf. *Ondatra zibethicus*	4	2	1	7
Neotoma cinerea	1	–	–	1
Neotoma sp.	11	3	–	14
cf. *Neotoma* sp.	–	1	–	1
Microtus sp.	2	24	–	26
Cricetidae	13	1	1	15
Mus musculus	16	–	–	16

Table B11. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total
Thomomys bottae	1	–	–	1
cf. *Dipodomys deserti*	–	1	–	1
Podicipediformes				
Aechmophorus occidentalis	–	1	–	1
Anseriformes				
Anas platyrhynchos	2	2	–	4
Anas sp.	4	–	–	4
cf. *Cygnus* sp.	–	–	1	1
Galliformes				
Tetraonidae	1	–	–	1
Charadriiformes				
cf. *Gallinago gallinago*	1	–	–	1
Passeriformes				
Corvidae	–	–	1	1
Cypriniformes				
Catostomus ardens	2	3	1	6
Gila atraria	30	9	1	40
cf. *Gila atraria*	2	1	–	3
Gila sp.	3	–	–	3
Total	977	194	102	1,273

Appendix C:

Bone Weights by Taxonomic Category Per Wolf Village Provenience

Table C1. Bone Weights by Taxonomic Category from Structure 1 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	7.7	47.0	56.4	111.1
Odocoileus hemionus	142.9	75.1	48.7	266.7
Ovis canadensis	46.1	206.4	19.4	271.9
cf. *Ovis canadensis*	2.9	–	–	2.9
Bison bison	–	66.8	–	66.8
Small Artiodactyl	369.3	851.8	61.0	1282.1
Carnivora				
Canis latrans	–	–	0.5	0.5
Lagomorpha				
Lepus californicus	0.2	2.4	0.4	3.0
cf. *Lepus californicus*	–	0.2	–	0.2
Lepus townsendi	1.0	0.4	–	1.4
Lepus sp.	0.3	8.0	0.3	8.6
Sylvilagus audubonii	1.1	5.4	2.0	8.5
cf. *Sylvilagus audubonii*	0.2	–	–	0.2
Leporidae	0.1	0.7	0.0	0.8
cf. Leporidae	0.6	–	–	0.6
Rodentia				
Spermophilus armatus	0.1	0.4	–	0.5
cf. *Spermophilus armatus*	0.2	1.0	–	1.2
Spermophilus variegatus	1.8	0.2	–	2.0
cf. *Spermophilus variegatus*	–	0.7	–	0.7
Spermophilus sp.	0.1	7.3	0.1	7.5
Sciuridae	–	0.1	–	0.1
Ondatra zibethicus	3.7	16.5	0.5	20.7
cf. *Ondatra zibethicus*	0.5	–	–	0.5
Neotoma cinerea	0.1	0.1	–	0.2
Neotoma stephensi	0.0	–	–	0.0
Neotoma sp.	0.0	0.1	–	0.1
Microtus sp.	0.0	0.3	–	0.3
Cricetidae	–	0.0	–	0.0
Thomomys bottae	0.0	–	–	0.0
Thomomys sp.	–	0.5	–	0.5
Dipodomys sp.	0.0	–	–	0.0

Table C1. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Anseriformes				
Anas platyrhynchos	–	1.2	–	1.2
cf. *Anas platyrhynchos*	0.3	–	–	0.3
Anas crecca	0.1	–	–	0.1
Anas sp.	–	0.1	–	0.1
Small Anatidae	–	0.1	–	0.1
Charadriiformes				
Gallinago gallinago	–	–	0.1	0.1
Columbiformes				
Zenaida macroura	0.0	–	–	0.0
Zenaida sp.	–	0.1	–	0.1
Passeriformes				
Bombycilla cedrorum	–	0.0	–	0.0
cf. *Turdus migratorius*	0.2	0.4	–	0.6
Cypriniformes				
Catostomus ardens	0.5	1.4	0.2	2.1
cf. *Catostomus ardens*	0.2	–	–	0.2
Gila atraria	1.0	4.5	0.5	6.0
Total	581.2	1299.2	190.1	2070.5

Table C2. Bone Weights by Taxonomic Category from Structure 2 at Wolf Village.

Taxon	Fill*	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	307.9	14.2	–	322.1
cf. *Antilocapra americana*	15.8	–	2.4	18.2
Odocoileus hemionus	1906.4	306.8	79.7	2292.9
cf. *Odocoileus hemionus*	26.0	–	9.7	35.7
Ovis canadensis	689.0	58.6	22.9	770.5
cf. *Ovis canadensis*	26.2	–	–	26.2
Bison bison	89.9	–	–	89.9
Large Artiodactyl	113.0	36.3	–	149.3
Small Artiodactyl	10610.0	2236.6	291.5	13138.1
Carnivora				
Canis latrans	0.4	–	–	0.4
cf. *Canis latrans*	0.8	–	–	0.8
Canis sp.	5.8	2.3	–	8.1
cf. *Procyon lotor*	0.6	–	–	0.6
Lagomorpha				
Lepus californicus	16.9	3.6	0.1	20.6
cf. *Lepus californicus*	0.4	–	–	0.4
Lepus townsendi	73.2	17.3	7.7	98.2
Lepus sp.	153.1	26.1	11.4	190.6
Sylvilagus audubonii	56.3	20.4	7.1	83.8
cf. *Sylvilagus audubonii*	–	0.3	–	0.3
Sylvilagus sp.	23.9	0.4	0.9	25.2
cf. *Sylvilagus* sp.	0.0	–	–	0.0
Leporidae	37.7	1.4	0.1	39.2
Rodentia				
Erethizon dorsatum	4.0	–	–	4.0
Spermophilus armatus	2.8	0.7	0.3	3.8
Spermophilus variegatus	1.0	–	–	1.0
cf. *Spermophilus variegatus*	–	–	0.0	0.0
Spermophilus sp.	2.8	1.9	–	4.7
Sciuridae	1.8	–	–	1.8
Ondatra zibethicus	96.9	17.6	16.0	130.5
cf. *Ondatra zibethicus*	0.4	–	–	0.4

Table C2. Continued.

