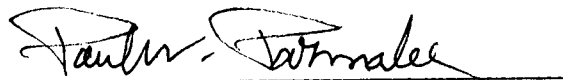


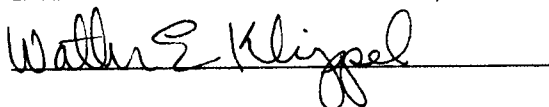
To the Graduate Council:

I am submitting herewith a thesis written by Mary Ellen Fogarty entitled "Bighorn Sheep and the Bugas-Holding Site Wyoming: A Study in Bone Breakage." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.



Paul W. Parmalee, Major
Professor

We have read this thesis
and recommend its acceptance:



Accepted for the Council:



Vice Provost
and Dean of the Graduate School

BIGHORN SHEEP AND THE BUGAS-HOLDING SITE, WYOMING:
A STUDY OF BONE BREAKAGE

A Thesis

Presented for the

Master of Arts Degree

The University of Tennessee, Knoxville

Mary Ellen Fogarty

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ABSTRACT

The identification of the patterns of bone fragmentation in archaeological faunal assemblages is useful in attempting to discern the possible agent or agents of bone destruction. Much work has been accomplished in the attempt to define the signature traits of animal destruction, but the pattern of human activity has yet to be defined. The unique formational history of the Bugas-Holding site in northwestern Wyoming and the quality of the bone recovered indicates that the breakage pattern is primarily referable to human activity. A description of this breakage pattern is the primary focus of this thesis, as this information will prove useful as a comparative example of cultural processing of bone.

A number of measurement techniques, some of which were newly designed for this study, are used to characterize the assemblage. The most important of these techniques is an actualistic study which quantifies the levels of identifiability the various elements undergo when reduced to fragmentary form. In this study, the majority of the elements underwent a 90% taphonomic loss due to fragmentation. Within the appendicular elements, when broken for marrow extraction, the general level of identifiability of the metatarsal, humerus, tibia, and femur is

approximately equal. The radius and metacarpal are less recognizable.

The Bugas-Holding site sheep breakage pattern shows a tendency for a greater processing of the humerus and femur with mixed results for the metatarsal. This difference is attributed to the preferential selection of these elements for grease processing.

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CHAPTER I

GENERAL INTRODUCTION

In early archaeological faunal analyses breakage was viewed in simple terms: the greater the degree of breakage, the greater the intensity of bone processing. In more recent years, researchers have suggested methods of discriminating between patterns of bone breakage on the assumption that differing patterns could be attributed to different agents of destruction. Some of these include: differentiating cultural versus carnivore destruction of bone (Binford 1981; Brain 1981; Bunn 1983), cultural versus natural bone breakage (Lyman 1984; Morlan 1984; Thorson and Guthrie 1984), and carnivore versus carnivore (Haynes 1981, 1983).

The primary objective of this thesis is to document the pattern of breakage evident in the bighorn sheep (Ovis canadensis) faunal assemblage of the Bugas-Holding site in northwestern Wyoming. The relevance in defining this pattern rests in the strong likelihood that this breakage is directly referable to human activity. If this premise is accepted, the documented pattern can be used as control data by other researchers attempting to identify the primary agent responsible for a bone accumulation. The secondary

objective of this thesis is to develop an interpretation of site usage that draws upon information derived from the breakage analysis, as well as ethnographic and historic accounts of the Tukikutikka, the historic Shoshone group inhabiting the area at the time of contact, and information on bighorn sheep ecology and behavior.

The Bugas-Holding site is located in northwestern Wyoming in the Sunlight Basin of the Absaroka Range of the Rocky Mountains. This area is approximately 36 miles northwest of Cody, Wyoming, and close to the eastern boundary of Yellowstone National Park. The Sunlight Basin floodplain sits at 6724 feet above sea level (ASL) and is surrounded by peaks which rise to 10-12,000 feet ASL. Sunlight Creek, a tributary of Clarks Fork of the Yellowstone River, forms the northern boundary of the site which thus far is estimated to be 2800 square meters in extent (Todd, Rapson and Ingbar 1984:2).

The site consists primarily of one well defined cultural level no greater than five centimeters (cm) beneath 50 cm of alluvium. The site was discovered in the 1970s through the excavation of a gasline trench near a ranch house on private land owned by the Bugas family. Testing and excavation programs have been conducted seasonally from 1983-1986 under the direction of George Frison, the

University of Wyoming, with grant funding provided by the National Science Foundation.

Through preliminary geomorphological work and study of the quality of bone recovered, it has been speculated that the site was occupied for one season and then quickly buried by low energy fluvial deposits. Site analysts have argued for a pristine site condition, citing such evidence as lack of size sorting of the elements, signs of no disturbance to delicate, conjoined elements such as nasals, and low evidence of carnivore and chemical damage. Due to this, the site was excavated meticulously, and all artifacts of 5 millimeters (mm) and greater in size were plotted in three dimensional space through use of grid coordinate system and transit. All fill from the site was water screened in 16 mm mesh. One hearth from the site has been radiocarbon dated to A. D. 1510 +/- 100, and site seasonality (based on bison fetal bones) has been determined to be late winter to early spring.

Bison (Bison bison bison) and bighorn sheep (Ovis canadensis) are the primary species represented so far at the site. A markedly lesser number (less than 1 %) of elk (Cervus elaphus) and pronghorn (Antilocapra americana) remains have also been recovered. This discussion will consider only the bighorn sheep faunal remains. As we are dealing with fragmentary bone in this study, the possibility

that elk and pronghorn fragments have been included in these bone computations exists, but it is likely that if present, they made only a small contribution to the material considered here.

The characterization of the Bugas-Holding bighorn sheep assemblage is difficult to accomplish due to the highly fragmented condition of the specimens. To undertake this task, means had to be devised to a.) determine element counts without reliance upon the articular ends as many of these appeared to have been selectively deleted, b.) show completeness of element representation despite the lack of fragments that could be refit and, c.) determine whether any inherent bias in element identifiability existed and, if so, how it could be controlled.

The first problem, that of quantifying element counts, was solved by using the most commonly identified element-specific landmark as representative of individual elements. Care was taken to insure the independence of each count. For some elements this most commonly identified landmark was a shaft fragment, for others it was the articular end.

The illustration of element completeness was accomplished through use of element diagrams which had been arbitrarily divided into sections. When a specimen identification was made, the appropriate section or sections the fragment represented was marked on the diagram. Counts

were made of these instances of representation. The final diagrams graphically display both through shading and raw count how many of the fragments came from the different parts of a complete element.

The final problem, that of potential bias in identifiability, was the most difficult to resolve. One aspect of this problem is the fact that only recognizable specimens, those that can be identified to species and element, are used in defining the breakage pattern. However, the fragmentation itself renders specimens non-identifiable. With greater destruction, therefore, less can be discerned of what we wish to define: the composition of the parent population and the method of breakage.

Additionally, the possibility that there may be inherent differences in identifiability from element to element must be addressed. If elements are not equally identifiable in a fragmented state, characterizations of assemblages would be biased towards the more readily recognizable elements. Studies which emphasize articular end counts as the basis of their calculations are not affected by this phenomenon, as the majority of the skeletal elements have the same number of uniquely identifiable articular ends. In highly fragmented assemblages, however, especially if selective deletion of the articular ends or other sections of the bone have occurred, emphasis must

shift to the levels of identifiability of the entire element.

Therefore, an actualistic study was conducted to help resolve some of the ambiguity surrounding potential differences in element identifiability. The study involved the controlled breakage of the elements of two white-tailed deer and an analysis of the identifiability of the resultant fragments. Estimations of the amount of taphonomic loss and relative levels of element identifiability under these specific conditions of breakage were produced. When compared to the Bugas-Holding site bighorn sheep frequency data, the results were an aid in developing an interpretation of site activities.

In addition to the diagrams of element completeness and element frequency data, other measures were implemented to characterize the breakage pattern. These included the estimation of the average fragment size per element, the percentages of impact scarring per element, and the average length of intact shaft per element.

In the final analysis, which combined the results of all of the above described measures, it appears as though the Bugas-Holding site bighorn sheep elements have undergone different levels of processing. While it is likely that all of the elements were processed for marrow extraction, the femur and humerus seem to have undergone greater levels of

fragmentation. It is considered likely that this differential element selection reflects a preference for certain elements in bone grease production.

The second objective of this thesis was accomplished by combining the assemblage breakage characterization with information derived from wildlife and ethnographic studies to offer an interpretation of how and why bighorn sheep were procured by the past inhabitants of the Bugas-Holding site.

The above information is organized in the following manner. Discussion of the relevance of the actualistic study and the experiment itself are presented in Chapters II and III. Chapter IV is the analysis of the Bugas-Holding site bighorn sheep assemblage breakage pattern as well as all of the measurement techniques. Chapter V contains general information on bighorn sheep ecology, and in Chapter VI, historic and ethnographic information on the Tukkutikka and bighorn sheep hunting is presented. Chapter VII contains the conclusions.

The major contribution of this thesis to the discipline is the characterization of a culturally derived pattern of breakage. This thesis is also significant in that it is a first attempt to quantify the relationship between identifiability and breakage. Although the bone breakage study results did not consistently detect differences in types of processing between elements in the data set, the

results are promising enough to encourage more research in this direction.

CHAPTER II

INTRODUCTION TO THE EXPERIMENT

Most archaeological bone assemblages are recovered in a fragmentary state. Analyses of these assemblages involve an initial focus on the identifiability of each specimen to the lowest taxonomic class possible, then to skeletal element if this can be discerned. Counts are then made of the various categories and, depending upon the research questions which are to be addressed, relative measures of species and element differences within the assemblage are then calculated. Fragmentary, non-identifiable bone specimens are rarely included in these analyses except in those situations where the quantity or quality of the bone itself is the subject of inquiry. Therefore, while non-identifiable bone generally makes up a significant portion of the recovered faunal remains, they are not, in most cases, included in the final characterization of a faunal assemblage. In assemblages where the bone has undergone a moderate amount of processing or destruction, the amount of information taphonomically lost due to breakage is most likely balanced out by the presence of isolated but highly identifiable articular ends. In those assemblages which have undergone severe fragmentation or selective deletion of articular

ends, however, this loss may have a profound effect on the accuracy of the analyses. Certain species or elements once present may go completely unaccounted for due to extensive processing.

Although it is generally recognized that the quality of specimen identification is directly related to the expertise of the zooarchaeologist analyzing the sample, any potential bias that may exist due to an inherent difference in the recognizability of the specimens themselves has yet to be quantified.

Therefore, the following study was designed to determine if such a bias may exist and how extensive the resultant information loss might be.

In the few studies where this differential visibility of specimens has been considered, researchers have expressed quite different operating assumptions. In one instance, Binford and Bertram (1977:125) offered the extreme opinion that all bone fragments are potentially identifiable, whereas Daly (1969:147) offered the opinion that certain broad classes of specimens such as vertebrae, ribs, and long bone "splinters" were not identifiable. Since both of the above statements are speculative and generalized, the following attempt to quantify this level of specimen identifiability is warranted.

Specimen recognition occurs on two levels in faunal

analysis, to species and to element. This study will focus solely on the identification of fragments to the element level.

It is my contention that due to the varying incidence of specific landmarks on certain bones, not all skeletal element fragments have the same probability of being identified. An experimental blind test was devised to measure the extent of these potential differences. This study is primarily relevant to faunal analysts interested in the information potential of skeletal element frequencies. Additionally, four primary methods of specimen quantification are based upon element identifications, and the identification of a possible bias in identifiability will have an effect upon these also.

In the following discussion I present a brief description of the major quantification techniques used today to illustrate how they are affected by fragmentation and differential identifiability. Where appropriate, I offer examples of other researchers' use of these measures to interpret fragmented assemblages without regard for this potential inherent bias. I then discuss one comparative technique suggested as a method of discerning the agent responsible for bone destruction which does not consider the possibility of differential identifiability.

QUANTIFICATION

Based on a review of the faunal literature, the faunal quantification measures in current use are the Minimum Number of Individuals (MNI), the Number of Identified Specimens (NISP), the Minimum Number of Elements (MNE) and the Minimum Number of Animal Units (MAU).

Minimum Number of Individuals (MNI)

The ultimate goal of this measure is to represent the minimum number of complete animals that could have been responsible for the sample of identified bones. Although there is some disagreement regarding how MNI calculations are made, Chaplin (1971:70-75) suggests this be accomplished by counting the most frequently identified and similarly sided element of a species, combined with counts made of other fragments which due to size, age, or other distinguishing criteria can be confidently counted as additional individuals. The element identification in MNI calculations is traditionally based on an articular end.

Fragmentation directly affects the certainty that specimens from the same individual have not been counted more than once, and Chaplin (1971:73) specifically excludes shaft fragments from his calculations due to this potential resulting error. Klein and Cruz-Urbe (1984:27) have discussed another aspect of this problem, that of

fragmented articular ends, and suggest that these be expressed as fractions of complete bones. Although fragments are traditionally viewed as a problem in quantifying faunal remains in highly fragmented assemblages, particularly where articular ends have been destroyed, diagnostic fragments could be counted instead of articular ends. Shaft landmarks which are element and side specific (such as the teres major tubercle of the humerus) may be the most frequently occurring identifiable specimen. These signature landmarks can be legitimately considered representative of different individuals if only clearly independent landmarks are counted. Indeed, an analyst who ignores a count of 10 left tibial crests in favor of a lesser number of articular ends is clearly deflating the MNI values for a counting unit.

A potential bias in element identifiability will not adversely affect MNI calculations if the researcher is aware of the possibility of interdependence. As this measure focuses on the most identifiable section of bone, knowledge of the signature quality of most of the boney landmarks can be an aid in making these calculations.

Number of Identified Specimens (NISP)

Calculation of the identified specimen counts are counts of all bone fragments that are identifiable to species. While the identification to species is what is sought in this technique, the presence of greater numbers of

signature landmarks in highly fragmented assemblages certainly will inflate the NISP count for a species. It is recognized that the NISP calculation has a number of inherent weaknesses (Grayson 1983:24; Klein and Cruz-Urbe 1984:25), but when used in the ratio of NISP/MNI it is a useful measure of the extent of fragmentation within an assemblage (Klein and Cruz-Urbe 1984:25). Researchers should be advised, however, that if certain elements are more identifiable in the fragmentary state, the kinds of elements which served as the basis for the fragmentation will also influence the NISP counts as much as the degree of fragmentation.

This phenomenon appears to be illustrated, although this was not the author's intent, by Noe-Nygaard (1977) in his comparison of the fragmentation patterns of the Star Carr and Praestelyngen faunal assemblages. Study of the data presented by the author indicates that the assemblage with the higher NISP count (766), Praestelyngen, averaged a higher number of identified fragments per element, which was 3-4, than the assemblage with the lower NISP count (588), Star Carr, which averaged 2-3 fragments per element (Noe-Nygaard 1977:233). Additionally, the Praestelyngen roe deer assemblage was represented by all skeletal element classes while the Star Carr roe deer assemblage lacked one major class of element, the femur. Although this lack of the femur

as a causal factor in a reduction of NISP counts is speculative, it serves as an illustration of the possible effect identification bias may have on NISP counts.

Minimum Number of Elements (MNE) and Minimum Number of Animal Units (MAU)

Skeletal element frequency data have been of interest to American archaeologists since White (1952, 1953a, 1953b, 1954, 1955) pointed out its potential utility in interpreting site function. Simply put, the presence of an element in an assemblage may be interpreted as representative of specific site use after all other assemblage characteristics have been considered.

White suggested that patterning in element representation in an assemblage, meat bearing bones versus marrow bones for example, might be indicative of site function. Binford (1978) found ethnographic support for these ideas among the Nunamiut of Anaktuvuk Pass, Alaska, and he categorized the various skeletal elements as representative of either high utility or low utility in terms of meat, marrow, or grease potential.