Taxon	Fill*	Floor Zone	Subfloor	Total Weight (g)
Neotoma cinerea	0.2	–	–	0.2
Neotoma stephensi	0.5	–	–	0.5
Neotoma sp.	0.9	0.8	–	1.7
Microtus sp.	2.9	0.7	–	3.6
Cricetidae	6.3	0.4	0.0	6.7
Mus musculus	0.1	–	–	0.1
Thomomys bottae	3.2	0.1	–	3.3
Dipodomys sp.	–	–	0.2	0.2
Pelecaniformes				
Ardea alba	–	–	0.1	0.1
Anseriformes				
Anas platyrhynchos	44.3	6.6	0.3	51.2
cf. *Anas platyrhynchos*	0.7	0.5	–	1.2
cf. *Anas americana*	0.3	–	–	0.3
Anas sp.	9.0	–	0.4	9.4
Cygnus sp.	11.2	4.3	–	15.5
Large Anatidae	3.5	–	–	3.5
Galliformes				
Dendragapus obscurus	6.4	–	–	6.4
Dendragapus sp.	0.3	–	–	0.3
Charadriiformes				
Recurvirostra sp.	–	0.1	–	0.1
Columbiformes				
Zenaida macroura	0.4	0.3	0.1	0.8
Piciformes				
Colaptes auratus	0.1	–	–	0.1
Passeriformes				
Bombycilla cedrorum	0.1	–	–	0.1
cf. *Bombycilla cedrorum*	–	–	0.1	0.1
Corvus brachyrhynchos	–	–	1.2	1.2
Turdus migratorius	0.6	0.1	–	0.7
cf. *Turdus migratorius*	0.1	–	–	0.1
Turdidae	–	0.1	–	0.1

Table C2. Continued.

Taxon	Fill*	Floor Zone	Subfloor	Total Weight (g)
Cypriniformes				
Catostomus ardens	5.7	3.0	0.4	9.1
Gila atraria	48.1	6.9	0.9	55.9
Gila sp.	0.3	0.2	0.1	0.6
Total	14408.2	2768.6	453.6	17630.4

*Bone weight only recorded for bones recovered from the gray shaded units in Figure 3.1.

Table C3. Bone Weights by Taxonomic Category from Structure 3 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Ovis canadensis	10.3	–	–	10.3
Large Artiodactyl	4.6	–	–	4.6
Small Artiodactyl	4.7	6.0	–	10.7
Lagomorpha				
Sylvilagus audubonii	0.2	–	–	0.2
Leporidae	0.2	–	–	0.2
Rodentia				
Ondatra zibethicus	0.1	–	–	0.1
Total	20.1	6.0	0.0	26.1

Table C4. Bone Weights by Taxonomic Category from Structure 4 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	2.1	–	–	2.1
Odocoileus hemionus	3.6	–	–	3.6
Small Artiodactyl	75.0	24.4	0.7	100.1
cf. Small Artiodactyl	3.2	0.3	–	3.5
Lagomorpha				
Lepus townsendi	0.6	–	–	0.6
cf. *Lepus townsendi*	0.2	–	–	0.2
Lepus sp.	0.0	0.1	–	0.1
Sylvilagus audubonii	1.4	0.2	–	1.6
cf. *Sylvilagus audubonii*	0.1	0.2	0.1	0.4
Leporidae	0.4	–	1.0	1.4
cf. Leporidae	0.8	–	–	0.8
Rodentia				
Spermophilus armatus	0.1	–	–	0.1
Spermophilus sp.	0.1	–	–	0.1
Ondatra zibethicus	5.5	0.4	0.7	6.6
cf. *Ondatra zibethicus*	0.1	0.1	–	0.2
Neotoma cinerea	0.1	–	–	0.1
Neotoma stephensi	0.1	–	–	0.1
cf. *Neotoma stephensi*	0.2	–	–	0.2
cf. *Thomomys bottae*	0.1	–	–	0.1
Anseriformes				
Anas platyrhynchos	0.1	–	–	0.1
cf. *Anas platyrhynchos*	0.1	–	–	0.1
Anas americana	1.2	–	–	1.2
Cypriniformes				
Catostomus ardens	0.2	–	0.1	0.3
Gila atraria	0.5	0.2	–	0.7
Total	95.8	25.9	2.6	124.3

Table C5. Bone Weights by Taxonomic Category from Structure 5 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Small Artiodactyl	–	1.0	3.3	4.3
Rodentia				
Microtus sp.	0.7	–	–	0.7
Total	0.7	1.0	3.3	5.0

Table C6. Bone Weights by Taxonomic Category from Structure 6 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	11.4	–	–	11.4
Odocoileus hemionus	488.5	12.1	–	500.6
Ovis canadensis	21.7	–	–	21.7
Large Artiodactyl	19.7	–	–	19.7
Small Artiodactyl	766.6	1.7	9.0	777.3
Carnivora				
Canis latrans	0.1	–	–	0.1
Canis sp.	1.2	–	–	1.2
Lagomorpha				
Lepus californicus	19.7	–	–	19.7
Lepus townsendi	11.2	–	–	11.2
Lepus sp.	23.2	–	–	23.2
Sylvilagus audubonii	38.2	–	0.6	38.8
Sylvilagus sp.	5.0	–	–	5.0
Leporidae	1.3	–	–	1.3
Rodentia				
Spermophilus armatus	0.3	–	–	0.3
Spermophilus variegatus	0.2	–	–	0.2
Spermophilus sp.	5.0	–	–	5.0
Sciuridae	0.3	–	–	0.3
Ondatra zibethicus	33.1	–	–	33.1
Neotoma cinerea	1.4	–	–	1.4
Neotoma sp.	0.2	–	–	0.2
Microtus sp.	3.2	–	–	3.2
Cricetidae	0.5	–	–	0.5
Mus musculus	0.1	–	–	0.1
Thomomys bottae	0.1	–	–	0.1
Thomomys sp.	0.0	–	–	0.0
Pelecaniformes				
Pelecanus erythrorhynchos	8.2	–	–	8.2
Anseriformes				
Anas platyrhynchos	4.6	–	–	4.6
Anas sp.	0.2	–	–	0.2
Cygnus sp.	8.9	–	–	8.9

Table C6. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Galliformes				
Dendragapus obscurus	4.3	–	–	4.3
Dendragapus sp.	0.9	–	–	0.9
Tetraoninae	0.1	–	–	0.1
Passeriformes				
Bombycilla cedrorum	0.0	–	–	0.0
Cypriniformes				
Catostomus ardens	0.8	–	–	0.8
Gila atraria	4.2	–	–	4.2
Gila sp.	0.4	–	–	0.4
Total	1484.8	13.8	9.6	1508.2

Table C7. Bone Weights by Taxonomic Category from Structure 7 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Small Artiodactyl	2.0	1.2	8.5	11.7
Carnivora				
Canis sp.	–	–	0.7	0.7
Lagomorpha				
Sylvilagus audubonii	–	–	1.0	1.0
Leporidae	0.1	–	–	0.1
cf. Leporidae	–	–	0.1	0.1
Rodentia				
cf. *Spermophilus armatus*	–	–	0.1	0.1
Spermophilus sp.	–	–	0.2	0.2
Ondatra zibethicus	–	0.2	–	0.2
Galliformes				
cf. *Dendragapus obscurus*	–	–	0.1	0.1
Columbiformes				
Zenaida macroura	–	–	0.8	0.8
Cypriniformes				
Catostomus ardens	–	–	1.5	1.5
cf. *Catostomus ardens*	–	–	0.5	0.5
Gila atraria	–	–	7.6	7.6
cf. *Gila atraria*	–	–	0.5	0.5
Total	2.1	1.4	21.6	25.1