Analysts who choose to discuss faunal remains in terms of their food utility use the minimum number of elements (MNE) as their basic counting unit, and also the minimum animal unit (MAU). Both terms were introduced by Binford in his discussion of the Klasies faunal material (Binford

1983:50-51) and it has gained popularity among analysts interested in questions pertaining to the processing and transport of animal segments.

Binford suggests that the MNE be calculated by counting the minimal number of fragments which represent a defined area of the element. The most frequently occurring element portion is presented as the MNE, although it is also useful to list counts of all the areas of an element that have been identified as an indication of the amount of processing the various elements have undergone. Siding, age, size, or sex criteria are not considered in this calculation, as only the counts of anatomical parts are of interest.

These counts can later be presented as MAU's, which is simply the MNE divided by two.

It is with the MNE and MAU calculations that an inherent bias in identifiability has the most serious effect upon the results of an analysis. Greater counts of shaft landmarks can totally bias interpretations in favor of these elements if certain controls are not met. This would be especially true in assemblages where selective deletion of the articular ends has taken place.

An example of a study which may be illustrative of this inherent bias is that of Bunn and Kroll (1986:434-436) in their discussion of the skeletal element frequencies of the faunal material recovered from the Zinjanthropus floor at

site FLK in Olduvai Gorge, Tanzania. The authors use these frequencies, along with other lines of evidence, to help define the extent to which Plio/Pleistocene hominids obtained and processed animal carcasses. Bunn and Kroll present newly derived MNE counts for these faunal remains which they specifically state are based upon shaft fragments as well as articular ends. The authors justify this new count by their suspicion that some articular ends had been destroyed by scavengers, thus deflating the previous count. The authors only minimally discuss the basis for their fragment identifications but do mention they included only those fragments which they were certain represented a separate element. While this caution is well taken, this does not control bias due to differential identifiability.

With the new calculations, Bunn and Kroll noted a radical change from previous counts for the radio-ulna, femur, and tibia, which increased by 50%, 367%, and 282%, respectively. Counts of the humerus, metacarpal, and metatarsal, however, barely changed. The authors observed that for the largest class of animals, the metapodials showed the lowest frequency of occurrence, whereas among the smaller classes of animals, the representation of all element types was fairly even. Additionally, they indicated that half of the total metapodial MNE for the smaller classes of animals were unbroken.

Bunn and Kroll (1986) interpret these observations as indications of the introduction of the smaller carcasses as complete leg units and a transport pattern among the larger class of animals which favored only the heavier meat bearing bones. Although the authors do not present information on other assemblage fragmentation characteristics such as the number of unidentified fragments nor the size or quantity of bone fragments overall, it is plausible to suggest that the magnitude of change observed in the identification of tibia and femur fragments may be in part due to a higher recognition factor with these well landmarked elements. If the assemblage was subjected to articular end destruction, as the authors maintain, less well landmarked bones (such as the metapodials) will be less represented in these counts.

ANALYTICAL TECHNIQUES

In addition to the above quantitative measures, there is one published technique suggested for use in the analysis and comparison of fragmented bone data which also could be strongly influenced by differential element identifiability.

During the course of his work with the Nunamiut, Binford (1978:155-157) devised a comparative technique which involves the calculation of the ratio of broken articular

ends to the number of fragments identified for that element. The technique is based on observations made while a Nunamiut couple, Jean and Johnny Rulland of Anaktuvuk Pass, extracted marrow from the bones of five caribou. Binford felt he had documentation of an element-specific regularity in the number of fragments ("splinters" and "chips") produced during this activity. He then suggested that given the recovery of any number of broken articular ends in an assemblage one could estimate the number of bone fragments which should be present if marrow processing had occurred. For example, relying on Binford's (1978:155) Table 4.6, if one humerus articular end is recovered an average of 3 "splinters" should have been produced. This information, viewed in light of other measured assemblage characteristics could then be used to interpret the factors responsible for the formation of the bone deposit. For example, if the expected number of fragments is less than the observed number of fragments, one could suspect that some deletion of articular ends had taken place.

In this case, any inherent bias in the identifiability of the fragments themselves would directly affect the number of fragments counted as representing any one element. Elements with low recognition probabilities would most likely be consistently underestimated. Binford did recognize this potential problem to some degree and suggests that

metapodials would be affected in this manner, but he appears confident this is still a good measure overall (Binford 1981:177).

CHAPTER III

THE EXPERIMENT

The following experiment was designed to determine if any inherent identification bias exists among skeletal elements in a fragmentary state and, if so, to measure the extent of this bias.

EXPECTATIONS

The decision to design and implement this study came about during an extensive element identification exercise involving bighorn sheep bone fragments from the Bugas-Holding site, a late prehistoric habitation site in northwestern Wyoming. During the course of this analysis a series of expectations regarding what factors might influence fragmentary element identifiability were formulated. The primary influencing factors were thought to be the presence of two or more articular surfaces as well as a high count and even spacing of signature landmarks over the extent of a bone. With fragmentation, a bone with a higher number of these factors would most likely have a greater probability of being identified. Bone density and distinctive internal structure were also thought to be

important but secondary identifying factors, as these features cannot be used in and of themselves to confirm an identification. It was also recognized that the degree of fragmentation an assemblage has undergone will affect the differential visibility of the original element population, as more extensive fragmentation would increase the incidence of fragments without signature landmarks. This factor was controlled to some degree by specifying the conditions of breakage. Breakage variation is, however, a factor that significantly impacts the applicability of this study, and this is discussed in some detail at the end of this chapter.

Expectations regarding element identifiability were formulated prior to conducting the experiment. I discuss these below on an element by element basis. These observations were made of a white-tailed deer (Odocoileus virginianus) specimen housed in the University of Tennessee comparative collection. This species was chosen for use in the experiment due to its frequent and abundant presence in faunal deposits throughout the eastern United States, its size comparability to the species of interest, Ovis canadensis, and the availability of white-tailed deer specimens. The element characteristics discussed below generally hold true for all species of ungulates. Notable exceptions include the caribou metatarsal and bison radio-cubitus.

Given the primary influencing factors of high articular end counts and the spacing of landmarks, it was expected that the cranium, pelvis, and mandible would be highly identifiable, as would be the tibia, femur and humerus. Elements which were expected to be less identifiable were the metapodials, radius, and scapula. Information on the identifiability of the ulna was not directly collected in this analysis due to its "rider" association with the radius.

The cranium is made up of a variety of separate distinctly shaped bones and features which are spread evenly over the surface of the element. An illustration of the cranium which depicts a number of these features and bones is offered in Figure 3.1. Additional identifying characteristics are the presence of the maxillary teeth and three articular surfaces.

The pelvis is a composite of the fusion of several bones. These are the pubis, ischium, and ilium which fuse to form each innominate, and the pair of innominates which fuse with maturity to form the pelvis. As a complete bone, the pelvis has four articular surfaces as well as a variety of distinctive features such as the ischiatic spines and sacral tubers (Figure 3.2). Pelvis bone in general is more dense than that of other elements, with the possible exception of the calcaneus and astragalus.

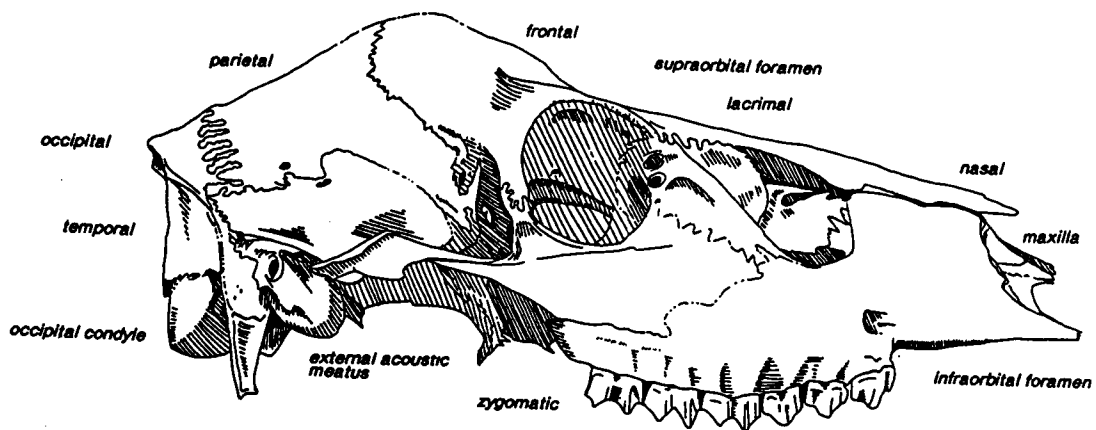


Figure 3.1 Diagnostic Bones and Features of the Cranium
White-tailed Deer, Odocoileus virginianus.

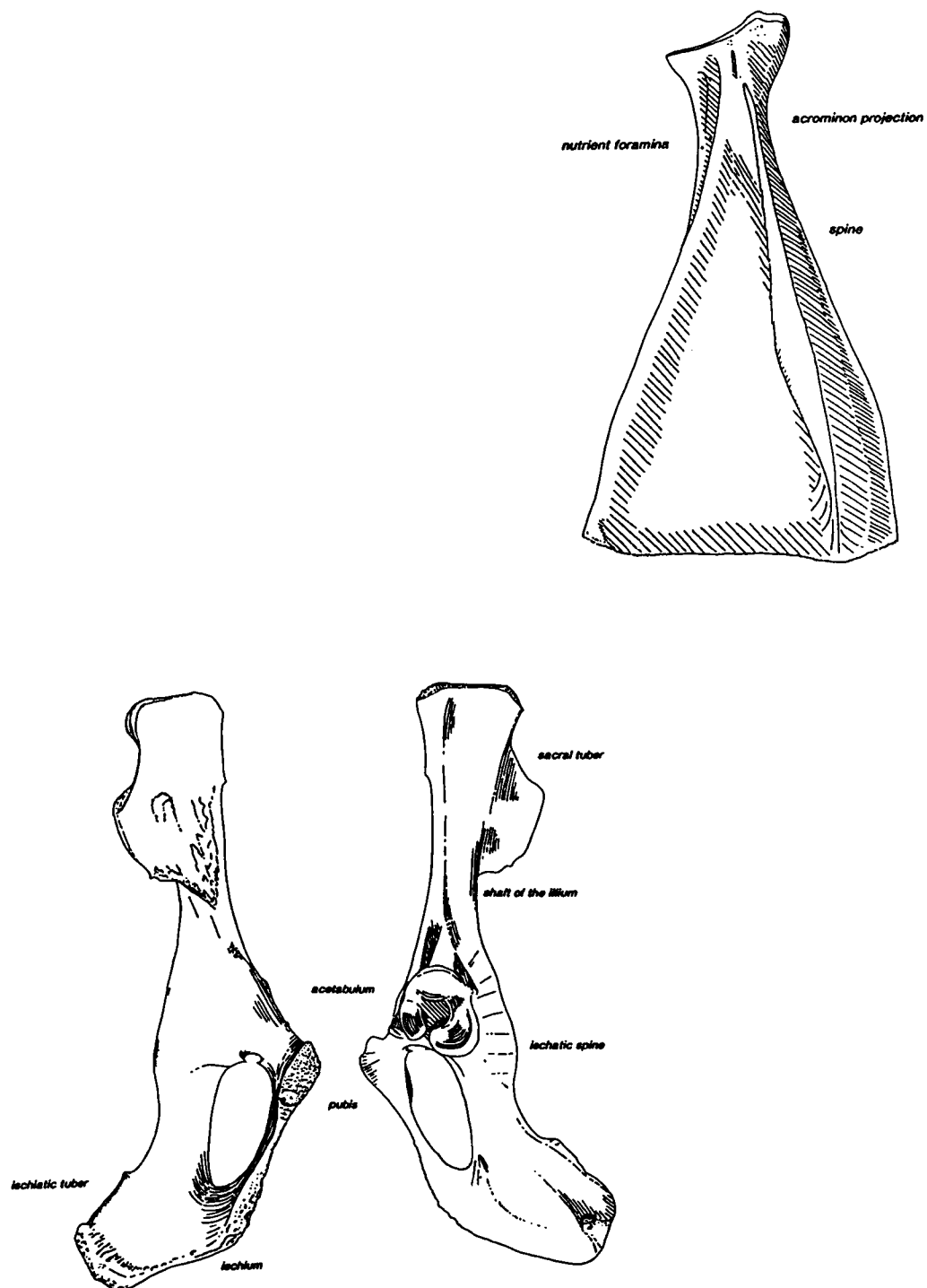


Figure 3.2 Diagnostic Features of the Pelvis and Scapula, White-tailed Deer, Odocoileus virginianus.

The mandible was also considered highly identifiable due to the presence of the mandibular teeth, the density of this element, and the distinctive appearance of the ascending ramus. This element has two articular surfaces.

Of the longbones, the humerus was considered to be one of the most identifiable with four landmarks somewhat evenly spread along the shaft and ends of the bone. These are the deltoid tuberosity, the teres major tubercle, the olecranon fossa, and the posterolateral foramen (Figure 3.3). The element also has a distinctive lattice and ladderwork pattern within its marrow cavity.

As the femur has five evenly spaced shaft landmarks, this element was also considered to be a highly identifiable element. These landmarks are: the lesser trochanter, anterior nutrient foramen, supracondyloid fossa, medial supracondyloid tuberosity, and two prominent posterior muscular lines (Figure 3.4). Additionally, femur fragments tend to be thin-walled and smooth internally.

The tibia has three distinguishing shaft features. These are the posteriolateral foramen, the anterior crest, and a series of posterior muscular lines which run from near the proximal extremity to approximately mid-shaft of the bone. These features are all found along the proximal end of the shaft while the distal shaft is basically smooth (Figure 3.4).

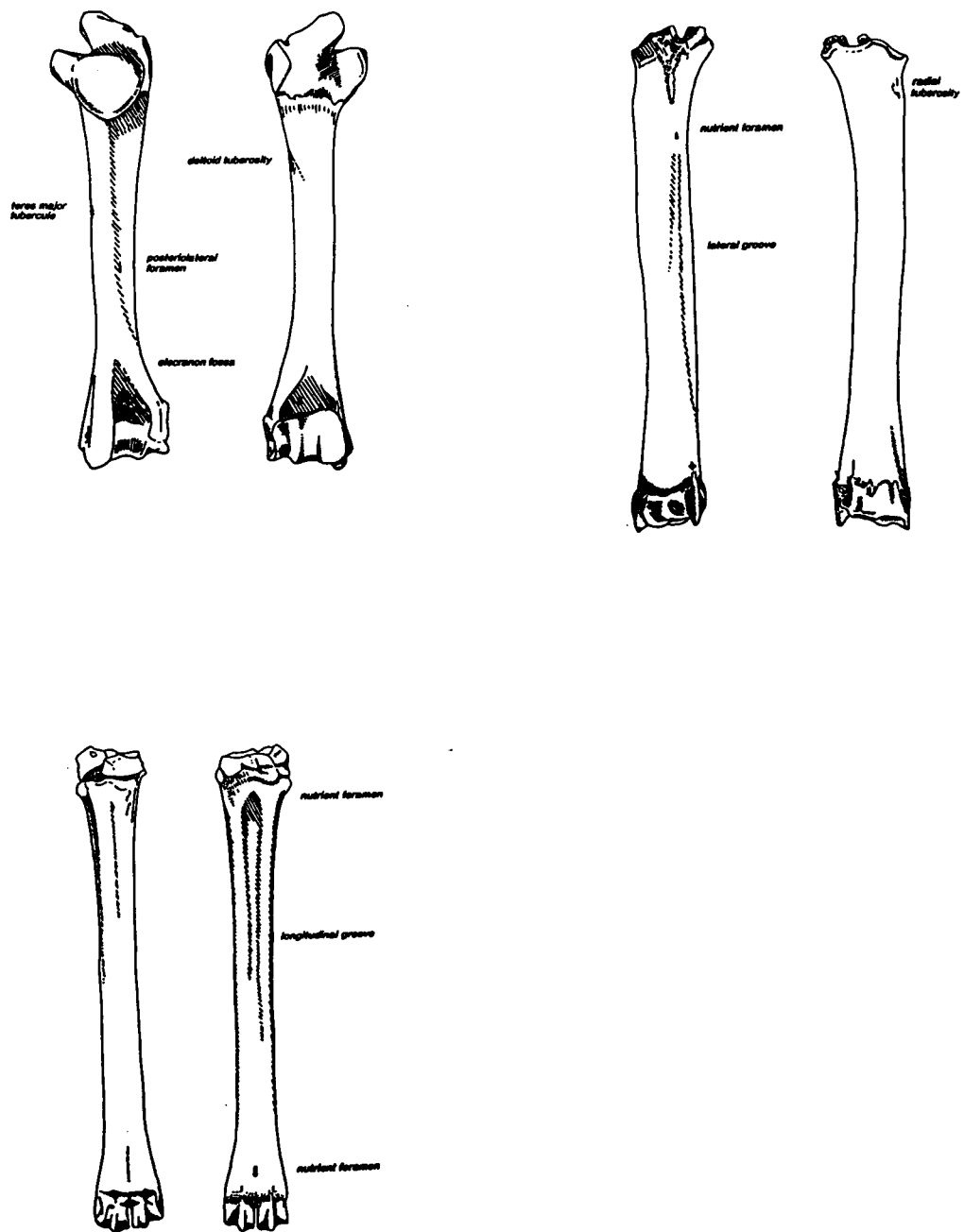


Figure 3.3 Diagnostic Features of the Humerus, Radius, and Metacarpal, White-tailed Deer, Odocoileus virginianus.