Table C8. Bone Weights by Taxonomic Category from Structure 8 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	72.8	46.6	–	119.4
cf. *Antilocapra americana*	31.0	2.6	–	33.6
Odocoileus hemionus	499.7	694.4	21.8	1215.9
cf. *Odocoileus hemionus*	101.2	85.5	–	186.7
Ovis canadensis	140.4	109.4	4.3	254.1
cf. *Ovis canadensis*	8.7	1.7	–	10.4
Large Artiodactyl	–	6.8	–	6.8
Small Artiodactyl	1938.3	2846.2	130.7	4915.2
Carnivora				
Canis sp.	2.0	0.7	–	2.7
Canidae	–	0.5	–	0.5
cf. *Procyon lotor*	4.6	–	–	4.6
Lagomorpha				
Lepus californicus	2.6	0.8	–	3.4
Lepus townsendi	5.8	8.9	0.6	15.3
cf. *Lepus townsendi*	–	0.3	–	0.3
Lepus sp.	3.9	6.8	–	10.7
Sylvilagus audubonii	8.2	7.6	0.4	16.2
cf. *Sylvilagus audubonii*	1.2	–	–	1.2
Leporidae	3.6	3.4	0.9	7.9
cf. Leporidae	0.2	0.3	0.5	1.0
Rodentia				
cf. *Erethizon dorsatum*	0.4	–	–	0.4
Ondatra zibethicus	60.8	45.9	20.4	127.1
cf. *Ondatra zibethicus*	1.0	–	1.7	2.7
Microtus sp.	0.8	–	–	0.8
cf. *Microtus* sp.	–	–	0.1	0.1
Cricetidae	0.9	0.1	–	1.0
Thomomys bottae	0.6	–	–	0.6
Anseriformes				
Anas platyrhynchos	1.0	4.4	0.8	6.2
cf. *Anas platyrhynchos*	0.6	–	–	0.6
Cygnus sp.	–	1.8	–	1.8

Table C8. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Falconiformes				
Falco mexicanus	–	0.1	–	0.1
Columbiformes				
Zenaida macroura	–	0.2	–	0.2
Strigiformes				
Strigidae	–	0.3	–	0.3
Piciformes				
Colaptes auratus	–	–	0.1	0.1
Passeriformes				
Turdus migratorius	–	0.2	0.1	0.3
Cypriniformes				
Catostomus ardens	0.1	0.1	–	0.2
Gila atraria	3.9	3.5	0.1	7.5
cf. *Gila atraria*	0.1	0.1	–	0.2
Total	2894.4	3879.2	182.5	6956.1

Table C9. Bone Weights by Taxonomic Category from Structure 9 at Wolf Village.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Artiodactyla				
Antilocapra americana	204.9	1.7	165.7	372.3
cf. *Antilocapra americana*	18.0	–	22.6	40.6
Odocoileus hemionus	336.4	26.3	140.4	503.1
cf. *Odocoileus hemionus*	23.4	18.8	36.5	78.7
Ovis canadensis	131.6	11.9	888.7	1032.2
cf. *Ovis canadensis*	56.9	1.6	–	58.5
Bison bison	149.0	–	–	149.0
Large Artiodactyl	7.8	–	–	7.8
Small Artiodactyl	1269.2	212.6	180.2	1662.0
Carnivora				
cf. Canidae	–	1.0	–	1.0
Lagomorpha				
Lepus californicus	0.6	–	0.3	0.9
cf. *Lepus californicus*	–	0.1	–	0.1
Lepus townsendi	6.4	1.8	1.4	9.6
cf. *Lepus townsendi*	0.3	–	–	0.3
Lepus sp.	5.8	0.4	–	6.2
Sylvilagus audubonii	12.2	3.3	3.0	18.5
cf. *Sylvilagus audubonii*	1.5	0.1	–	1.6
Sylvilagus sp.	2.8	–	–	2.8
Leporidae	5.0	1.1	–	6.1
Rodentia				
cf. *Castor canadensis*	8.2	–	–	8.2
Spermophilus armatus	0.4	–	–	0.4
Spermophilus variegatus	0.4	–	–	0.4
Spermophilus sp.	0.7	–	–	0.7
Ondatra zibethicus	31.8	1.3	0.1	33.2
cf. *Ondatra zibethicus*	0.8	0.6	0.2	1.6
Neotoma cinerea	0.6	–	–	0.6
Neotoma sp.	0.7	0.2	–	0.9
cf. *Neotoma* sp.	–	0.1	–	0.1
Microtus sp.	0.9	3.5	–	4.4
Cricetidae	1.2	1.3	0.2	2.7

Table C9. Continued.

Taxon	Fill	Floor Zone	Subfloor	Total Weight (g)
Mus musculus	0.3	–	–	0.3
Thomomys bottae	0.5	–	–	0.5
cf. *Dipodomys deserti*	–	1.3	–	1.3
Podicipediformes				
Aechmophorus occidentalis	–	2.0	–	2.0
Anseriformes				
Anas platyrhynchos	1.3	0.7	–	2.0
Anas sp.	0.9	–	–	0.9
cf. *Cygnus* sp.	–	–	6.5	6.5
Galliformes				
Tetraonidae	1.2	–	–	1.2
Charadriiformes				
cf. *Gallinago gallinago*	0.1	–	–	0.1
Passeriformes				
Corvidae	–	–	0.3	0.3
Cypriniformes				
Catostomus ardens	0.2	0.2	0.1	0.5
Gila atraria	3.1	1.1	0.1	4.3
cf. *Gila atraria*	0.1	0.1	–	0.2
Gila sp.	0.2	–	–	0.2
Total	2285.4	293.1	1446.3	4024.8

Appendix D:

MNE and MAU Values for Wolf Village Artiodactyls

Table D1. MNE and MAU Values for Mule Deer from Wolf Village, Period I.

Element	MNE	MAU	%MAU
Mandible	4	2.0	100.0
Lumbar vertebrae	1	0.2	8.3
Pelvis	1	0.5	25.0
Ribs	2	0.1	3.8
Distal humerus	1	0.5	25.0
Proximal ulna	1	0.5	25.0
Carpals	1	0.1	4.2
Tarsals	4	0.3	16.7
Calcaneus	1	0.5	25.0
Phalanges	2	0.1	4.2

Table D2. MNE and MAU Values for Combined Small Artiodactyls from Wolf Village, Period I.