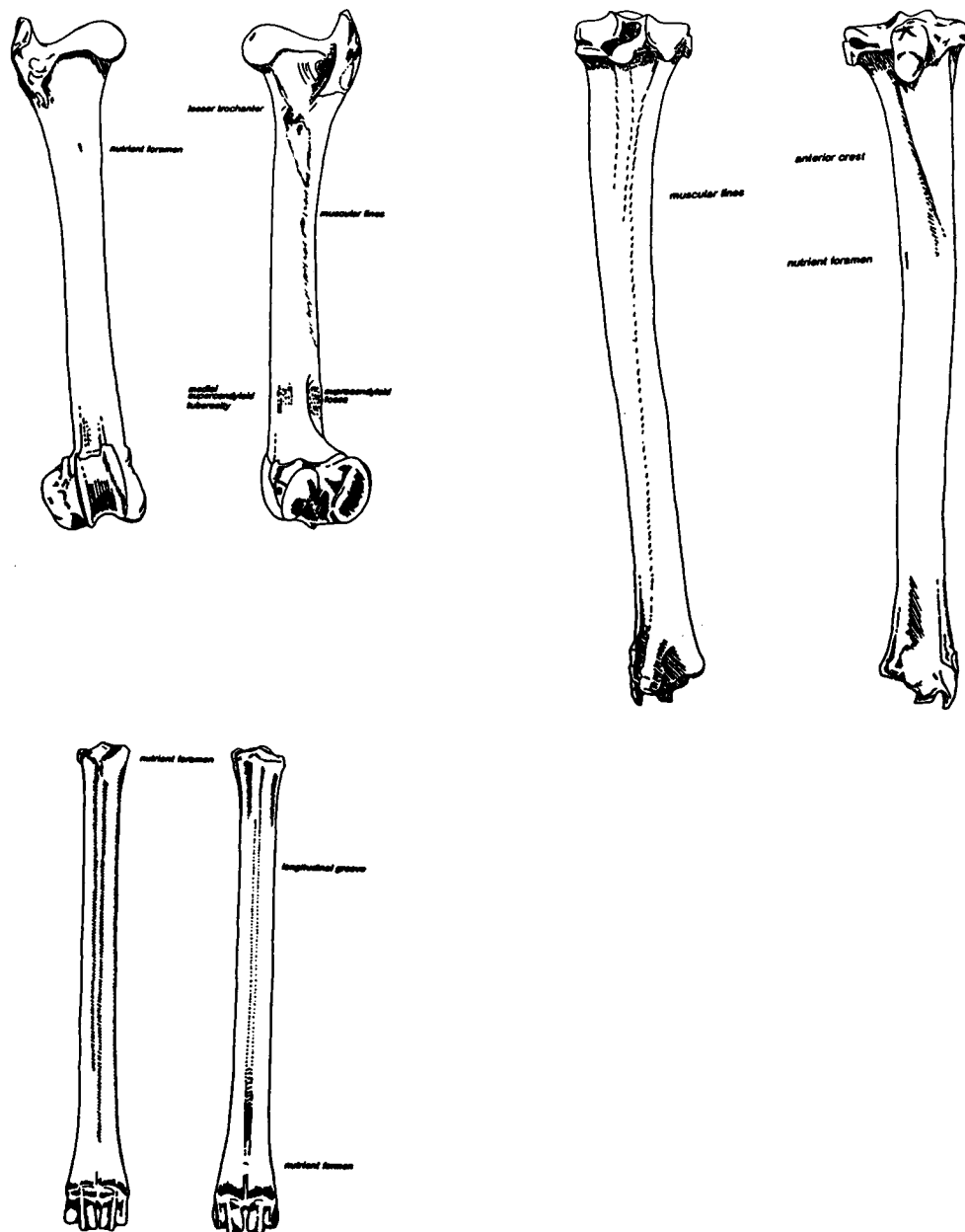


Figure 3.4 Diagnostic Features of the Femur, Tibia, and Metatarsal, White-tailed Deer, Odocoileus virginianus.

The white-tailed deer scapula (Figure 3.2) has three bony features which would stand out as distinctive landmarks when in a fragmentary state. These are the thin curved spine with its pointed acromion projection, and two nutrient foramina on and near the caudal border. These features are all located towards the articular end, however, which would reduce the chance that a diagnostic fragment would be found. Scapula identification was also thought to be less likely than other elements in that each scapula has only one articular end, but the thin flat fragments from the blade might prove distinctive in fragmentary form.

The radius, metacarpal, and metatarsal were expected to fall generally in the same low level of identifiability in that a great deal of their shaft surface area, in comparison to the other longbones, is smooth. On the whole, the three elements are more dense than the other major limb bones.

The radius has three diagnostic landmarks: the posterolateral foramen, the radial tuberosity, and the lateral groove which supports the shaft of the ulna. The lateral groove runs the length of the shaft, and the remaining two features are located close to the proximal and distal extremities of the bone (Figure 3.3).

The metacarpal is also basically smooth, exhibiting only three shaft landmarks: the wide dorsal longitudinal

groove, and the proximal and distal nutrient foramen. As with the radius the two foramen are located close to the articular surfaces of the bone (Figure 3.3).

The metatarsal is very similar to the metacarpal in that it has two articular ends and a vascular groove (Figure 3.4). This groove is more pronounced in this element, however, and runs a greater length of the bone.

SAMPLE COMPOSITION

Two deer specimens were used in this experiment. Both of these individuals were highway fatalities donated to the University of Tennessee by the Tennessee Wildlife Resources Agency. To create a realistic approximation of an archaeological faunal assemblage, an attempt was made to include two quite diverse individuals, one a skeletally complete four year old male, and the second a skeletally incomplete yearling doe. The doe was missing the left scapula, left metatarsal, and left tibia. It was reasoned that a variety of fragmentary sizes and breakage conditions would be obtained by using these diverse individuals due to the inherent difference in element representation, epiphyseal fusion, and sexual dimorphism.

Sample preparation

Each carcass was processed in the following manner.

The long bones and pelvis of each were stripped of meat and broken in a fresh, green state with the periosteum still intact. Due to difficulties in removing all the meat from the vertebrae, phalanges, and crania, these sections were cleaned through slow cooking processing prior to breakage.

Breakage

Four people of varying strengths were involved in breaking the bones, and neither skeleton was exclusively broken by one person. Bone-breakers were instructed to break the mandible, humerus, radius and ulna, metacarpal, femur, tibia, and metatarsal of each skeleton with the intent of extracting marrow. Breakage instructions for the axial elements, the crania, sternum, ribs, scapula, pelvis, and vertebra, as well as the phalanges, carpals, tarsals and sesamoids were to fragment these elements for grease production.

Points of impact for both sets of long bones were those previously identified in the Bugas-Holding site bighorn sheep assemblage. These impact points were marked for reference on a deer specimen from the University of Tennessee osteological faunal collection which the bone-breakers had access to throughout the experiment. The axial elements had no defined point of impact and were just generally smashed. All bones were broken through use of several small, smooth hammerstones. Specific information regarding the number of

times a particular element was broken was not collected. The bone-breakers were independent judges as to whether the desired aim, marrow extraction or grease production, could be accomplished with the resultant degree of breakage.

In the case of those bones which were broken for marrow, each element was broken individually and treated separately, with the exception of the radius and ulna which were broken as discrete pairs. All of the bone fragments derived from each element were collected and placed in separate boxes which were labeled according to individual, side, and element.

Of the elements broken for grease processing, the rib group (ribs plus sternbrae), vertebrae group (all types), and phalange group (carpals, tarsals, and phalanges) were broken and boxed collectively as single groups of like items for each individual. The intent in including these broken fragments was to more closely approximate a recovered bone assemblage in the form of a broad element population and a greater variety of bone fragments. However, due to the fact that these elements were not broken in a separate, controlled manner, specific information such as the relative identifiability of thoracic versus lumbar vertebrae is not available for these elements. The remaining grease elements, the crania, scapula, sternebra, and pelvis received more individual treatment. The older, fused pelvis of the mature

male was treated as one bone while the doe innominates were processed as two separate bones. As a result, the buck contributed 21 discrete elements to the fragmentary assemblage, and the doe contributed 19 discrete elements (Table 3.1).

TABLE 3.1

NUMBER OF ELEMENTS CONTRIBUTING TO THE EXPERIMENTAL ASSEMBLAGE; COUNTS PER INDIVIDUAL DEER

ELEMENT	BUCK	DOE
Crainum	1	1
Mandible	2	2
Humerus	2	2
Radius/Ul	2	2
Metacarpal	2	2
Scapula	2	1
Pelvis	1	2
Femur	2	2
Tibia	2	1
Metatarsal	2	1
Vertebral Group	1	1
Phalange Group	1	1
Rib Group	1	1
Total	21	19

Numbering

The separate boxes of bone fragments were cleaned, some through dermestid action and others by cooking, then allowed to dry. Through use of a random numbers table keyed to the individual box numbers, all of the fragments generated in

the experiment were serially assigned numbers from one to 1918, and each specimen number was inked on to the surface of each fragment. A master list was kept of these fragment assignments, and all of the 1918 fragments were placed collectively in a box.

Identification

Two individuals were responsible for independently identifying the fragments. Each fragment was therefore analyzed separately and received two separate identifications. At no time did the two analysts confer on a fragment identification. Identifier #1 had no previous knowledge of the death assemblage other than that it consisted of deer bone. Identifier #2 was aware of the number of individual deer involved and the variety of elements which were included. The experiment analysts also differed in their levels of professional experience. Identifier #1 had approximately 10 years of experience in faunal analysis which emphasized identification to species. Identifier #2 had less than three years of faunal identification experience but was more experienced in identifying fragments to element. Neither identifier had seen the fragments produced prior to receiving the box of identified specimens. Given that the fragments could conceivably be refitted or otherwise organized into likely groups for identification, the identifiers were instructed

to draw a fragment from the box, make an identification, and then remove that fragment from consideration. Lists of the fragment identifications per element were compiled by each identifier and these were compared to the master list of identifications upon the completion of this phase of the experiment.

RESULTS

The experimental results and the basis of the calculations of the element identifiability percentages are presented in Table 3.2.

TABLE 3.2
EXPERIMENT RESULTS

ELEMENT	A Identifier		B mean id specimens	C total fragments	D # of elements	E* %Id
	#1	#2				
Cranium	129	223	176	317	2	.27
Scapula	13	10	11.5	34	3	.11
Mandible	15	16	15.5	50	4	.07
Pelvis	16	27	21	97	3	.07
Metatarsal	16	15	15.5	47	3	.10
Humerus	16	21	18.0	49	4	.09
Tibia	17	14	15.5	55	3	.09
Femur	19	21	20	67	4	.07
Metacarpal	8	8	8	30	4	.06
Radius/Ul	20	28	25	69	8	.04
Totals	269	383	326	815	38	

* $E = B/C/D$

In Column A, the counts of the correctly identified fragments are presented by analyst. These counts are averaged in Column B. Column C lists the total number of fragments per element included in the experiment, and Column D indicates how many individual elements contributed to that fragment total. Column E is the percentage of identifiability. This was calculated by dividing the values of column B by C and then norming the resultant percentage with the value in Column D. This Column E percentage, therefore, is an indication of how much of the element surface was identified given the number of fragments produced for each element. A graphic illustration of these percentage results is offered in Figure 3.5.

As illustrated in Table 3.2 and Figure 3.5, the axial elements retained a higher visibility per element in their fragmentary state with a range of 27% to 7% identifiability. The long bones, in contrast, ranged from 10% to 4%. The crania underwent the least amount of taphonomic loss with 27% (n=2) of each element accurately identified. The scapulae followed at 11% (n=3). The pelvis(n=3) and mandible (n=4) both fell within the general range of long bone identifiability at 7%. The long bones were identified at generally the same level, with the metatarsal (10%:n=4), tibia (9%:n=3), and humerus (9%:n=4) at slightly higher percentages per element, and the femur (7%:n=4),

%
Identifiable

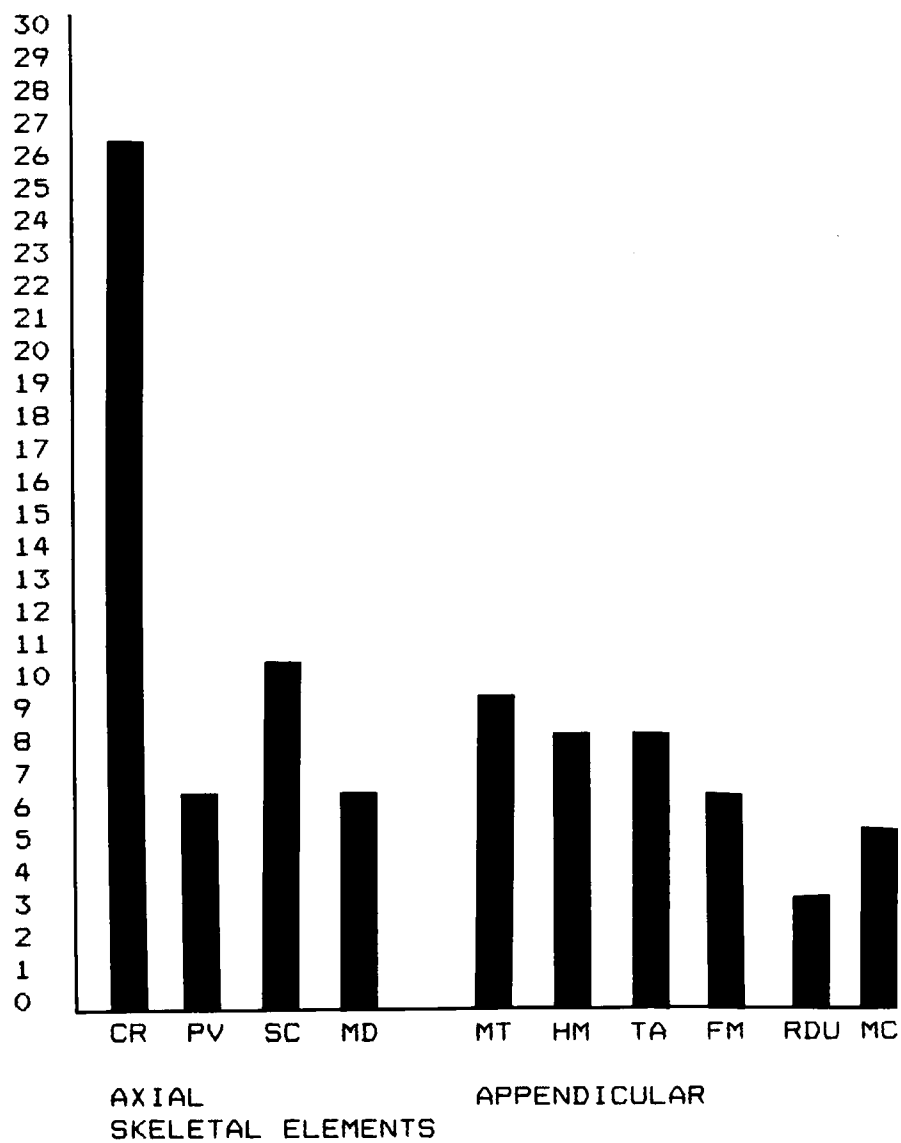


Figure 3.5. Percentage of Fragments Identified per Element (with articular ends).

metacarpal (6%;n=4), and radius-ulna (4%;n=8) at a lower level. When compared as mean numbers of bones identified per element, the element differences appear to be even more stark (Figure 3.6). Eighty-eight cranial bones were identified per element whereas only two metacarpal identifications were made per element. The major long bones again ranged generally at the same level with approximately five fragments identified for each bone, and the radius-ulna averaged three identifications per element.