Element	MNE	MAU	%MAU
Cranium	8	8.0	100.0
Mandible	9	4.5	56.3
Thoracic vertebrae	1	0.1	0.7
Lumbar vertebrae	1	0.2	2.1
Pelvis	4	2.0	25.0
Ribs	29	1.1	13.9
Scapula	9	4.5	56.3
Proximal humerus	1	0.5	6.3
Distal humerus	1	0.5	6.3
Proximal ulna	1	0.5	6.3
Carpals	6	0.5	6.3
Distal femur	1	0.5	6.3
Proximal tibia	2	1.0	12.5
Distal tibia	2	1.0	12.5
Tarsals	5	0.4	5.2
Calcaneus	3	1.5	18.8
Phalanges	4	0.2	2.1

Table D3. MNE and MAU Values for Mule Deer from Wolf Village, Period II.

Element	MNE	MAU	%MAU
Antler/Horn	33	16.5	33.7
Cranium	49	49.0	100.0
Mandible	93	46.5	94.9
Cervical vertebrae	7	1.0	2.0
Thoracic vertebrae	14	0.8	1.6
Lumbar vertebrae	7	1.2	2.4
Pelvis	29	14.5	29.6
Ribs	24	0.9	1.9
Scapula	28	14.0	28.6
Proximal humerus	3	1.5	3.1
Distal humerus	16	8.0	16.3
Proximal radius	4	2.0	4.1
Distal radius	25	12.5	25.5
Proximal ulna	20	10.0	20.4
Carpals	4	0.3	0.7
Proximal metacarpal	22	11.0	22.4
Distal metacarpal	14	7.0	14.3
Proximal femur	1	0.5	1.0
Distal femur	8	4.0	8.2
Proximal tibia	3	1.5	3.1
Distal tibia	16	8.0	16.3
Tarsals	22	1.8	3.7
Astragalus	15	7.5	15.3
Calcaneus	27	13.5	27.6
Proximal metatarsal	33	16.5	33.7
Distal metatarsal	14	7.0	14.3
Phalanges	2	0.1	0.2
1st Phalanx	37	4.6	9.4
2nd Phalanx	52	6.5	13.3
3rd Phalanx	54	6.8	13.8

Table D4. MNE and MAU Values for Bighorn Sheep from Wolf Village, Period II.

Element	MNE	MAU	%MAU
Antler/Horn	1	0.5	8.3
Cranium	1	1.0	16.7
Mandible	12	6.0	100.0
Cervical vertebrae	7	1.0	16.7
Thoracic vertebrae	4	0.2	3.7
Lumbar vertebrae	2	0.3	5.6
Pelvis	7	3.5	58.3
Ribs	7	0.3	4.5
Scapula	4	2.0	33.3
Proximal humerus	4	2.0	33.3
Distal humerus	12	6.0	100.0
Proximal radius	6	3.0	50.0
Distal radius	8	4.0	66.7
Proximal ulna	2	1.0	16.7
Carpals	2	0.2	2.8
Distal metacarpal	3	1.5	25.0
Proximal femur	4	2.0	33.3
Proximal tibia	3	1.5	25.0
Distal tibia	11	5.5	91.7
Tarsals	2	0.2	2.8
Astragalus	8	4.0	66.7
Calcaneus	8	4.0	66.7
Proximal metatarsal	5	2.5	41.7
Distal metatarsal	5	2.5	41.7
Phalanges	2	0.1	1.4
1st Phalanx	16	2.0	33.3
2nd Phalanx	8	1.0	16.7
3rd Phalanx	14	1.8	29.2

Table D5. MNE and MAU Values for Pronghorn from Wolf Village, Period II.

Element	MNE	MAU	%MAU
Mandible	9	4.5	90.0
Thoracic vertebrae	5	0.3	5.6
Lumbar vertebrae	3	0.5	10.0
Pelvis	10	5.0	100.0
Ribs	2	0.1	1.5
Scapula	3	1.5	30.0
Distal humerus	6	3.0	60.0
Distal radius	1	0.5	10.0
Proximal ulna	7	3.5	70.0
Carpals	2	0.2	3.3
Proximal metacarpal	3	1.5	30.0
Distal metacarpal	5	2.5	50.0
Proximal femur	2	1.0	20.0
Distal femur	1	0.5	10.0
Proximal tibia	1	0.5	10.0
Distal tibia	5	2.5	50.0
Tarsals	2	0.2	3.3
Astragalus	8	4.0	80.0
Calcaneus	10	5.0	100.0
Proximal metatarsal	6	3.0	60.0
Distal metatarsal	6	3.0	60.0
1st Phalanx	16	2.0	40.0
2nd Phalanx	20	2.5	50.0
3rd Phalanx	11	1.4	27.5

Table D6. MNE and MAU Values for Combined Small Artiodactyls from Wolf Village, Period II.

Element	MNE	MAU	%MAU
Antler/Horn	38	19.0	17.0
Cranium	112	112.0	100.0
Mandible	200	100.0	89.3
Cervical vertebrae	45	6.4	5.7
Thoracic vertebrae	78	4.3	3.9
Lumbar vertebrae	45	7.5	6.7
Pelvis	132	66.0	58.9
Ribs	717	27.6	24.6
Sternum	1	1.0	0.9
Scapula	127	63.5	56.7
Proximal humerus	20	10.0	8.9
Distal humerus	75	37.5	33.5
Proximal radius	13	6.5	5.8
Distal radius	52	26.0	23.2
Proximal ulna	38	19.0	17.0
Distal ulna	1	0.5	0.4
Carpals	24	2.0	1.8
Proximal metacarpal	63	31.5	28.1
Distal metacarpal	35	17.5	15.6
Proximal femur	37	18.5	16.5
Distal femur	21	10.5	9.4
Proximal tibia	15	7.5	6.7
Distal tibia	53	26.5	23.7
Tarsals	58	4.8	4.3
Astragalus	32	16.0	14.3
Calcaneus	55	27.5	24.6
Proximal metatarsal	67	33.5	29.9
Distal metatarsal	33	16.5	14.7
Phalanges	85	3.5	3.2
1st Phalanx	93	11.6	10.4
2nd Phalanx	102	12.8	11.4
3rd Phalanx	88	11.0	9.8

Appendix E:

Strontium Isotope Data

Table E1. Strontium (^{87}Sr/^{86}Sr) Results for Primary Samples from Wolf Village (42UT273).