Given that the articular ends of each long bone element are highly recognizable, these percentages of identifiability were then compared strictly in terms of the percentage of identified shaft fragments (Figure 3.7). Under these conditions, the greater loss of the metacarpal (1%) and radius-ulna (0%) in comparison to the other long bones is made apparent. The metatarsal (8%) remains the most highly visible bone followed by the humerus (6%), tibia (5%) and femur(4%).

DISCUSSION

The relevance of this experiment lies in the extent to which the results can be applied to analyses of archaeological bone assemblages. The applicability of this study hinges on two important factors.

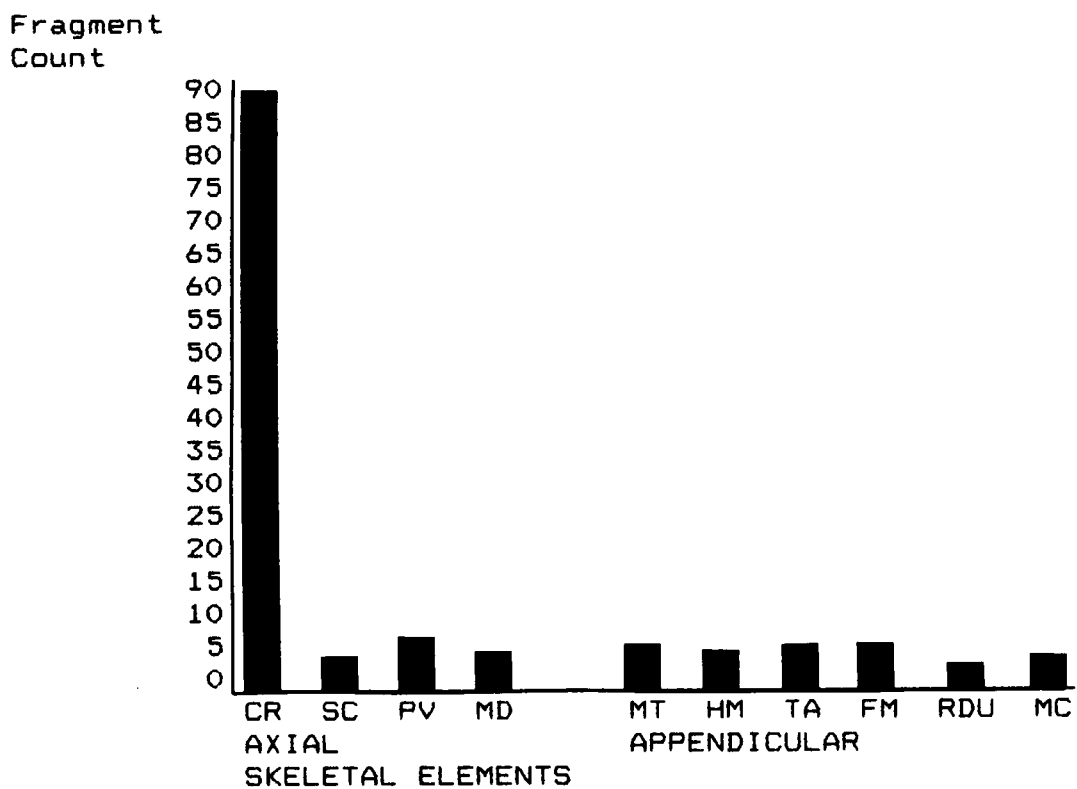


Figure 3.6. Number of Fragments Identified Per Element (articular end included).

%
Identified

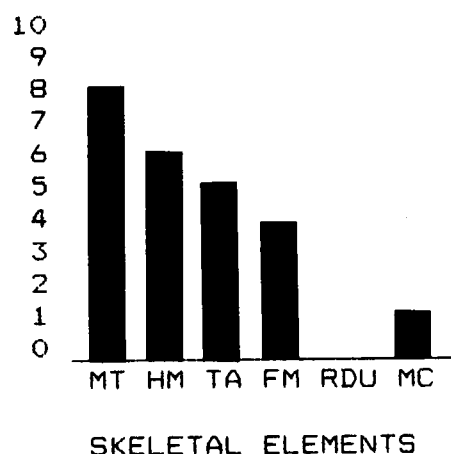


Figure 3.7 Percentage of Long Bone Shafts (without articular ends) Which Were Identifiable.

The first is that these are the results of only two analysts' decisions. A greater number of investigators should conduct the test for these results to have any statistical validity. The close count of identifications per element made by both individuals suggests that inherent levels of identification appear consistent, but these kinds of statements cannot be made at any level of probability.

Secondly, these results are directly linked with the conditions of breakage produced in this experiment. As there is no assurance that there is a predictable pattern of fragmentation for any bone processing procedure, the kinds and numbers of fragments involved in this experiment may be a unique event. It is also possible that a different level of identifiability is obtained each time an element is

processed. An attempt was made at the onset of the experiment to replicate the heterogeneous situation which presumably characterizes most archaeological assemblages, and it is only an assumption that a good level of comparability has been achieved. Further work needs to be done to see if the levels of identifiability documented here are valid. The experimental results do offer preliminary quantitative information on a subject that previously has not been approached in this manner, and if used as a measure of general tendencies these results can be profitably applied in archaeological analyses.

The two measures presented here, the percentage of identifiability and the mean number of shaft counts, are best used in two separate ways.

The percentage of identifiability is an element-specific measure that does not lend itself to direct assemblage element comparisons. This value is an internal ratio of identified to non-identified fragments per element. This measure indicates how much of the fragmented bone is recognizable and, by default, how much is taphonomically lost. For the majority of these elements, the amount of loss was greater than 90%. This measure is not recommended for assemblage comparison purposes as it is directly affected by the number of fragments produced, which in turn is dependent upon the choice of the bone processor.

Additionally, in some cases, this difference in fragment number may also depend upon the varying sizes of the bones. Although this does not hold true for the cranium or metacarpal, a review of Column C of Table 3.1 shows that increasingly larger bones produced increasingly larger fragment counts with lower percentages of identifiability overall. The cranium and metacarpal fragment count results, which represent both extremes in the range of the experimental findings, directly negate this observation, but for the majority of the long bones element size appears to influence the element's level of taphonomic loss.

The mean identified fragment count per element is recommended for archaeological assemblage comparisons. Although the measure is dependent upon the breakage patterns of this experiment, it is not dependent upon the number of fragments produced or the size of the element involved. It is based rather on the number of identified fragments. Therefore, the mean identified fragment count offers a more likely profile of element representation in a fragmented assemblage if the assumption of an adequate level of heterogeneity in the experimental assemblage can be accepted.

Despite the factors discussed above, it is highly likely that in two instances a clear bias in identifiability has been isolated. One is the case of the cranium which was identified above at a much higher level than all of the

other elements. The second is the hindlimb. As a whole, this group of elements was more readily identifiable than those which make up the forelimb. The experimental expectations and the individual element results are discussed below.

Axial Elements

The cranium performed well in both measurements. This was most likely due to the high number of individual bones that make up this complex element. Although the cranium was the most highly fragmented element, the percentage of identifiability was in this case higher than all other elements. The even spacing boney landmarks across the surface of the bone was suggested to be an important factor in identifiability and this may well have added to the high visibility of the cranium. The density and distinctive cross section of some parts of the cranium may also have increased this element's identification potential.

The scapula, with its low articular end count and small number of landmarks was predicted to be a low visibility bone. However, this element underwent less of a taphonomic loss than the pelvis or mandible. In the mean fragment count however, the scapula was the lowest axial bone identified.

The pelvis and innominate contributions to the experimental assemblage, which included eight possible articular surfaces, performed far below expectations. This

element registered a high total taphonomic loss at 93%. In the mean identified fragment count however, the pelvis was second only to the cranium. Also, when compared to the long bones for this measure, the pelvis finished at a slightly higher level than the highest scoring long bones. This occurred despite the less intensive processing of the marrow bones. Fragment size, overall element size, and a lack of distinguishable landmarks are all possible reasons for the taphonomic loss of the pelvis in the percentage of identifiability.

The poor performance of the mandible in both categories was not expected. Apparently, when processed for grease production, few of the landmarks associated with this bone are clearly identifiable. This bone underwent a high amount of internal taphonomic loss.

Appendicular Elements

Of the long bones, only the metacarpal and radius results met the experimental expectations, with low levels of identifiability registered overall. The remaining long bones deviated in many respects from expectation.

The metatarsal results were perhaps the most surprising. This element underwent the least amount of internal taphonomic loss and scored equally as well as more highly landmarked bones, such as the humerus, tibia, and femur, in the mean fragment count. This is remarkable given that these

other bones had four, five, and three distinctive and well spaced landmarks, respectively. Apparently the long vascular groove that runs the length of the bone is pronounced enough in the white-tailed deer in fragmentary form that the analysts felt confident they were dealing with metatarsal fragments.

The humerus, femur, and tibia were expected to be identified more frequently than the other long bones and this held generally true in the mean identified fragment count. The tibia scored generally higher than expected given that it only has three landmarks and all are located on the proximal half of the bone. The tibia also equaled the humerus in the amount of taphonomic loss it underwent despite its larger size and lower number of landmarks.

Although the humerus did relatively well overall, it was expected that this element would be the highest registering long bone. Its comparability with the other long bones was unexpected.

The high internal taphonomic loss of the femur was also unexpected. This may be due to the greater number of fragments produced in breaking this bone. As with the pelvis, this element scored higher in recognizable fragments in the mean fragment count.

The metacarpal and radius underwent the most internal taphonomic loss when broken, and also lost most of their

visibility as well. Although the metacarpal also has a vascular groove, the element did not register the same high values in identifiability as the metacarpal. This was perhaps due to the fact that the vascular groove in this element is not as long or pronounced as that of the metatarsal. The radius performed as expected. Much of its surface area is smooth and it was not identified frequently. The low performance of these two elements in comparison to the remaining longbones is the prime reason why the hind limb would be identified more frequently.

CHAPTER IV

THE BUGAS-HOLDING SITE SHEEP ASSEMBLAGE

The following is a description and analysis of the bone breakage pattern of the Bugas-Holding site bighorn sheep faunal assemblage. The objective in documenting this breakage pattern is to: 1.) illustrate a pattern which may well be primarily referable to human activity and, 2.) interpret what this breakage pattern represents in terms of site activity and social organization. A series of measures and figures are used to document this breakage pattern. These are diagrams of element completeness, element frequency data, averages of fragment size per element, percentages of impact scars per element, and shaft length ratios.

ELEMENT COMPLETENESS

As the bone from the Bugas-Holding site is very fragmented, diagrams of element completeness were created to illustrate how well the various sections of an element are represented. It was expected that if selective deletion of any portions of an element had occurred, this would become obvious in diagram form. This was accomplished by

first making scale sized drawings of each element, which were then divided into sections. When the fragment identifications were made, the appropriate area of origin was shaded on the diagram. The composite result of these fragment identifications is presented in the following diagrams. Review of Figure 4.1 indicates that the femur is well represented. Fragments were identified from all sections of the element. The sections with the greatest amount of representation were in the vicinity of the postero-lateral foramen and the lesser trochanter. While both articular ends were identified for the femur, they were far fewer in number than those of the shaft of the bone. The area most frequently identified on the tibia (Figure 4.2) was that around the tibial crest. The distal end of the tibia was rarely identified, and no proximal end fragments were recovered.

The proximal end of the humerus (Figure 4.3) was also completely missing, but in comparison to the tibia and femur, this element was represented primarily by the distal end. The section of this bone which was most frequently identified was around the mid-section. The articular ends of the radius, metacarpal, and metatarsal (Figures 4.4 - 4.6) were the primary areas represented for these elements. Additionally, the proximal end predominated in all three cases.

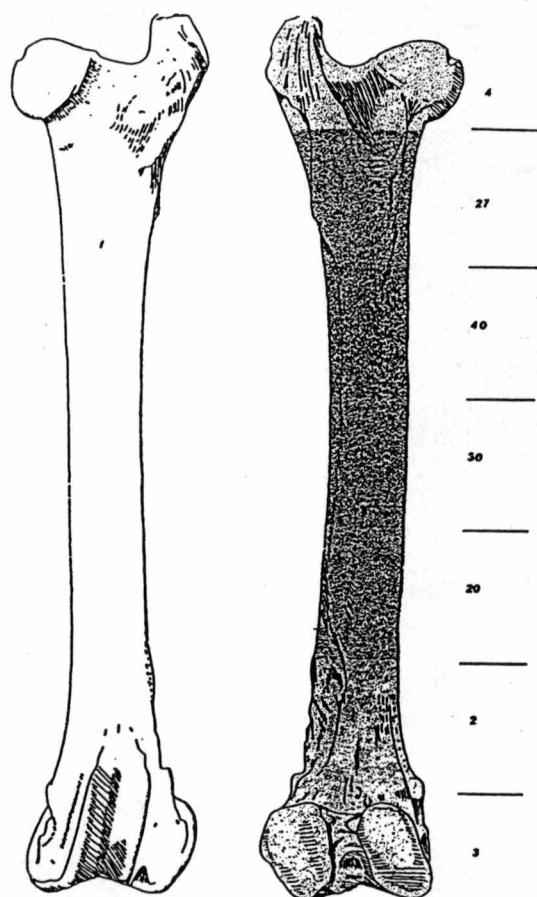


Figure 4.1 Femur Element Completeness, Bugas-Holding Site
Big Horn Sheep (Ovis canadensis) assemblage.

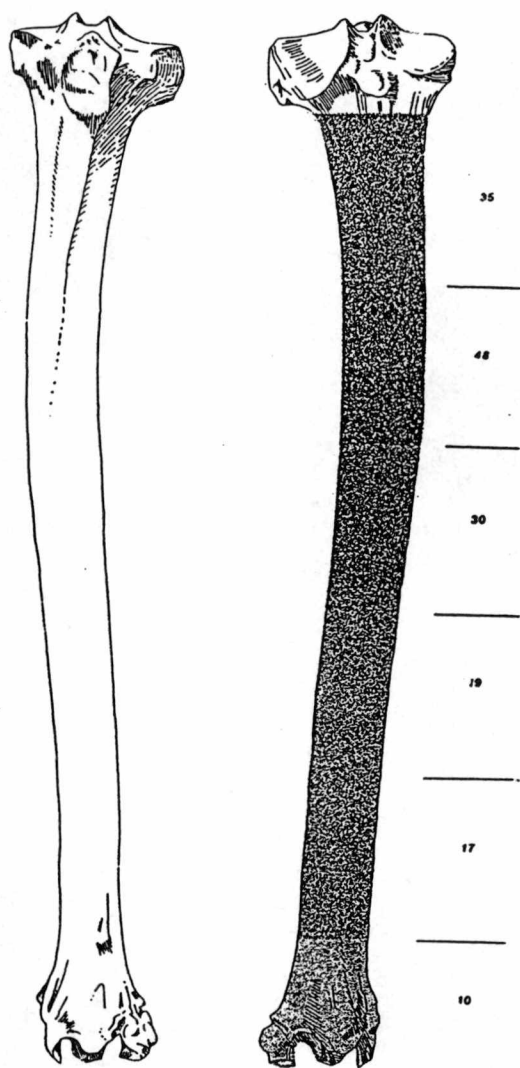


Figure 4.2 Tibia Element Completeness, Bugas-Holding Site
Bighorn Sheep (Ovis Canadensis) Assemblage.