Sample ID	^{87}Sr/^{86}Sr	Standard Error	MPC Catalog No.	Taxon	Provenience	Tooth	Side	Weight (g)
1494-01	0.71022	0.000005	2016.010.16450.016	*Odocoileus hemionus*	Str. 8 Floor zone	M$_3$	Right	0.07
1494-02	0.71014	0.000004	2012.002.09206.001	*Odocoileus hemionus*	Str. 2 Midden/Fill	M$_3$	Right	0.07
1494-03	0.70990	0.000003	2013.017.13606.000	*Odocoileus hemionus*	Str. 1 Room 3	M$_2$	Right	0.06
1494-04	0.71047	0.000005	2012.002.10238.003	*Odocoileus hemionus*	Str. 2 Roof fall/Floor zone	M$_3$	Right	0.08
1494-05	0.71020	0.000004	2013.017.13617.000	*Odocoileus hemionus*	Str. 8 Fill	M$_1$	Right	0.1
1494-06	0.71025	0.000004	2012.002.09148.001	*Odocoileus hemionus*	Str. 2 Midden/Fill	PM$_2$	Right	0.05
1494-07	0.70999	0.000004	2010.003.03598.002	*Odocoileus hemionus*	Str. 6 Ventilation tunnel	PM$_2$	Right	0.05
1494-08	0.70986	0.000006	2010.003.03448.003	*Odocoileus hemionus*	Str. 6 Ventilation tunnel	M$_2$	Right	0.05
1494-09	0.71032	0.000004	2012.002.09206.002	*Odocoileus hemionus*	Str. 2 Midden/Fill	M$_3$	Right	0.16
1494-10	0.71020	0.000004	2012.002.10230.002	*Odocoileus hemionus*	Str. 2 Midden/Fill	PM$_2$	Right	0.1
1494-11	0.71040	0.000005	2011.007.07286.002	*Odocoileus hemionus*	Str. 2 Midden/Fill	M$_1$	Right	0.07
1494-12	0.71060	0.000005	2012.002.08835.001	*Odocoileus hemionus*	Str. 2 Midden/Fill	M$_2$	Right	0.12
1494-13	0.71025	0.000004	2013.017.13536.000	*Odocoileus hemionus*	Str. 2 Midden/Fill	M$_2$	Right	0.08
1494-14	0.71014	0.000004	2016.010.16664.004	*Antilocapra americana*	Str. 8 Ventilation tunnel	M$_3$	Right	0.1
1494-15	0.71140	0.000005	2011.007.06929.001	*Antilocapra americana*	Str. 2 Midden/Fill	M$_1$	Right	0.11
1494-16	0.71022	0.000004	2016.010.15568.001	*Antilocapra americana*	Str. 9 Ventilation tunnel	M$_3$	Left	0.16
1494-17	0.71013	0.000004	2011.007.07286.003	*Antilocapra americana*	Str. 2 Midden/Fill	M$_1$	Right	0.05
1494-18	0.71021	0.000004	2016.010.15568.002	*Ovis canadensis*	Str. 9 Ventilation tunnel	M$_3$	Right	0.17
1494-19	0.71074	0.000004	2010.003.02733.001	*Ovis canadensis*	Str. 2 Midden/Fill	M$_3$	Left	0.09
1494-20	0.71001	0.000005	2010.003.03496.007	*Ovis canadensis*	Str. 2 Fill of eastern tunnel	M	Right	0.08
1494-21	0.71071	0.000005	2012.002.10401.000	*Ovis canadensis*	Str. 2 Midden/Fill	M	–	0.05
1494-22	0.71057	0.000004	2012.002.10238.002	*Ovis canadensis*	Str. 2 Roof fall/Floor zone	M$_2$	Right	0.13
1494-23	0.71025	0.000004	2013.017.12292.000	*Ovis canadensis*	Str. 1 Habitation room	M	–	0.1
1494-24	0.71021	0.000005	2013.017.13621.000	*Ovis canadensis*	Str. 8 Floor zone	M	–	0.06

Table E1. Continued.

Sample ID	$^{87}Sr/^{86}Sr$	Standard Error	MPC Catalog No.	Taxon	Provenience	Tooth	Side	Weight (g)
1494-25	0.71055	0.000005	2013.017.12602.000	*Ovis canadensis*	Str. 2 Midden/Fill	M_2	Left	0.12
1494-26	0.71024	0.000005	2012.002.10276.002	Small Artiodactyl	Str. 2 Midden/Fill	N/A	–	0.16
1494-27	0.71012	0.000005	2012.002.11294.001	Small Artiodactyl	Str. 2 Midden/Fill	N/A	–	0.07
1494-28	0.71021	0.000005	2016.010.14673.002	Small Artiodactyl	Activity Area #4	N/A	–	0.07
1494-29	0.71021	0.000005	2011.007.07959.002	Small Artiodactyl	Str. 2 Midden/Fill	N/A	–	0.06
1494-30	0.71011	0.000005	2012.002.09177.001	Small Artiodactyl	Str. 2 Midden/Fill	N/A	–	0.09

Table E2. Strontium ($^{87}Sr/^{86}Sr$) Results for Baseline Samples from Fremont Sites in Utah.

Sample ID	Site No.	Site Name	$^{87}Sr/^{86}Sr$	Standard Error	Catalog No.	Taxon	Side
1494-31	42SV633	Nawthis Village	0.70967	0.000004	42SV633FS1292.3	*Sylvilagus* sp.	Right
1494-32	42SV633	Nawthis Village	0.70942	0.000004	42SV633FS3074.101	*Sylvilagus* sp.	Right
1494-33	42SV633	Nawthis Village	0.71018	0.000005	42SV633FS3208.1	*Sylvilagus* sp.	Right
1494-34	42SV633	Nawthis Village	0.71018	0.000005	42SV633FS3214.32	*Sylvilagus* sp.	Right
1494-35	42SV633	Nawthis Village	0.70957	0.000005	42SV633FS3112.11	*Sylvilagus* sp.	Right
1494-36	42SV633	Nawthis Village	0.70995	0.000004	42SV633FS2956.5	*Sylvilagus* sp.	Right
1494-37	42SV633	Nawthis Village	0.71004	0.000004	42SV633FS3028.1	*Sylvilagus* sp.	Right
1494-38	42SV633	Nawthis Village	0.70992	0.000005	42SV633FS2878.1	*Sylvilagus* sp.	Right
1494-39	42SV633	Nawthis Village	0.70987	0.000004	42SV633FS1680.1	*Sylvilagus* sp.	Right
1494-40	42SV633	Nawthis Village	0.70964	0.000005	42SV633FS2878.1	*Sylvilagus* sp.	Right
1494-41	42JB02	Nephi Mounds	0.70849	0.000003	42JB02FS12769	*Ondatra zibethicus*	Left
1494-42	42JB02	Nephi Mounds	0.70941	0.000004	42JB02FS823.13	*Lepus* sp.	Right
1494-43	42JB02	Nephi Mounds	0.70845	0.000004	42JB02FS12739	*Ondatra zibethicus*	Left
1494-44	42JB02	Nephi Mounds	0.70855	0.000005	42JB02FS825.1	*Sylvilagus* sp.	Right
1494-45	42JB02	Nephi Mounds	0.70965	0.000004	42JB02FS711.50	*Lepus* sp.	Right
1494-46	42JB02	Nephi Mounds	0.70875	0.000005	42JB02FS460.1	*Ondatra zibethicus*	Left
1494-47	42JB02	Nephi Mounds	0.70867	0.000004	42JB02FS12880	*Ondatra zibethicus*	Left
1494-48	42JB02	Nephi Mounds	0.70839	0.000003	42JB02FS258.25	*Ondatra zibethicus*	Left
1494-49	42JB02	Nephi Mounds	0.70932	0.000004	42JB02FS12859	*Lepus* sp.	Left
1494-50	42JB02	Nephi Mounds	0.70906	0.000004	42JB02FS680.77	*Ondatra zibethicus*	Left
1494-51	42IN100	Parowan	0.71055	0.000004	42IN100FS283.5	*Sylvilagus* sp.	Left
1494-52	42IN100	Parowan	0.71015	0.000004	42IN100FS509.1	*Sylvilagus* sp.	Left
1494-53	42IN100	Parowan	0.71067	0.000004	42IN100FS238.3	*Sylvilagus* sp.	Left
1494-54	42IN100	Parowan	0.71015	0.000004	42IN100FS283.4	*Sylvilagus* sp.	Left
1494-55	42IN100	Parowan	0.71046	0.000004	42IN100FS283.6	*Sylvilagus* sp.	Left
1494-56	42IN100	Parowan	0.71046	0.000005	42IN100FS433.9	*Sylvilagus* sp.	Left