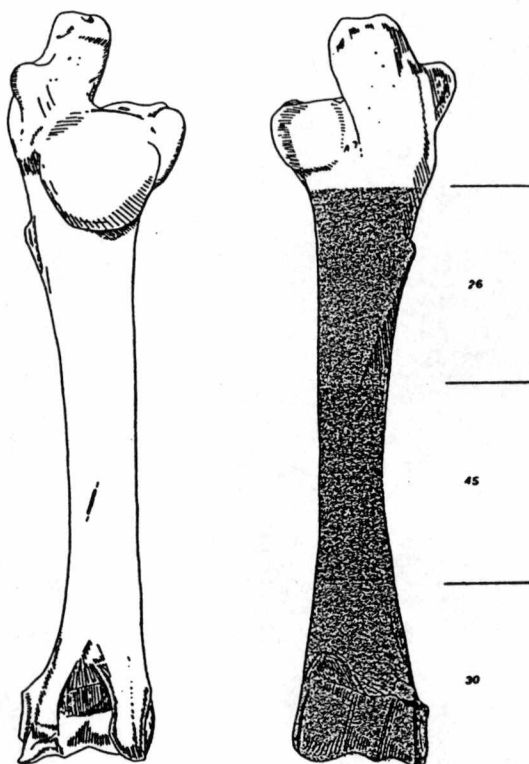


Figure 4.3 Humerus Element Completeness, Bugas-Holding
 Site Bighorn Sheep (Ovis canadensis)
 Assemblage.

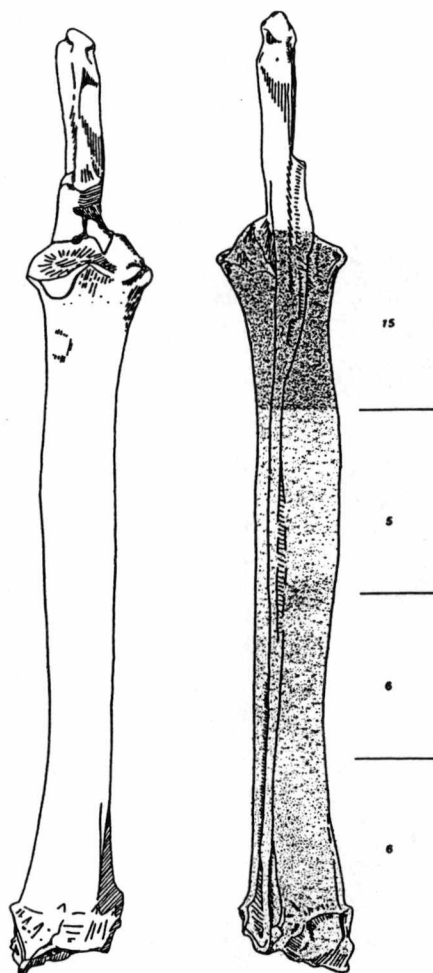


Figure 4.4 Radius Element Completeness, Bugas-Holding Site
Bighorn Sheep (Ovis canadensis) Assemblage.

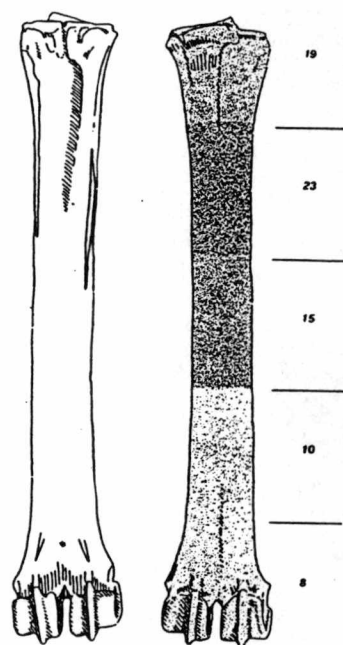


Figure 4.5 Metacarpal Element Completeness, Bugas-Holding
 Site Bighorn Sheep (Ovis canadensis)
 Assemblage.

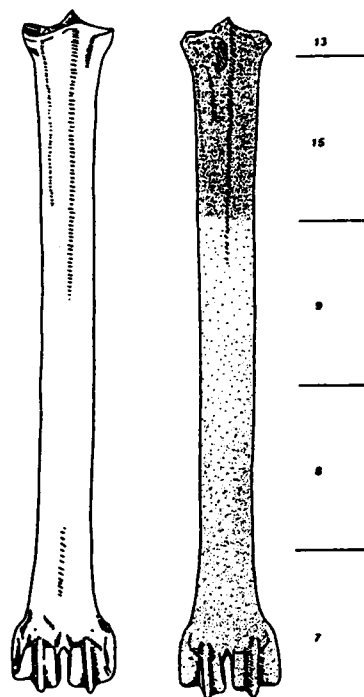


Figure 4.6 Metatarsal Element Completeness, Bugas-Holding
 Site Bighorn Sheep (Ovis canadensis)
 Assemblage.

ELEMENT FREQUENCY DATA

The Bugas-Holding site bighorn sheep assemblage element frequency data is presented in Table 4.1. Element frequencies are made up of minimum numbers of element counts based upon the greatest number of similarly landmarked. The landmarks used to make these calculations are listed by element in the table below. As can be seen, the tibia (n=19), humerus (n=19) and radius (n=18), were identified most frequently, followed by the metacarpal (n=15) and metatarsal (n=15) at a slightly lower level. The femur (n=9) was poorly represented. The minimal number of animal unit (MAU) count for the bighorn sheep forelimb (n=13.5) was higher than that of the hindlimb (n=10.75).

TABLE 4.1

BUGAS-HOLDING SITE SHEEP ASSEMBLAGE: ELEMENT FREQUENCY DATA

Element	Art/end			Total	MNE	Basis
	Dis.	Prox	Shaft			
Humerus	12	1	45	58	19	p-1 foramen
Radius	13	18	16	47	18	p-1 foramen
Metacarpal	7	15	8	30	15	proximal
Femur	2	3	47	52	9	minor troch.
Tibia	6	0	61	67	19	tibial crest
Metatarsal	5	15	15	35	15	distal
Forelimb Totals: NISP=135; MNE=52; MAU=13.5						
Hindlimb Totals; NISP=154; MNE=43; MAU=10.75						

of differential transport and introduction of elements to a site, and interpretations of site function are then made along those lines. In this instance, however, the bighorn sheep from the Bugas-Holding site will be compared to the results of the breakage experiment (Chapter III) to see how these compare with a known instance of marrow fracturing.

To do this, the ratios of the average number of identified specimens per element (NISPE) were calculated and compared to the experimental results. The expectation involved in this exercise was that if the Bugas-Holding site assemblage patterned after the experiment, the frequency data might well indicate the results of marrow processing. The results are presented in Figure 4.7.

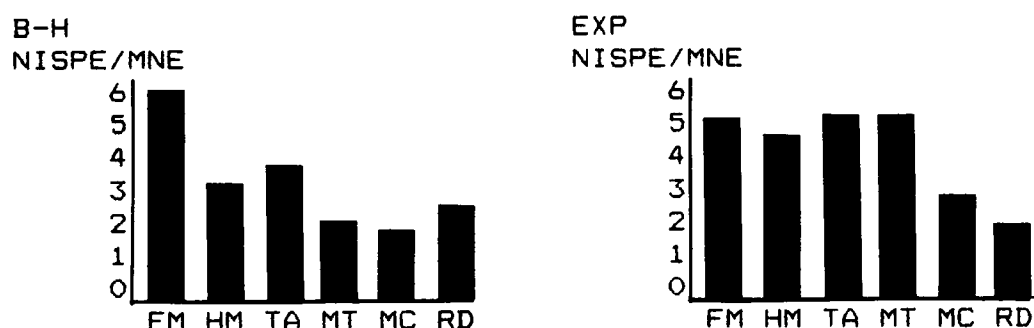


Figure 4.7 Comparison of Mean Fragment Count per Element: Bugas Holding Site (B-H), and the Experiment (EXP).

When compared to the experimental data, the Bugas-Holding element ratios hindlimb vs. forelimb comparison falls generally as it did in the identification experiment, but similarity in the relative representation of the metatarsal, femur, humerus, and tibia is not found.

As can be seen, the metatarsal and femur ratios show the greatest deviation from the experimental results with the metatarsal value lower than expected and the femur value higher than expected.

These differences in the long bone fragmentation results may be attributable, at least in the case of the femur, to differential processing. The metatarsal change, however, may be explained by a technical difference between deer and bighorn sheep metatarsals which was not observed at the beginning of this study. Although osteological features of the element for each species are generally the same shape and in the same location, the vascular groove of the white-tailed deer is more pronounced than that of the bighorn sheep. Comparison after the fact leads me to believe that the experimental results cannot be applied for this element. The other elements are reasonably alike, and the experimental comparisons are still considered valid for these elements. In all likelihood, the greater similarity of the metacarpal and metatarsal in Ovis canadensis created less certainty in the identification of the metatarsal,

which resulted in similar identification results for both elements.

Study of Table 4.1 indicates that the reason the number of identifiable fragments per MNE is higher for the femur is primarily due to that element's lower MNE count in relation to a fragment count which is similar to that of the humerus and the tibia. This means a lesser number of similarly landmarked fragments were recovered, which may indicate greater processing of the femur. As the other elements generally patterned after those of the experiment, it is possible that marrow fracturing occurred for the majority of the elements and the femur was selected for further processing, perhaps grease production. This and other possibilities are discussed in later sections of this chapter.

FRAGMENTATION

To further explore whether differential breakage patterns were apparent between elements an index of fragmentation (IF) was devised. This index combines two measures of bone size, the areal surface (length x width) of each fragment and an approximate measure of the areal surface (length x width) of the respective average male bighorn sheep element from which the fragment was derived.

The index value was derived for each fragment through use of the following formula:

$$IF = \frac{\text{length X width element}}{\text{length X width fragment}}$$

The average bighorn sheep element size was based on measurements compiled by Jack Fisher (1983) using Ovis canadensis comparative material curated by the Department of Anthropology, University of Wyoming. It is estimated that the areal surface measurement used for the elements is roughly half of the surface of the bone.

Sets of values were computed for each fragment, and these values were then averaged for each element. The resultant averages per element are listed in Table 4.2 below. The metacarpal is not included in this calculation due to the low (n=8) fragment count.

TABLE 4.2

BUGAS-HOLDING SITE SHEEP ASSEMBLAGE:
RELATIVE FRAGMENT SIZE PER ELEMENT

Element	Fragment ratio
Tibia	601.52
Radius	553.65
Femur	463.98
Humerus	293.53
Metatarsal	263.53

When expressed as a ratio of fragment size to average element size, the metatarsal and humerus fragment sizes appear to be smaller than the other elements of the assemblage. The tibia and radius both have a high mean fragment size, and the femur mean fragment size falls between these two groups.

There are two major drawbacks in using Fisher's data in this way. First, the element samples Fisher used were small, but I elected to use them because sample standard deviations were never greater than one centimeter and the projected standard error was very low in each case. The second problem with this measure is that, in all cases, the total length measurement used to calculate the average areal size of one half of the element surface included the articular end of each bone. Ideally, only total shaft measurements should be used in this measure to yield a more accurate representation of shaft fragmentation. With the inclusion of the articular ends, those elements with larger proximal and distal ends such as the femur would be expected to yield smaller overall fragmentation index values, since the surface area considered is enlarged by the inclusion of larger and basically irrelevant bony masses. And while this may indeed be reflected in the low index of fragmentation accorded the femur above, it should be noted that the metatarsal with its extremely small articular ends is still

lowest in the standings of average fragment size.

IMPACT SCARS

Counts of impact scars, the direct point of impact on a bone fragment, can also be taken as a general indicator of how completely an element was broken. These impact locations were noted when present on a bone specimen and the percentage per element was calculated. These results are presented in Table 4.3. The metacarpal was also not included in this count due to the low total number (n=8) of these fragments.

TABLE 4.3

BUGAS-HOLDING SITE SHEEP ASSEMBLAGE:
PERCENTAGE OF AN ELEMENT THAT EXHIBITED IMPACT SCARS

Element	Scar Percentage
Humerus	83%
Femur	50%
Metatarsal	30%
Tibia	20%
Radius	0

As can be seen, 80% of the identified humerus fragments had impact scars on their surfaces, followed by 50% of the

femur, 30 % of the metatarsal, 20% of the tibia and 0% of the radius fragments.

SHAFT/LENGTH RATIO

The length of the shaft still attached to the articular end of a broken bone is a good indicator of impact area as well as the general completeness of the bone. A comparative technique developed by Todd (Todd and Rapson 1987) which takes into account the differences in individual element size as well as sexual dimorphism and species differences, involves expressing the shaft length as a ratio of length of shaft/width of articular end. These were calculated for the Bugas-Holding site bighorn sheep assemblage and the results are presented in Table 4.4. Again, the metacarpal is not used in this count.

TABLE 4.4

BUGAS-HOLDING SITE SHEEP ASSEMBLAGE:
AVERAGE SHAFT/LENGTH RATIO PER ELEMENT

Element	Shaft/length Ratio
Humerus	1.94
Femur	1.98
Metatarsal	2.10
Radius	2.85
Tibia	3.62

In this measure it appears as though the elements fall in the same order as that of the impact scarring except for a change in positions of the radius and tibia.

DISCUSSION

In general, the Bugas-Holding site bighorn sheep assemblage is highly fragmented. Selective deletion of the articular ends of the humerus, tibia, and femur had taken place with particular emphasis on the proximal ends of the humerus and tibia. The metacarpal, metatarsal, and radius are well represented by their articular ends. In other estimations of differential treatment, the shafts of the femur and humerus appear to have undergone a greater degree of fragmentation while the tibia and radius shafts appear to have been less fragmented. This statement is based upon the larger fragment size, less evidence of impact scarring, and greater shaft/length ratio of the radius and tibia in comparison to the femur and humerus. The metatarsal does not fit clearly into either category as it has a small fragment size and moderate to low shaft/length ratio, but falls into the mid-range in amount of impact scarring.

Comparisons based solely upon element portion representation, that is, the predominance of shaft fragment representation to articular end representation, appears to

divide the elements into two discrete groupings. The metatarsal, metacarpal, and radius were broken primarily for marrow, while the remainder underwent greater processing. Comparison with the results of the marrow processing experiment indicated that the radius, metacarpal, tibia, and humerus levels of representation are as expected for this activity, with the femur registering a higher level of identifiability. The metatarsal results were not used in this comparison due to the suspected effects of a discrepancy in the morphology of the bighorn sheep and white-tailed deer metatarsal.

Further investigation of the levels of processing to which the elements had been subjected appears to indicate that the shafts of the femur and humerus have been more completely broken than those of the tibia or radius. Consequently, it appears as though while all of the bighorn sheep bone specimens of the assemblage were processed for marrow extraction, the femur and humerus were preferentially chosen for further processing, most likely for the production of grease.