Table E2. Continued.

Sample ID	Site No.	Site Name	^{87}Sr/^{86}Sr	Standard Error	Catalog No.	Taxon	Side
1494-57	42UT273	Wolf Village	0.70949	0.000004	2016.010.16548.000	*Ondatra zibethicus*	Left
1494-58	42UT273	Wolf Village	0.70891	0.000004	2010.003.03565.015	*Ondatra zibethicus*	Left
1494-59	42UT273	Wolf Village	0.70928	0.000004	2012.002.10678.000	*Ondatra zibethicus*	Left
1494-60	42UT273	Wolf Village	0.70971	0.000004	2013.017.13518.000	*Ondatra zibethicus*	Left
1494-61	42UT273	Wolf Village	0.70951	0.000003	2013.017.13521.000	*Ondatra zibethicus*	Left
1494-62	42UT273	Wolf Village	0.70948	0.000003	2013.017.13678.000	*Ondatra zibethicus*	Left
1494-63	42UT273	Wolf Village	0.70970	0.000003	2016.010.16314.001	*Ondatra zibethicus*	Left
1494-64	42UT273	Wolf Village	0.71071	0.000003	2016.010.16692.030	*Ondatra zibethicus*	Left
1494-65	42UT273	Wolf Village	0.70915	0.000004	2012.002.09855.000	*Ondatra zibethicus*	Left
1494-66	42UT273	Wolf Village	0.71001	0.000004	2011.007.04942.004	*Ondatra zibethicus*	Left
1494-67	42IN43	Paragonah	0.70904	0.000004	42IN43125.8251	*Sylvilagus* sp.	Left
1494-68	42IN43	Paragonah	0.70931	0.000005	42IN43125.6798	*Sylvilagus* sp.	Left
1494-69	42IN43	Paragonah	0.70935	0.000004	42IN43125.8233	*Lepus californicus*	Left
1494-70	42UT102	Woodard Mound	0.70945	0.000004	1973.480.01175.614	*Ondatra zibethicus*	Left
1494-71	42UT102	Woodard Mound	0.70890	0.000005	1973.480.01179.252	*Ondatra zibethicus*	Left
1494-72	42UT102	Woodard Mound	0.70945	0.000005	1984.011.00457.000	*Ondatra zibethicus*	Left
1494-73	42UT102	Woodard Mound	0.70940	0.000004	1984.010.00246.004	*Ondatra zibethicus*	Left
1494-74	42UT102	Woodard Mound	0.70911	0.000004	1984.010.00246.010	*Ondatra zibethicus*	Left
1494-75	42UT102	Woodard Mound	0.70934	0.000004	1984.010.00246.000	*Ondatra zibethicus*	Left
1494-76	42UT102	Woodard Mound	0.70968	0.000004	1984.010.00246.000	*Ondatra zibethicus*	Left
1494-77	42UT102	Woodard Mound	0.70933	0.000004	1984.010.00246.000	*Ondatra zibethicus*	Left
1494-78	42UT102	Woodard Mound	0.70942	0.000003	1984.010.00246.000	*Ondatra zibethicus*	Left
1494-79	42UT102	Woodard Mound	0.70927	0.000003	1984.010.00246.000	*Ondatra zibethicus*	Left
1494-80	42UT111	Hinckley Mounds	0.71023	0.000003	2015.004.00218.004	*Ondatra zibethicus*	Left
1494-81	42UT111	Hinckley Mounds	0.71018	0.000003	2015.004.00218.001	*Ondatra zibethicus*	Left
1494-82	42UT111	Hinckley Mounds	0.71003	0.000003	2015.004.02463.010	*Ondatra zibethicus*	Left

Table E2. Continued.

Sample ID	Site No.	Site Name	$^{87}Sr/^{86}Sr$	Standard Error	Catalog No.	Taxon	Side
1494-83	42UT111	Hinckley Mounds	0.70998	0.000002	2015.004.00086.004	*Ondatra zibethicus*	Left
1494-84	42UT111	Hinckley Mounds	0.70984	0.000003	2015.004.01983.002	*Ondatra zibethicus*	Left
1494-85	42UT111	Hinckley Mounds	0.71005	0.000003	2015.004.02441.001	*Ondatra zibethicus*	Left
1494-86	42UT111	Hinckley Mounds	0.71021	0.000003	2015.004.02310.012	*Ondatra zibethicus*	Left
1494-87	42UT111	Hinckley Mounds	0.71017	0.000004	2015.004.00192.007	*Ondatra zibethicus*	Left
1494-88	42UT111	Hinckley Mounds	0.71016	0.000002	2015.004.01075.001	*Ondatra zibethicus*	Left
1494-89	42UT111	Hinckley Mounds	0.70972	0.000004	2015.004.02397.005	*Ondatra zibethicus*	Left
1494-90	42UT111	Hinckley Mounds	0.71022	0.000003	2015.004.01007.004	*Ondatra zibethicus*	Left

Appendix F:

MNE and MAU Values for Ten Fremont Sites

Table F1. MNE Counts for Ten Fremont Sites.

Anatomical Part	42SV1686 [1]	42SV633 [2]	42SV23 [3]	42IN100 [4]	42IN43 [4]	42IN40 [4]	26WP63 [5]	42UT111 [6]	42UT271 [7]	Bee Sites [8]
Antler/Horn	–	4	5	4	33	44	1	30	–	1
Cranium	1	12	18	187	48	81	42	35	4	6
Mandible	21	13	27	108	8	133	53	48	1	11
Atlas	–	1	–	24	4	5	1	2	–	–
Axis	–	10	4	14	–	16	1	–	–	–
Cervical vertebrae	–	9	17	70	21	54	15	17	–	1
Thoracic vertebrae	–	16	17	158	61	64	26	26	–	9
Lumbar vertebrae	–	5	16	213	84	70	57	24	2	5
Pelvis	–	16	–	232	116	171	64	23	2	10
Ribs	1	37	44	375	226	183	956	146	15	42
Sternum	–	2	–	3	–	2	1	–	–	–
Scapula	25	14	18	60	22	84	76	29	–	2
P. Humerus	1	7	2	13	10	16	1	1	–	1
D. Humerus	23	6	12	97	26	67	18	22	–	4
P. Radius	19	7	14	64	12	55	11	15	–	7
D. Radius	13	4	7	38	14	24	–	7	–	2
P. Ulna	10	5	9	29	11	37	4	9	–	2
D. Ulna	–	1	–	8	2	5	–	3	–	1
Carpals	1	26	35	68	32	160	29	31	3	10
P. Metacarpal	4	22	9	41	20	38	8	8	1	6
D. Metacarpal	9	6	6	121	21	187	8	9	1	2
P. Femur	–	11	5	32	4	54	5	6	–	4
D. Femur	2	8	3	26	17	21	4	4	–	–
P. Tibia	2	15	1	37	9	15	12	11	–	2
D. Tibia	40	21	13	40	5	24	4	17	–	2

Table F1. Continued.

Anatomical Part	42SV1686[1]	42SV633[2]	42SV23[3]	42IN100[4]	42IN43[4]	42IN40[4]	26WP63[5]	42UT111[6]	42UT271[7]	Bee Sites[8]
Tarsals	–	11	5	19	8	4	6	12	–	–
Astragalus	40	19	12	89	12	107	20	17	–	–
Calcaneus	35	11	7	107	18	79	16	12	2	1
P. Metatarsal	7	26	19	62	19	47	7	16	–	6
D. Metatarsal	33	17	2	76	16	133	4	11	–	4
Phalanges	130	–	–	25	4	11	6	21	1	1
1st Phalanx	–	42	101	81	16	102	10	27	–	2
2nd Phalanx	–	57	48	80	14	184	3	24	3	3
3rd Phalanx	–	89	45	87	20	196	4	32	3	3

[1] Five Finger Ridge (Talbot et al. 2000:484)

[2] Nawthis Village (Sharp 1992:152)

[3] Round Springs Site (Rood and Butler 1993:358–360)

[4] Parowan, Paragonah, and Summit/Evans Mound sites (Unpublished data courtesy of Sara Stauffer; see also Stauffer 2012)

[5] Baker Village (Unpublished data courtesy of Lindsay Johansson)

[6] The Hinckley Mounds (Note: Sites from the Hinckley Farm (42UT110, 42UT111, and 42UT112) have been condensed into one assemblage. Unpublished 2015 data courtesy of Michael Searcy; unpublished 1940s-1960s data courtesy of Lindsay Johansson and Adrien Mooney; see also Mooney 2014)

[7] Seamons Mound (Unpublished data courtesy of Lindsay Johansson and Adrien Mooney; see also Mooney 2014)

[8] Note: Fremont sites recorded by the Bees (Sites 6, 11, 13, 17, and 18) have been condensed into one assemblage. Unpublished data courtesy of Lindsay Johansson and Adrien Mooney; see also Mooney 2014

Table F2. %MAU Values for Ten Fremont Sites.

Anatomical Part	42SV1686 1	42SV633 2	42SV23 3	42IN100 4	42IN43 4	42IN40 4	26WP63 5	42UT111 6	42UT271 7	Bee Sites 7
Antler/Horn	–	15.4	–	1.1	28.4	23.5	1.2	42.9	–	8.3
Cranium	–	46.2	94.1	100.0	82.8	86.6	100.0	100.0	100.0	100.0
Mandible	52.5	50.0	91.2	28.9	6.9	71.1	63.1	68.6	12.5	91.7
Atlas	–	7.7	5.9	12.8	6.9	5.3	2.4	5.7	–	–
Axis	–	76.9	23.5	7.5	–	17.1	2.4	–	–	–
Cervical vertebrae	–	13.9	–	5.3	5.2	8.3	5.1	6.9	–	2.4
Thoracic vertebrae	–	9.5	–	4.7	5.8	3.8	3.4	4.1	–	8.3
Lumbar vertebrae	–	5.5	–	19.0	24.1	12.5	22.6	11.4	8.3	13.9
Pelvis	–	61.5	41.2	62.0	100.0	91.4	76.2	32.9	25.0	83.3
Ribs	0.2	11.0	17.5	7.7	15.0	7.5	87.5	16.0	14.4	26.9
Sternum	–	2.2	–	1.6	–	2.1	2.4	–	–	–
Scapula	62.5	53.9	100.0	16.0	19.0	44.9	90.5	41.4	–	16.7
P. Humerus	2.5	26.9	20.6	3.5	8.6	8.6	1.2	1.4	–	8.3
D. Humerus	57.5	23.1	32.4	25.9	22.4	35.8	21.4	31.4	–	33.3
P. Radius	47.5	26.9	20.6	17.1	10.3	29.4	13.1	21.4	–	58.3
D. Radius	32.5	15.4	20.6	10.2	12.1	12.8	–	10.0	–	16.7
P. Ulna	–	19.2	8.8	7.8	9.5	19.8	4.8	12.9	–	16.7
D. Ulna	–	3.9	–	2.1	1.7	2.7	–	4.3	–	8.3
Carpals	–	15.4	–	3.0	4.6	14.3	5.8	7.4	6.3	13.9
P. Metacarpal	10.0	84.6	17.6	11.0	17.2	20.3	9.5	11.4	12.5	50.0
D. Metacarpal	22.5	23.1	5.9	32.4	18.1	100.0	9.5	12.9	12.5	16.7
P. Femur	–	42.3	5.9	8.6	3.4	28.9	6.0	8.6	–	33.3
D. Femur	5.0	30.8	8.8	7.0	14.7	11.2	4.8	5.7	–	–
P. Tibia	5.0	57.7	5.9	9.9	7.8	8.0	14.3	15.7	–	16.7
D. Tibia	100.0	80.8	29.4	10.7	4.3	12.8	4.8	24.3	–	16.7

Table F2. Continued.