The application of the experimental results to the Bugas-Holding site bighorn sheep faunal counts makes it obvious that the use of this information is problematic. While the apparent greater processing of the femur, as indicated by comparison to the experimental results, was

borne out in the later analysis, the similar treatment of the humerus was not indicated in the initial comparison. This inconsistency in accuracy is most likely due to the preliminary nature of the experimental results. As stated in Chapter III, more tests and a greater number of analysts need to be involved to determine if particular processing techniques result in consistently different levels of identifiability. If these levels are found to be replicable, then the findings would be most useful at the assemblage level of analysis, as comparative measures of general tendency.

CHAPTER V

SHEEPHUNTERS AND SHEEPEATERS

Ethnographic and historic information relevant to the study of the Bugas-Holding site is presented in this chapter to aid in the development of an interpretation of site. Although there is only a small amount of data available for the establishment of site chronology, all indicators suggest a Shoshonean affiliation for the Bugas-Holding occupation. A single charcoal sample taken from hearth #2 of the Bugas-Holding excavations has been dated to A. D. 1510 ($\pm$ 100). Shimkin (1940), and later Wright (1978) have argued for a Shoshonean presence in northwest Wyoming by A. D. 1500. Ceramics recovered at the Bugas-Holding site have been described as Shoshonean (Haspel 1984:25).

Historic Shoshonean speakers are known to have inhabited a large and ecologically diverse area within the regions of the Great Basin, Columbia Plateau, Snake River Plain, middle Rocky Mountains, Wyoming Basin, and Northern Plains (D'Azevedo 1986:12). Shoshonean groups which generally lived in Idaho and Wyoming during the historic period are now classified as the Northern and Eastern Shoshone, respectively, while the mountain dwelling members of both of these groups are further identified collectively as the Tukkutikka, or "eaters of mountain sheep" (Murphy and

Murphy 1986:306; Shimkin 1986:335).

Other earlier names given for this group are: Tukadika (Steward 1938:186-187); Tukudika (Hultkranz 1966/67:156; Liljeblad 1959:47); Dukurika (Dominick 1964:142); Durarika (Murphy and Murphy 1960:309); and those listed in Hodge (1907-1910, 2:835) under the heading Tukuarika. When offered, translations of the above variant group names are uniformly given as "meat eater" with the general note that the principal food available in these areas was bighorn sheep. Another name for this group, particularly in the Yellowstone area, is Toyanhini or "mountaineer" (Shimkin 1986:335), and Toyaniee (Hultkrantz 1966/67:158).

The identification of a "sheep-eater" subgroup for both the Northern and Eastern Shoshone is the result of an initial misunderstanding on the part of early ethnographers that the Shoshone custom of naming the inhabitants of a region by a local food name signified band level political designations (Steward 1955:116; Murphy and Murphy 1986:287). As Liljeblad (1957:54) has noted, the Shoshone were not territorial and their subsistence needs necessitated the movement of small groups, usually nuclear families, over a wide area. As families moved from one region to the next they were referred to by the key resource they were exploiting in that area. Therefore, a "groundhog eater" could become a "salmon-eater" in the course of a seasonal

round. While this was the general rule, Liljeblad (1959:47) also noted, "...the uneven geographical distribution of resources caused local specialization of food habits to some degree," so it may be that the adaptation of the mountain dwelling Shoshone was found to be more distinctive than most. While the other local food names were soon abandoned as official designators of various groups, the term "Tudedeka" and its variants have persisted in the ethnographic literature (Lowie 1909:206; Steward 1938:173). This confusion was enhanced by the perception of individuals living on the Wind River Reservation that the mountain dwellers were quite distinct from the Plains Shoshone (Dominick 1964:143), a fact which encouraged Hultkrantz (1961:21) to classify the tukkutikka living there as descendants of an "independent ethnic unit" from the other Wyoming Shoshone.

Dominick (1964:143) suggests that this perception of the Wyoming Shoshone as a heterogeneous group was primarily due to extreme group contrasts produced when the Wyoming Plains Shoshone adopted the horse (cf. Wissler 1914). In contrast, he notes that Shoshone elders interviewed on the Fort Hall Reservation of Idaho considered the sheepeaters to be mountain dwelling Shoshone. As one of the informants, E.B. of Blackfoot, Idaho, remarked, "This whole group of Indians are all the same people...the Tukudeka people from

the mountains know people from all over Idaho real well...by names and by relation" (Dominick 1964:134). Also, in support of the ephemeral nature of the Shoshone local food names, another of Dominick's informants, W. G. of Fort Hall, Idaho remarked "Just whatever they ate is what I called them. We could even call them coffee-drinkers" (Dominick 1964:134). Dominick attributed this difference in perception to a greater intensity of trade and interaction on the part of Shoshone groups on the western side of the continental divide. In the mid-1960s, Hultkrantz reviewed the ethnological position of the Tukikutikka and concluded that the group represented a mountain adaptation of the Western Shoshone pattern (Hultkrantz 1966/67:161). Additionally, both Hultkrantz and Dominick agreed that the Tukikutikka retained many of the traditional Shoshone "walker" characteristics which were lost in other Shoshone groups with the introduction of the horse (Hultkrantz 1958:152, 1961:34; Dominick 1964:146).

Despite the fact that the Tukikutikka of Idaho were the last Shoshone speakers to submit to reservation life (Liljeblad 1957:104) and that some isolated families continued to live in the mountains until the end of the nineteenth century (Liljeblad 1959:49; Hultkrantz 1961:27), very little is known of the lifeways of these people. Apparently the remoteness of the mountains, the low native

population, and the Tukkutikka tendency to avoid white settlements accounts for the infrequent mention of the "sheepeaters" in historic records. While the Tukkutikka are remembered by twentieth century Wind River Shoshone informants as a mysterious people with supernatural powers (Hultkrantz 1954:63), military reports from the 1800s describe them as impoverished, hermitic, and non-threatening.

The earliest military expedition to encounter the Mountain Shoshone was that of Captain Benjamin Bonneville in his 1835 explorations of the Wind River Range of Wyoming. He described them as:

...a hermit race, scanty in number that inhabit the most inaccessible fastnesses. They speak the Shoshone language and probably are offsets from that tribe although they have peculiarities of their own which distinguish them from all other Indians. They are miserably poor, own no horses and are destitute of every convenience to be derived from intercourse with the whites. Their weapons are bows and stone pointed arrows with which they hunt the deer, the elk, and the mountain sheep (Irving 1850:139).

A second, more general description of the sheepeaters as a "branch of Shoshone who live almost entirely in the Mountains [and] very seldom visit the white settlements" was offered by Fort Bridger Indian Agent Luther Mann in 1867 (Mann 1958:198). In 1869, the Folsom-Cook expedition encountered a band of "sheepeaters" who are described by

Cook simply as "friendly" (Cook 1932:84). And a year later in his report of the Yellowstone expedition of 1870, Lieutenant G. C. Doane offers the following impression of sheep eaters as "wretched beasts who run from the sight of white men " and who are "poorly armed and dismounted, obtaining a precarious subsistence in a defenseless condition" (Doane 1932:137).

These military impressions of the historic Tukikutikka contrast sharply with what is perhaps the best and earliest ethnographic description of the Mountain Shoshone recorded in the writings of Osborne Russell, a journalist turned trapper, who camped with a party of Indians he identified as "Snakes" in the Lamar Valley of Wyoming in 1835. He found them to be well armed, well dressed, and happy. He described the group as:

...comprising six men, seven women and eight or ten children who were the only inhabitants of this lonely and secluded spot. They were all neatly clothed in dressed deer and sheepskins of the best quality and seemed to be perfectly contented and happy. They were rather surprised at our approach and retreated to the heights where they might have a view of us without apprehending any danger, but having persuaded them of our pacific intentions we then succeeded in persuading them to encamp with us. Their personal property consisted of one old butcher knife, nearly worn to the back, two old shattered fuses which had long since become useless for want of ammunition, a small stone pot and about 30 dogs on which they carried their skins, clothing, provisions etc. on their hunting excursions. They were well armed with bows and arrows pointed with obsidian

with bows and arrows pointed with obsidian
(Russell 1955:26).

Russell also noted that the party he encountered had a large number of skins to trade and specifically mentioned elk, deer, sheep, and panther, and that they had "beautifully wrought" hunting bows made of buffalo, sheep, and deer "horns" (Russell 1955:26). This brief description of the group has been little improved by the ethnologists Sven Liljeblad, Ake Hultkrantz, David Dominick, and to a lesser extent Robert and Yolanda Murphy, who attempted to collect what information they could about the Wyoming and Idaho mountain groups in the mid-twentieth century. Very few descendants of the Mountain Shoshone were still alive at that time, so the following reconstruction is based on sketchy and secondhand information. It appears, however, that while there were some significant differences between the Wyoming and Idaho groups such as the use of salmon and the establishment of large winter villages by the Idaho Tukkutikka (Liljeblad 1959:48; Murphy and Murphy 1960:323) the basic lifeways of both appear to have been similar.

Hultkrantz stated that the Wyoming Tukkutikka had lived in small, generally familial groups which exploited a wide variety of plants, lake fish, and small game, as well as elk, deer, and bighorn sheep. Of the larger game he noted that sheep were of primary importance, used for both food and clothing (Hultkrantz 1961:34). Murphy and Murphy

(1960:310) added timber buffalo and trout to the above list of Wyoming Tukkutikka food resources.

Liljeblad (1957:98) indicated that the Tukkutikka of Idaho were respectfully referred to by other Shoshone groups as "hunters of big game," and that their preferred prey was sheep, elk, deer, and antelope. Liljeblad also pointed out that all varieties of plants which were utilized by the Basin Shoshone were available to the Idaho Tukkutikka with the exception of the pinon (Pinus monophylla). He notes that the seed of the lime pine (Pinus flexilis) was used instead (Liljeblad 1957:96).

Osborne Russell's mention of the many furs the Tukkutikka carried with them foreshadows Liljeblad's later description of the historic Idaho Tukkutikka as furriers of renown who established trading ties with the surrounding Shoshonean groups and white traders (Liljeblad 1959:49). In addition to the furs discussed above, the Idaho Tukkutikka also processed and traded furs of badger, fox, coyote, antelope, rabbit, wolf, and otter (Liljeblad 1957:97). Russell also indicated that they trapped and traded beaver pelts as well (Russell 1955: 46, 65).

Russell noted 30 large dogs used for packing by the Mountain Shoshone and Hultkrantz's informants mentioned that dogs were used not only in packing, but also for hunting. The Murphy's concur that dogs were used in hunting

(Murphy and Murphy 1960:310). Liljeblad's informants verified the use of small dogs for hunting by the Idaho Tukkutikka, but not for packing. The drive method of hunting is common among native groups who hunt gregarious animals, and among sheep hunters, the drive was used to take advantage of the animal's tendency to flee, commonly upward. The Tukkutikka apparently used dogs in their bighorn sheep drives directing the animals either towards other hunters or to a death fall.

A Fort Hall Shoshone elder identified as C.G., a descendant of the Tukkutikka and interviewed by Dominick, explained that dogs were used by her father to circle sheep towards him (Dominick 1964:153). Liljeblad recorded a technique whereby dogs were used to drive sheep to the edge of a cliff. If a sheep did not jump to its death, it would be killed by the dogs (Liljeblad, in Butler 1978:54). Additionally, Hultkrantz (1966/67:156) mentions that the Wyoming Tukkutikka used dogs to "trace" sheep and force the animals up the mountain to "isolate points," where they were killed by hunters following the dogs. A more unusual technique related by Liljeblad involved driving the sheep off cliffs onto poisoned sticks. He offers the following details:

A stick with poison was placed at a place where the sheep was expected to jump from a higher point. Such a stick was of "the grey willow" which is harder than the common

willow. There was grass tied on the stick so that it looked like a large grass. It was a little larger than the front legs of the animal for giving a chance to hit it. The poisoned sticks were put at places where the sheep usually had their way and where they had to jump. Often, there was a stick placed on each side of the obstacle, always at an angle so that the stick pointed in the direction from where the animal had to jump off. These sticks were about as thick as an ordinary arrow shaft. They could easily break. There was a poisoned black stone point fixed to it (Liljeblad in Butler 1978:54).

In their summary statement on the Western Shoshone, Thomas et al. (1986:267) mention that dogs were used to hunt sheep in the summer months, but give no further details. Fowler (1986:79) also mentions that the Shoshone used dogs to "drive sheep toward waiting hunters."

Hultkrantz noted that in addition to the dog drives, both the the Wyoming and Idaho Tukkutikka hunted bighorn sheep individually or as families, and suggested that this was the most effective method given that bighorn sheep herds available to the Tukkutikka were small (Hultkrantz 1961:27, 35).

Entrapment techniques used by the Shoshone which may have been used by the Tukkutika included the simulation of ram dueling noise by knocking together logs (Steward 1941:220), and the use of sheep skin and horn disguises (Fowler 1986:79). Fowler's sources stated that this last technique was dangerous if the hunter was dressed as an adult sheep because rams might choose to challenge and

charge the hunter. Disguises of sub-adult animals were considered "safer" (Fowler 1986:79).

An additional type of entrapment that Frison suspects was used prehistorically for bighorn sheep procurement was that of the throw net (Frison et al. 1986). One of these was recently found on Sheep Mountain in the Absaroka Range and has been radio carbon dated to 8860 YBP. The net was made of juniper bark fibers. Frison et al. (1986:352) estimate its size to have been large enough to catch two deer or bighorn sheep-sized individuals.

One form of entrapment which Dominick (1964), Hultkrantz (1966/67:156), and Darlington (1984) suggest was used by the Tukikutikka is that of the deliberately constructed enclosure commonly referred to as a sheep trap. Many such enclosures have been identified at high elevations along the southern boundary of the Absaroka Mountains and the northern boundary of the Wind River Mountains (Dominick 1964:159, Frison 1978:264) but, interestingly, only one very brief ethnographic description of their use has been given by a Shoshonean informant. This was collected by a researcher of the Mountain Crow who interviewed an elderly sheepearer woman at the turn of the twentieth century (Allen 1913:73-75). This woman told Allen of "...sheep pens where the Indian catch much sheep to eat." Otherwise, there is no direct mention of the existence and use of these traps as

direct mention of the existence and use of these traps as bighorn sheep procurement devices. Dominick (1964:158-159) argues for their use by virtue of their presence. Hultkrantz, on the other hand, specifically states that traps were used, but describes these more as fences than enclosures. He relates:

Another method of slaying the bighorn was to catch them in traps consisting of log or stone fences placed where game used to pass, and sometimes leading to precipices which not even those animals could escape (Hultkrantz 1966/67:156).

Frison (1978:257-270) presents some evidence suggestive of bighorn sheep entrapment in the form of high elevation drive lines in the Absarokas at the Boulder Ridge and Dubois sites located east of the South Fork of the Shoshone River, and a group of possible bighorn sheep procurement complexes located at Wiggins Mountain on the east side of the Wiggins Fork tributary of the Wind River. One of the Wiggins Mountain sites, the Windy Gap drive line as described by Darlington (1984:19), is very similar to the above description offered by Hultkrantz. It consists of stone and log fences which lead to a steep cliff. Frison's analysis of this site led him to the conclusion that due to the presence of a narrow ledge halfway down the cliff, bighorn sheep could have survived this fall successfully. He speculated that a holding pen of some sort might have been present at

407) presents a description of a Nunamiut hunting drive that took advantage of the successful negotiation of a steep cliff by sheep at Kollutuk salt lick near Anaktuvuk Pass, Alaska. Instead of a holding pen at the bottom, however, hunters concealed themselves until the sheep were committed to their descent. As the animals reached the bottom, the hunters killed as many as they could.

Three sites of a fence and catch pen configuration were also located at Wiggins Mountain and Frison considers these to be the more credible sheep procurement facilities. Two bighorn sheep mandibles were found in the catch pen of one of these, the Bull Elk Pass Site (48FR307) (Frison 1978:264; Darlington 1984:15). Frison speculates that sheep capture involved driving them into a circular corral where they were then funneled into narrow chutes with ramps at the end. The animals dropped from the ramp into a catch pen where they were then killed (Frison 1978:264). Darlington (1984:11) indicates that the ramps may have been perceived by the bighorn in the corral as an escape route.