Anatomical Part	42SV1686[1]	42SV633[2]	42SV23[3]	42IN100[4]	42IN43[4]	42IN40[4]	26WP63[5]	42UT111[6]	42UT271[7]	Bee Sites[7]
Tarsals	–	21.2	–	0.8	1.1	0.4	1.2	2.9	–	–
Astragalus	100.0	73.8	14.7	23.8	10.3	57.2	23.8	24.3	–	–
Calcaneus	87.5	42.3	5.9	28.6	15.5	42.2	19.0	17.1	25.0	8.3
P. Metatarsal	17.5	100.0	44.1	16.6	16.4	25.1	8.3	22.9	–	50.0
D. Metatarsal	82.5	65.4	8.8	20.3	13.8	71.1	4.8	15.7	–	33.3
Phalanges	27.0	–	–	0.6	0.3	0.5	–	2.5	1.0	0.7
1st Phalanx	–	40.4	70.6	5.4	3.4	13.6	3.0	9.6	–	4.2
2nd Phalanx	–	54.8	31.5	5.3	3.0	24.6	0.9	8.6	9.4	6.3
3rd Phalanx	–	85.6	33.1	5.8	4.3	26.2	1.2	11.4	9.4	6.3

[1] Based on the MNE of bighorn sheep and deer (Talbot et al. 2000:484)
[2] Based on the MNE of small artiodactyls (Sharp 1992:152)
[3] Based on the MNE of bighorn sheep and deer (Rood and Butler 1993:358–360)
[4] Based on the MNE of all artiodactyls (Unpublished data courtesy of Sara Stauffer; see also Stauffer 2012)
[5] Based on the MNE of all artiodactyls (Unpublished data courtesy of Lindsay Johansson)
[6] Based on the MNE of all artiodactyls (Unpublished 2015 data courtesy of Michael Searcy; unpublished 1940s-1960s data courtesy of Lindsay Johansson and Adrien Mooney)
[7] Based on the MNE of all artiodactyls (Unpublished data courtesy of Lindsay Johansson and Adrien Mooney; see also Mooney 2014)
[8] Based on the MNE of all artiodactyls (Unpublished data courtesy of Lindsay Johansson and Adrien Mooney; see also Mooney 2014)

Appendix G:

Raw Bone Bead Data from Wolf Village

Table G1. Raw Bone Bead Data from Wolf Village. All measurements are in mm.

Catalog No.	Taxon	Element	Type	Length	Width	Thickness	Hole diameter	Weight (g)
2009.35.268.1	Artiodactyl	–	Disk	7.2	7.0	2.4	2.8	–
2009.35.978.1	Artiodactyl	–	Disk	10.3	10.3	3.2	4.1	0.3
2009.35.994.1	Artiodactyl	–	Disk	10.0	5.5	2.4	3.2	0.1
2010.3.2695.1	Large bird	Radius	Tube	11.0	11.4	2.6	–	–
2010.3.3031.1	Artiodactyl	Longbone	Tube	12.7	9.5	1.5	–	0.9
2010.3.3825.2	Large bird	Longbone	Tube	24.2	7.7	0.6	–	0.6
2010.3.4170.1	Small mammal	CF Tibia	Tube	31.8	5.6	0.9	–	0.8
2010.3.8118.1	Small mammal	Longbone	Tube	16.6	7.6	1.8	–	0.7
2011.7.4798.1	Small mammal	Longbone	Tube	7.4	2.8	0.3	–	–
2011.7.6953.1	Medium Anatidae	Humerus	Tube	32.4	7.4	0.8	1.6	0.6
2011.7.7605.1	Small mammal	Longbone	Tube	32.2	6.4	0.4	–	0.7
2012.2.10218.1	cf. *Lepus* sp.	Humerus	Tube	13.2	6.4	0.3	–	0.2
2012.2.10253.1	Large Anatidae	Humerus	Tube	49.9	6.7	0.5	–	1.1
2012.2.10254.1	Small mammal	Longbone	Tube	19.2	5.0	0.9	–	0.4
2012.2.10282.1	cf. *Sylvilagus* sp.	Femur	Tube	24.0	7.0	1.1	–	–
2012.2.11292.1	Large bird	Longbone	Tube	20.8	9.2	1.0	–	0.6
2012.2.9178.1	Large bird	Longbone	Tube	12.3	9.1	0.2	–	0.3
2012.2.9605.1	–	–	Disk	9.3	9.1	3.3	3.7	–
2012.2.9794.1	Small mammal	Longbone	Tube	12.7	5.7	0.3	–	0.4
2013.17.11821.1	Artiodactyl	–	Pendant	26.2	11.4	2.9	2.9	–
2013.17.11865.1	cf. *Lepus* sp.	Humerus	Tube	39.8	3.9	0.1	–	0.6
2013.17.11866.1	–	Longbone	Tube	6.4	3.9	0.3	–	–
2013.17.13798.1	Artiodactyl	–	Pendant	20.6	8.8	3.6	2.7	–
2013.17.13819.1	Artiodactyl	–	Pendant	19.3	8.6	3.0	3.0	–

Table G1. Continued.

Catalog No.	Taxon	Element	Type	Length	Width	Thickness	Hole diameter	Weight (g)
2013.17.13827.1	Small mammal	Longbone	Tube	33.1	4.3	0.4	–	0.6
2013.17.13829.1	Medium bird	Longbone	Tube	9.2	4.7	0.2	–	0.1
2013.17.13829.2	Medium bird	Longbone	Tube	7.7	5.9	0.4	–	0.1
2013.17.13830.1	cf. *Lepus* sp.	Radius	Tube	18.2	3.5	0.5	–	0.2
2013.17.13831.1	Small mammal	Longbone	Tube	14.4	4.6	0.3	–	0.3
2013.17.13832.1	Small mammal	Longbone	Tube	18.5	5.4	0.2	–	0.5
2013.17.13832.2	Small mammal	Longbone	Tube	13.7	3.6	0.2	–	0.1
2013.17.13832.3	Small mammal	Longbone	Tube	6.6	3.0	0.1	–	–
2013.17.13832.4	Small mammal	Longbone	Tube	9.0	3.3	0.9	–	0.1
2013.17.13850.1	–	–	Disk	7.5	7.8	2.1	3.4	0.1
2013.17.14035.1	Artiodactyl	Longbone	Pendant	21.8	8.1	1.7	3.7	0.3
2016.10.14479.1	Artiodactyl	–	Pendant	22.4	13.4	2.6	2.9	2.6
2016.10.14677.1	–	–	Disk	7.8	7.7	3.0	2.7	0.2
2016.10.14795.1	Medium bird	Longbone	Tube	11.4	3.6	0.2	–	0.1
2016.10.15747.1	–	–	Disk	7.1	4.2	0.6	0.6	–
2016.10.15853.1	Small mammal	Longbone	Tube	11.1	4.7	0.2	–	0.2
2016.10.16561.1	Artiodactyl	Longbone	Pendant	16.2	9.1	3.0	2.6	0.5
2016.10.16563.1	Bird	Longbone	Tube	10.5	5.2	–	–	0.3
2016.10.16812.1	Small mammal	Longbone	Tube	8.8	5.4	1.1	–	0.3
2016.10.16826.1	Small mammal	Longbone	Tube	16.6	5.2	1.3	–	0.2
2016.10.16849.1	cf. *Lepus* sp.	Longbone	Tube	29.9	7.6	1.2	–	1.1
2016.10.16855.1	Small mammal	Longbone	Tube	13.5	5.3	–	–	0.4