The Wiggins Fork traps have been dated through dendrochronological means to the late 1700s and so are considered to have been used by the Wyoming Tukkutikka (Darlington 1984:107). This pre-contact date for such traps offers some explanation as to why only one description of their use has been recorded in the historic and ethnographic

record of the Shoshone. In a discussion of native oral historians of Northwest Alaska, Ernest Burch remarked upon how he was confident that specific informants had been told and could accurately recall important events that had occurred in their grandparents lifetime, but probably not any earlier (Burch 1986). In view of this it is interesting to note that Steward's Nevada Shoshone informants stated that enclosures such as snares, traps, and nets were not used and were considered to be ineffective for hunting sheep (Steward 1941:220). It may be that knowledge of this previous hunting technique had dissappeared from the group's oral history. It is also possible that the dramatic decline in sheep numbers as has been noted in the Rockies for the 1800s reduced the herd size and therefore the economic feasibility of building and maintaining these traps. As mentioned above, Hultkrantz specifically noted that the herds available to the Tukkutikka were small, and that stalking the animal was considered the most effective method of hunting them. In a similar vein, Darlington (1984:111) speculates that the small-pox epidemics of 1781 and 1805 which were known to have severely affected the sheepeaters (Shimkin 1938:415), may have reduced their ability to operate and maintain these procurement devices.

In the Great Basin and on the Colorado Plateau, Monson and Sumner (1980:8) have noted the presence of winged

corrals presumably used to trap bighorn sheep. Thomas (1982) noted a gradual decrease in the use of these and other permanent hunting facilities such as rock walls and blinds in the Great Basin through time. In a comparison of the temporal contexts of hunting facilities such as rock alignments, corrals, one-man blinds and soldier cairns in the central and western Great Basin, Pendelton and Thomas (1983:31) noted that the majority of these were associated with pre-A.D. 1300 diagnostics. Coupling this with the lack of mention of such facilities/structures in the ethnographic literature, the authors suggest that there may have been a change in artiodactyl hunting strategies from prehistoric to protohistoric periods.

In an attempt to gain more information on the possible use of these high altitude sheep procurement structures, a survey of the ethnographic literature of native North American groups which relied upon sheep either for primary or supplementary subsistence was conducted. Of the sources consulted thus far, only one other North American group, the Kaska of northern British Columbia and the southern Yukon Territory, used what Honigmann (1954:41) describes as a "surround" for sheep hunting. He relates:

Sometimes the Indians drove caribou and mountain sheep into surrounds where they could be shot or where they might trap themselves in snares. Sheep surrounds were built upon relatively low ground near that animal's

trails. Upon completing the structures, the hunters ascended the mountain and drove the sheep toward the corral (Honigmann 1954:41).

While the drive and individual stalking techniques ascribed to the Tukkutikka were also used by other groups, it would appear that the most popular sheep hunting technique used by historic native North Americans was that of the snare.

Gubser (1965:291) has noted that for the Nunamiut, the snare technique was the most productive "if a family wanted to live in a sheep area for some time" because the hunter would not be seen and frighten the sheep away. Given their dependence upon bighorn sheep as noted in historic times, it is curious that the Tukkutikka did not also use this technique. Another mountain group who were primarily dependent upon sheep, the Mountain Indians of the Mackenzie Mountains of the Yukon and Northwest Territories snared sheep in brush fences (Gillespie 1981:332). While Fowler (1986:79), in her summary statement on Shoshonean subsistence noted that snares were used to hunt sheep, Driver is the only source consulted thus far who records an instance of this, the Owens Valley Paiute (Driver 1937:110).

Athabaskan groups from northern British Columbia to the Brooks Range and eastward along the Yukon River regularly hunted sheep in their seasonal rounds, and apparently all favored the use of snares as a procurement technique. In

addition to the Mountain Indians, the Canadian groups include the Sekani of British Columbia (Denniston 1981:436), the Tagish, Inland Tlingit, and Kaska of British Columbia and the Yukon Territory (McClellan 1975:120; Honigmann 1954:41), the Tutchone of the Yukon Territory (McClellan 1975:120). The only sheep hunting group from this area of North America that is not included here is the Tahltan of northern British Columbia who are noted by MacLachlan (1981:462) as having used snares in hunting, but the prey is not specified.

Alaskan groups which hunted sheep with snares include the Netsi-Kutchin (Hadleigh-West 1963:141); the Chandalar Kutchin (Osgood 1936:36), the Upper Tanana (McKenna 1958:32; Vitt 1971:160), the Ahtna (de Laguna and McClellan 1981:648), the Tanaina (Alexie 1978:8) and the Yukon Ingalik (Snow 1981:604). Within the vicinity of the Brooks Range, sheep were snared by the Nunamiut (Gubser 1965:291, Binford 1978:278) and also by the Naupaktomiut of the Noatak Valley (Hall 1975:23). The Kuuvanmuit of the Kobuk River also hunted sheep by bow and arrow (Giddings 1961:132) and by snare (Giddings 1952:42-43, 1956:8)

When specified, the most commonly cited type of snare was that of the drag pole or clog snare, which is described in some detail by Cooper (1938:25) for caribou procurement among the Moose Factory and Kesagami Cree, and for sheep

hunting by McClellan (1975:109) for the Tutchone, Tagish, and Inland Tlingit.

These groups would create "fences" of brush designed to look like windfalls, either across a valley or mountainside, so that they would intersect game trails. Twenty to 30 snares, large nooses of babibche (line made of dried and braided or twisted caribou or moose hide strips) were set into this fence. Each noose was made as wide as necessary to allow for passage of the expected quarry, with the bottom of the noose two to three feet from the ground. The noose was rubbed with dirt and grass to eliminate the human scent. The end of the line was attached to a drag pole which Cooper details as a log or other object sufficiently large to impede movements of the snared animal but not of a nature to render the trap immovable. McClellan states this log was positioned above the snare so that it would drop on the animal as soon as the snare was touched, causing it to run forward, dragging the object behind it, and becoming entangled in the underbrush and surrounding trees. Cooper also noted that a double slip knot was used in making the noose so that the line would not slacken around an animal's neck. The more the animal pulled on the line, the more the line would tighten around its neck. Eventually, the animal would choke to death.

While hunters have been recorded as having driven herds

of sheep into snares (Honigmann 1954:41), it was not necessary for the hunters to be present when a snare is activated to achieve a kill. They need only to retrieve the carcass before the initiation of putrefaction (McClellan 1975:110). Tanaina elder Emma Alexie of Lime Village, Alaska, offered extreme evidence to this effect in describing her grandfather's method for snaring sheep. While hunting at the head of the Swift River, her grandfather would set 20 snares and then purposely leave them unattended. Mrs. Alexie related, "When they [the sheep] went into the snares, no one would watch," as if this was taboo. Only when all 20 snares were full would the family returned and retrieve the carcasses (Alexie 1978:8).

McKenna states that the Upper Tanana used snares because it was difficult to stalk the sheep in the high country of the Alaska Range (McKenna 1965:32). And, other than Gubser's statement related above that snares were considered highly productive by the Nunamiut, no reasons were given for a group's choice to snare sheep. Alternative techniques of sheep hunting were also utilized by some of the above groups, and these include dog drives (Osgood 1937:35; Gubser 1965:291), hunter to hunter drives (Reckcord 1983:32; Kari and Fall 1987:263) and simple stalking (Hadleigh-West 1963:141; Ingstad 1954:167; and Secondchief 1988).

The Tukkutikka have no oral tradition of snaring sheep, and the use of the snare in hunting sheep may have become popular only recently with the decreases in numbers of sheep available. The different Shoshonean groups have a tradition of animal drives, and given the Tukkutikka dependence on the animal, snaring may not have provided the satisfactory numbers needed for survival.

CHAPTER VI

SHEEP ECOLOGY

HISTORICAL BACKGROUND

Bighorn sheep historic accounts as well as ecological and behavioral information is presented in this chapter as background to the development of an interpretation of Bugas-Holding site usage.

Nineteenth century reports of the presence and distribution of Ovis sp. in the western United States are in agreement that sheep were once very numerous, wide spread, and easily hunted. The aboriginal sheep population of the United States, Canada, and Mexico has been put at 1.5-2.0 million individuals (Seton 1929:535). Buechner (1960:15) has reconstructed the past distribution of sheep in the American West which he defined as including not only mountainous areas but also the plains of eastern Wyoming, Montana, and parts of the Dakotas (Buechner 1960:73). The frequently cited presence of bighorn sheep on the plains in the nineteenth century was due to the animals' tendency to establish winter ranges in low-lying areas. Although it has been speculated that bighorn sheep were originally a plains animal driven into the mountains by shrinking ranges and

hunting pressure, this is no longer considered a viable hypothesis (Smith 1954:22; Beuchner 1960:16). Sheep were observed at high elevations in the Rockies in the 1830s (Russell 1955:133) as well as along the North Platte River in 1812 (Stuart 1935:191). Grinnell (1928:1) noted that when sighted in these lowland areas, bighorn sheep were never far from escape terrain such as buttes, rimrock, or badlands. While bighorn sheep are now isolated in the more remote areas of their original range, they have always been a mountainous animal.

An early Rocky Mountain trapper, Osborne Russell, offered the following observation on bighorn sheep habitat:

They inhabit the highest and most craggy mountains and never descend to the plains unless compelled by necessity. In the winter season the snow drives them down to the low craggy mountains facing the south but in the spring as the snow begins to recede they follow it, keeping close to where the grass is short and tender (Russell 1955:133).

The first description of Ovis canadensis was recorded by a member of the Lewis and Clark expedition, Sergeant Patrick Gass. The party encountered sheep in the spring of 1805 at low elevations along the cliffs of the Missouri River. Sightings were made from the confluence of the Yellowstone to the confluence of the Three Forks of the Missouri (Coues 1893:326,420,422,423). Early travellers through Wyoming and Idaho such as the Astorians in 1811-

1813, Bonneville in 1832, Russell in 1839, and Fremont in 1842 recorded numerous herds of sheep at both low and high elevations.

On their return trip from the mouth of the Columbia River the Astorian party noted large herds of "ibex" along the North Platte River in early November of 1812, and "innumerable" herds of sheep in the low-lying hills which border the Platte (Stuart 1935:191). Coutant (1899:303) noted that sheep were plentiful and available when Fort Laramie was built in 1834. In 1832 Captain Benjamin Bonneville recorded the following observations on bighorns while camping along the Salmon river of Idaho:

Besides numerous groups of elk, large flocks of ahsahta or bighorn, the mountain sheep were to be seen bounding among the precipies. These simple animals were easily circumvented and destroyed. A few hunters may surround a flock and kill as many as they please. Numbers were daily brought into camp... (Bonneville in Irving 1843:169).

Osborne Russell hunted bighorn sheep frequently throughout the Rockies in the 1830s. In July 1835 at Togwotee Pass in the Absaroka Range, he noted the presence of thousands of sheep at various elevations on the mountainside, with many on the higher areas (Russell 1955:26-28). Russell also observed in January of 1839 "immense numbers of mountain sheep" at the Snake River Canyon in the Grand Tetons. He noted they had been driven

down to "low points of rock facing south near the river..." by heavy snows (Russell in Haines 1955:95). In July of 1842, Fremont recorded large herds of sheep on the North Platte River a few miles above the confluence of the Sweetwater, and large herds of sheep at approximately 10,000 feet in the Wind River Range in mid-August of that year (Fremont 1845:61-71).

As settlement of the West increased throughout the nineteenth century, sightings of large numbers of sheep were less common. This was probably due to losses from disease, reduction of range, increased hunting, and also to an increasing wariness on the part of the sheep. In 1876 Grinnell (1876:70) reported that the Yellowstone Park bighorn sheep were seldom seen even though their population was high. Six years later, in the Teton Range, Baillie-Grohman (1882:175) observed that bighorn sheep were present only in the "very out of the way nooks." This situation was further commented upon by John Spears who observed in 1892:

The northwestern part of Wyoming was once famous as the home of the sheep, but while elk and moose abound there now, I was told when in Jackson's Hole, in October 1891, that sheep were rarely seen...(Spears 1892:74).

In contrast, however, Baillie-Grohman (1882:146) also described an unidentified place in Wyoming where in winter, bighorn sheep could be reliably hunted. This place was

characterized as being at a low elevation (7000 feet ASL) and within 14 miles of a major settlement. Baillie-Grohman attributed the presence of bighorn sheep at low elevations to the heavy snowfall in the upper ranges.

SEASONAL ROUND

Rocky mountain bighorn sheep herds generally inhabit a variety of ranges in the course of a year. These usually include summer and winter ranges, lambing areas, and rutting and salt lick ranges (Geist 1971:63; Adams et al. 1982:11). These ranges are made up of a wide variety of terrain types which generally meet the herd's needs for escape terrain such as talus slopes or broken cliff faces, good visibility, and light snow depth (Risenhoover and Bailey 1980:18; Adams et al. 1982:9). Summer ranges are usually in high alpine areas and winter ranges are in the lowlands (Honest and Frost 1942:116; Smith 1954). Sheep herds bifurcate into essentially two bands throughout the year; ram bands which include all males over the age of two years, and ewe-lamb bands which are comprised of the remaining individuals. Occasionally, barren ewes will join the ram bands. The herd comes together during the rut, otherwise they remain in separate bands. Under severe snow conditions, herds have been observed on a common winter range, but even then the

bands remained segregated (Geist and Petocz 1977:1808).

Geist (1975) characterized the ewe-lamb band as the "home range group," stating they were more tightly knit than the ram bands. The ewe-lamb bands maintain four ranges: winter, spring, lambing, and summer. The rams frequent pre-rut, rut, and salt lick ranges in addition to their winter, spring, and summer ranges. Movement of the home range group is dictated by a mature, non-barren ewe. The ram band associated with a specific ewe-lamb band tends to travel in a dispersed manner in the near vicinity of the ewe-lamb band. The rut usually takes place on the ewe-lamb winter range. Ranges are connected by migration routes, and distances covered between ranges can be as great as 20 miles. While sheep are consistent in their choice of range lands which offer good visibility and escape terrain, migration routes may not always offer the same security (Adams et al. 1982:11). When left undisturbed, sheep remain generally loyal to their traditional ranges and migration routes (Geist 1971:62). Choice in lambing ranges is varied, however, seemingly dependent more upon depth of snow and extent of spring greening rather than use in a previous year (Becker et al. 1978).

Researchers have speculated that the timing of a band's seasonal round is dependent upon the onset of estrus or lambing (Geist 1971:96) which in turn appear to be a

function of latitude (Thompson and Turner 1980; Bunnell 1982). Wild sheep lambing periods follow a latitudinal cline in that alpine populations tend to have a later and shorter season (Thompson and Turner 1980:311). This has been related to the appearance of spring plant growth and general lamb survival (Spurr and Barnes 1973:41; Bunnell 1982:7). Lambing season in the Bugas-Holding area (west latitude 40) generally begins in May and concludes by mid-July (Bunnell 1982:3). One extreme variation has been recorded in this area, however; the June onset of lambing season in the West Rosebud range of the Montana Beartooth Mountains (Stewart 1982:154-155). As the gestation period of mountain sheep is six months (Frost 1942), a general lambing period in the Bugas-Holding site vicinity beginning in May would put the beginning of the estrus cycle in December.

Bands begin to move down from their high summer ranges in late fall with the ewe-lamb bands headed for their winter range and the dispersed rams congregating at their pre-rut range. Sheep migrations are generally slow, done in a drifting fashion. The exception to this is the movement of rams toward their rutting range or bands surprised by snow storms after they have left their winter grounds. The sheep then move in a steady, purposeful manner. After a general congregation of males at the pre-rutting range, which lasts from two to five weeks, the ram band moves to their rutting

range, which is the ewe-lamb band's winter range. Although the ewe-lamb bands have a lower number of ranges, the ewes appear later on their winter ranges and spend a lower total amount of time there. Geist (1975) noted ewes tended to spend 240-268 days on their winter range while rams remained on wintering grounds for 271-303 days. After the rut the youngest and oldest males remain on the ewe-lamb range while the middle aged males return to the pre-rut range or go to a separate mid-winter home range. Wintering sheep move to those areas where forage is most accessible and snow is less deep. This means open slopes in mid-winter when the snow is soft and south facing cliff terrain in late winter after the snow has developed a crust. Consequently, sheep are more visible in mid-winter and less so in late winter. The south facing cliffs are preferred in winter due to the quicker snow melt, forage exposure, and rock warming in these areas. Also at lambing time the rams come together in large concentrations again on the pre-rut range. In late spring both bands move to late winter/spring green-up ranges to take advantage of new grass. At lambing time the pregnant ewes move to lambing areas and the rams may move to their salt lick ranges. After this, the bands slowly make their way back up the mountainside to the higher elevation summer ranges.

THE TROUT PEAK SHEEP HERD

One bighorn sheep herd which resides in the mountains directly south and east of the Sunlight Basin, the Trout Peak bighorn sheep herd, was studied in the early 1980s (Hurley 1985). Herd population at that time was estimated to be 500 individuals. In the summer, this herd was located at high elevations from Trout Peak to the Yellowstone National Park Boundary. In early fall most of the sheep were still above the timber line, but slowly worked their way through the timbered areas as the season progressed. The herd generally moved to the lower winter ranges during October and November, but at times appeared on winter ranges as early as September if snow came early in the high ranges. From November until early June, 70.8% of all sheep groups remained below 8000 feet, and slopes along major drainages were preferred. Most notably, concentrations of 10-50 sheep wintered along Sunlight Creek in the general area of the Bugas-Holding site. As the Sunlight Basin is north of the Trout Peak area, however, the majority of the herd preferred to winter on the southerly side of the mountains towards the North Fork of the Shoshone River. The remaining 25% of the herd wintered above 8000 feet on snow free ridge tops and southern and western aspects of Jim and Sleeping Giant mountains. These sheep moved to lower elevations in late

winter/early spring, attracted by new grass and disturbed by increasing snow depth. Lambing took place on the winter ranges primarily in the vicinity of the North Fork of the Shoshone River between 29 May and 15 June. Barren ewes and rams left their winter ranges by the end of June and were on their summer range by the end of July. Hurley (1985) characterized the herd as having three types of seasonal movements: long distance, which included crossing at least one major drainage, general altitudinal drift, and lateral movement along the low elevation wintering areas.

REACTIONS TO HUNTING

While sheep have been noted to accept and even ignore the regular presence of a non-threatening human in their midst (Geist 1975:41), they are adversely affected by hunting (Buechner 1960:6; Geist 1971:87; Thorne et al. 1978). Geist noted two instances where rams abandoned traditional ranges after their bands had been disturbed by hunters. Michael Whitfield (1983:146) made similar observations in the Grand Tetons of Wyoming, particularly noting the abandonment of ranges and a strong flight reaction to humans by rams. In a study of hunted sheep on Whisky Mountain, Wyoming, Thorne et al. (1978:47) noted that the ram abandonment of favorable ranges had led to an

increased use of harsh and marginal environments which was threatening the survival of the males. They appeared with some regularity on their rutting and early spring ranges, but even then not all the available males were present. The ewe-lamb bands, however, which were not hunted, remained on their home ranges and visible for most of the year. The unhunted sheep did shy away from approaching humans, but tended to remain in the same vicinity. In contrast, the researchers observed a ram group run for 1.6 miles when disturbed by two hikers who merely appeared on their range and were never aware of the band's presence. Thorne et al. (1978:47) speculate that the strong flight reaction and the abandonment of productive ranges would have a disastrous affect on herd survival if all sheep bands were subjected to hunting. The authors predicted the ewes' greater nutritional needs would not be met if this band was regularly hunted. Winter hunting of ewes would lead to mortality due to malnutrition while summer hunting would lead to lamb mortality due to a reduction in milk production. Geist and Petocz (1977:87) noted that winter range is more critical to herd survival than summer range, and that a herd could survive trophy hunting only if the population was large, the environment open, and the ranges free of any other use.

CHAPTER VII

CONCLUSIONS

The first objective of this thesis was to document the breakage pattern of the sheep specimens of the Bugas-Holding site as an illustration of what is most likely a humanly derived pattern of breakage. This assemblage can be briefly described as highly fragmented with no complete bones recovered. The metatarsal, metacarpal, and radius are represented primarily by their articular ends, while the femur, tibia, and humerus are represented primarily by their shaft fragments. None of the articular ends of the tibia nor the proximal ends of the humerus were recovered, and a relatively small number of the femoral articular ends were identified. The humerus and femur shafts appear to have undergone a greater amount of processing.

Use of this kind of information as a controlled case study of human breakage is useful only if the circumstances of breakage are well defined. In this instance, the activities conducted at the Bugas-Holding site can at best only be inferred. In the following I draw upon the assemblage breakage data, the ethnographic information on the historic Tukkutikka, information on sheep ecology, and other sources to present a plausible series of arguments as

to what this assemblage represents.

The most basic activity that can be inferred is the intensive processing of certain elements for bone grease production.

The elements apparently selected by the past inhabitants of the Bugas-Holding site for selective deletion of the articular ends are the same as those chosen by the Nunamiut (Binford 1978:36) for spring grease processing. These selections are listed below in Table 7.1. The values given in this table represent the consistency with which the bone processors retained an articular end for grease processing.

TABLE 7.1
SPRING SHEEP APPENDICULAR ELEMENT SELECTION
FOR BONE GREASE PRODUCTION

ELEMENT	VALUE
Distal Femur	100
Proximal Humerus	80
Proximal Tibia	75
Distal Metatarsal	75
Proximal Femur	66
Proximal Radius	60
Distal Metacarpal	50
Distal Tibia	50
Distal Radius	33
Proximal Metatarsal	25

Values from Binford (1987:36)

As can be seen, the distal femur and proximal humerus were the highest choices for springtime processing, followed by the proximal tibia and distal metatarsal. The similarity of these choices to those reflected in the Bugas-Holding breakage data is strong support for an argument of selective processing of the femur and humerus. While more intensive processing of the tibia shaft was not suggested by the analysis, the total deletion of the articular ends of this element is apparent.

Binford (1978:32) states that element choices in grease processing are influenced by three factors: type of grease, expediency in breakage, and the kind of fragments produced. Two types of grease are produced in processing bones. The preferred grease is white in color and is obtained from the appendicular elements. Grease from the axials is yellow and of a lesser quality. Expediency in breakage is a factor in that elements with known grease potential such as tarsals are only processed if there is an extreme need. Apparently the effort involved in breaking these bones is far greater than the quality of grease produced. The last factor, and the one most relevant to the current study, is the knowledge that more grease is obtained from bones that break into small chunks. Binford, however, did not identify which bones were favored for this quality or if the distinction

was between appendicular versus axial elements, or among the axial elements themselves.

The fragment size differences in the Bugas-Holding site assemblage may be due in part to a natural tendency for the bone of an element to fracture in a patterned way due to the thickness or shape of the element. As the bone breakage study was designed for marrow extraction of the long bones, data are not available on this subject. Bonnicksen (1979), Binford (1981), and Haynes (1983) have collected observations or conducted studies on bone breakage, but these have been limited to marrow extraction also. It would be useful to conduct another study in which elements are processed beyond marrow extraction to see if a natural tendency for different fragment sizes between appendicular is apparent and consistent.

Another possible reason for the preferential selection of these elements is that they were chosen for gease production rather than their marrow content. In Binford's work with the Nunamiut, he found that marrow quality was accorded more value than quantity (Binford 1978:28). Reasoning that quality was caused by a higher percentage of oleic acid in the marrow, Binford had chemical assays run on the marrow collected from a six month old domestic sheep killed in November of 1973. The oleic values derived are presented below in Table 7.2.

TABLE 7.2

MARROW OLEIC ACID PERCENTAGE: IMMATURE SHEEP
APPENDICULAR ELEMENTS

ELEMENT	PERCENTAGE
Distal Metacarpal	78
Distal Metatarsal	76
Proximal Metacarpal	73
Distal Tibia	71
Proximal Metatarsal	71
Distal Radius	67
Proximal Tibia	54
Distal Femur	53
Proximal Radius	48
Distal Humerus	48
Proximal Femur	44
Proximal Humerus	40

Values from Binford (1978:24)

Study of this table indicates an inverse relationship in long bone choices for marrow as opposed to those for grease (see Table 7.1). When compared to the Bugas-Holding site assemblage it is apparent that other than the metatarsal, those bones which exhibited the lesser amount of impact scarring and the greatest shaft lengths, the metacarpal, radius, and tibia, were the preferred marrow bones. The metatarsal's small fragment size, and tendency to register in the mid-ranges of shaft length, and percentage of scarring may be due to its favored status as both a marrow and grease bone.

There is some question as to what this comparison of

Binford's data to the Bugas-Holding site bighorn sheep data actually represents, however, as the lamb is an immature animal and its gender is not specified.

Wildlife studies have shown that the body and marrow fat of ungulates undergoes a seasonal rise and fall in quality (Harris 1945; Riney 1955; Anderson et al. 1974; Stockle et al. 1978). Among white-tailed deer, this cycle is also known to vary between sexes and increase in magnitude with age (Johns et al. 1982). In this study, it was found that male white-tailed deer older than 1.5 years of age achieved a peak in body and marrow fat levels in the early fall which decreased steadily throughout the rutting season. The 1.5 year olds' fat levels, however, did not noticeably decrease during the same time period. Conversely, the fat level of the fawns steadily increased throughout the fall and by December was comparable to the 1.5 year olds at the start of the rut (Johns et al. 1982).

If the fat levels of the domestic lamb can be assumed to follow the same pattern as the white-tailed deer fawn, the values presented by Binford most likely represent a young animal in prime condition who has yet to participate in a rut. The lack of an identified gender is not considered a drawback as it is assumed that all immature animals gain and store fat in the same manner. While it is likely that mature animals of both sexes achieve fat levels which exceed

the levels given in Table 7.2, it is assumed that the oleic acid levels of a mature animal in optimal condition register in the same relative proportions from element to element.

When animals undergo a decline, however, all categories of body fat are slowly utilized, and this mobilization occurs in an orderly fashion. Among the marrow bones it has been found that the femur, humerus, tibia, and radius are affected before the metatarsal and metacarpal. Fuller et al.(1986) found that the oleic values of the lower bones remained high even when the femur marrow had decreased by 30%. In another study, the femur marrow fat of caribou in poor body condition was found to be less stable than that of the tibia while the metatarsal value remained high (Ringberg et al. 1980).

Given that the oleic acid levels of the lamb are the lowest in the femur and humerus, and that the femur and humerus are the first elements in a sequence of fat mobilization, it is likely that under a variety of conditions, the marrow fat values of these elements will always be proportionately less than the other limb bones. The lower marrow value is most likely a contributing factor in the recorded cultural bias towards using these elements for bone grease production. Ease of breakage or the easy acquisition of a preferred fragment size may also be a factor.

Another factor of interest to someone wishing to use the assemblage description as controlled data is the composition of the original sheep band, and how these sheep were procured and introduced to the site.

The seasonality and length of occupation of the Bugas-Holding site has been interpreted to be winter to early spring based on the developmental stages of the bison fetal material recovered. The lack of sheep fetal bones in the assemblage suggests the possibility that the hunted sheep were taken from a ewe-lamb band on their winter range sometime close to the rut (December). The ewes would be the fattest sheep at this time of year. Another alternative is that they were derived from a ram band. As the rams are at their poorest level nutritionally just after the rut, this possibility is the least likely of the two. As the sexual dimorphism of sheep is not pronounced, the gender of the hunted animals cannot be detected through an analysis of the bones themselves.

An unspecified band of bighorn sheep from the Trout Peak herd were recently observed wintering in the near vicinity of the Bugas-Holding site. The tendency for sheep to return to traditional ranges year after year suggests that the sheep processed at the site were most likely hunted in the near vicinity. The general similarity in MAU counts for the hindlimb and forelimb supports an interpretation

that the sheep were hunted in an area close to the site and introduced as whole animals. Support for this can be found in other ethnographic sources which document a tendency of hunters to selectively remove unnecessary carcass bulk when it is necessary to transport their kill over long distances. Binford (1978) has exhaustively discussed aspects of this phenomenon. Additionally, in a discussion of caribou hunting practices, two Inupiat elders from Noatak, Alaska, Harold Downey and Kenneth Ashby, mentioned that they would dry the meat and completely discard the bones of a carcass if they had a long distance to travel. Downey remarked:

And also they would backpack the caribou from inland. They would travel inland, searching the land, the strong ones backpacking the meat...They would dry the meat. The people were very strong then, and they would backpack piles and piles of meat...(Downey, Stalker, and Ashby 1987).

Ashby explained further that bones were removed when they had to cover long distances, but when near the village site, bones are carried, broken, and stored. He stated:

By walking and packing them after they dry them up. And when they do theat, you know, they skinning the caribou, even they skinning the bones, because they don't want to pack the bones. Only, only, the meat without bone. But when they are near, they bust it up, and put them together and store them (Downey, Stalker, and Ashby 1987).

The group that hunted these bighorn sheep, most likely

the predecessors of the historic Tukkutikka, came from a tradition familiar with big game drives. They are credited with the construction of the high altitude traps found throughout the Absaroka Mountains, and were most likely familiar with the processing of a high number of carcasses at one time. Also, as it has been noted that bands of sheep become extremely wary after having been hunted, it is likely that the bighorn sheep represented at the Bugas-Holding site were killed in a single event. Although it is certainly possible that the sheep were hunted individually with some storage of bone prior to processing, the short estimated length of occupation (four months) and the tendency of bands to leave an area after a hunting incident lessens this possibility. As a group, the historic Tukkutikka actively hunted bighorn sheep and depended primarily upon these animals for survival. It is logical to assume that their predecessors, presumably also dependent upon the species, would attempt to hunt bighorn sheep in a manner that would gain high yields. Although the historic Tukkutikka did not drive sheep, the herd sizes available to them were much smaller than those in the West prior to the 1800s.

The final factor of interest in interpreting the Bugas-Holding bighorn sheep assemblage is why the bone was processed in this manner.

Fat is a dietary necessity and a more concentrated

energy source than protein or carbohydrate (Guthrie 1975:45). The late winter/early spring period of occupation is a critical one for hunter-gatherers due to the reduced number of dietary choices and especially the general leanness of animals at that time of year. The high level of bone fragmentation at the Bugas-Holding site is an indication that the group that processed these animals were utilizing every possible source, and it appears that they were selective in element choices for processing. Supplementary studies need to be conducted to determine if the fragmentation pattern documented here represents the general maintenance activities of the group or if it is an indication of dietary stress.

Bone grease was used by native groups on the Plains in a variety of ways. Grinnell (1972: 216) recorded its use to tan hides, Lowie (1924) and Densmore (1929:44) its use in making pemmican, and Leechman (1951:355) and Dorsey (1884:303) its use as a spread. Again, as this study has focused strictly upon the assemblage level of bone analysis, more specific studies of site context need to be conducted to further define the use of the grease processed at the Bugas-Holding site.

In conclusion, at the barest minimum, the data best support an interpretation that grease processing of bighorn sheep bone occurred at the Bugas-Holding site with a

preferential selection of elements for this activity. The further suggestions that the bighorn sheep were taken from a ewe-land band, that they were hunted in a drive in an area near the site, that they were introduced as whole carcasses to the site are not as well supported, and are worthy of further investigation.

The value of this work lies in the development and demonstration of techniques for isolating finer differences in the levels of processing the elements of the bone assemblage have undergone. This study is also important in that it is a first attempt to quantify the relationship between identifiability and level of breakage an assemblage has undergone.

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