THE WYOMING ARCHAEOLOGIST

VOLUME 31(1-2)

SPRING 1988

THE WYOMING ARCHAEOLOGIST

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ANNOUNCEMENTS

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The Smoke Signal covers from Volume 1(1) through Volume 2(3).

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1971-1983 back issues are $2.50 each. Beginning with the Spring 1984 issue, charges are $5.00 each.

Back issues will be available at the Spring WAS meeting in Riverton.

UPCOMING ARTICLES

Present plans are to have articles on the Pine Bluffs site in Laramie County and various sites in Goshen County in the next issue. Any member of the Wyoming Archaeological Society with articles describing the archaeology of Wyoming is invited to submit an article to the editor for inclusion as well.

HIGH PLAINS ANTHROPOLOGY PROJECT

Dr. Charles Reher and U.W. Anthropology students will be in the Pine Bluffs, Wyoming, area this summer (1988) conducting excavations and working in a field lab/visitor center.

Visitors and volunteers are welcome. There is an RV park in town, and field camp facilities are available in the bluffs near town. There is also a free swimming pool in Pine Bluffs.

Tentative dates are: June 27-July 7; July 12-21; July 26-August 4; August 9-18; and August 23-30. Please check with the U.W. Anthropology Department for final details near the start of the field season.

The main excavation is the Pine Bluffs site (48LA312), a stratified camp with levels ranging from early historic to 10,000 yrs ago. Seven Mile Point (48LA304), a large butte top-stratified camp with levels going back over 3500 yrs, is another main area of excavation.

Field trips/tours are a possibility if prior arrangements are made. For information, contact Charles Reher at P.O. Box 3431, University Station, Laramie, WY 82071, or call his office (307) 766-2208, or the U.W. Anthropology Department Office, (307) 766-5136.

Historic archaeology shelves, one of many displays at the High Plains Anthropology Project Visitor Center, Pine Bluffs, Wyoming.

Excavations in progress at the Pine Bluffs site, adjacent to the east bound I-80 off-ramp at Pine Bluffs, Wyoming.

The Wyoming Archaeologist
Volume 31, Nos. 1-2, 1988

HEAD OF BARBARA AND BUFFALO SKULL

WILLIAM P. MAYCOCK

HEAD OF BARBARA

Several years back, my wife and I were riding horseback when we decided to go down a point at a fork where two draws came together, and then on down the creek known as Barber, named after the former governor of Wyoming.

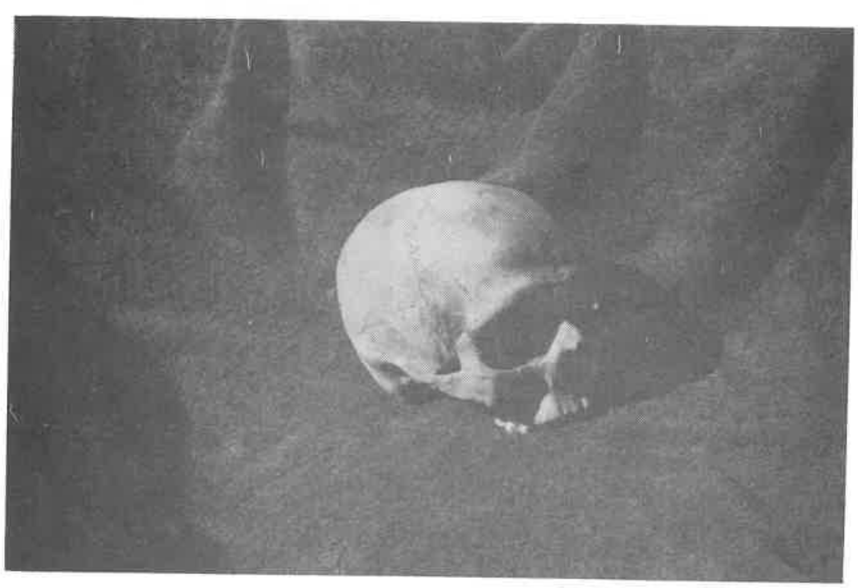
Where the draws came together, we dropped down into the creek channel. The channel had been washed out about twenty feet wide and fifteen feet deep. In fact, it had eroded itself clear down to a seepy spring. Cattle had been stomping around trying to sup out of the tracks they had made. We had our eyes down as it looked boggy. Our horses were also a bit skeptical of walking in the area as well.

I saw this bone-looking thing right beside where we were riding. This was really nothing to notice, as many wild animals as well as domestic are continually dying on the range and we find their bones constantly.

Taking a second glance, I said to my wife Audrey, "Look at that bone. Looks like a deer head, but not quite." "Why don't you get off and look it over," she suggested. I didn't especially want to as it was pretty wet there, but I got off, stepped over closer and immediately could see an eye socket.

"Hell, Mom," I said "that's a human skull." It was covered for the most part, with dirt and sand completely filling the braincase. We were so elated, we carried it right home and proceeded to hose it clean. After it was dry, we varnished and painted it. It has three teeth in the upper jaw on one side and a couple others broken off in the other side. It was amazing to us that the teeth were so worn and smooth. The head looked so small. It looked like a young woman's skull, but the teeth must have had a good work out to have been worn so. Dr. George Frison examined it and declared it not very old. I even checked out my mother's teeth as she was about 85 years old and her teeth were very sharp in comparison.

Neighbors decided it must be an old sheepherder, but the skull has a triangular piece of bone at the back, which is supposedly not characteristic of caucasians.



We also noticed one-third of the skull was bleached white, which indicated quite a lot of exposure to the sun. We surmised that it had lain for quite a while in one spot.

We worked both draws later, which are from one-half to one mile in length, for more bones with no success. The head is in such good condition, we thought that it was probably wrapped in a buffalo robe to protect it for so long.

Rocks had fallen in the draw and water had washed down it, until the rest of the story will probably be lost. We call her "Head of Barbara". The skull must be over 100 years old.

BUFFALO SKULL

One day, I was touring around in my pickup with a neighbor and pulled into the ranch and asked my wife where our son was. "Michael went over to fix a watergap fence that a recent flood ripped out," she said.

The watergap in question was not too far away, so we decided to go over and see if he needed any help or material. When getting close to the gully and fence line, we discovered what looked to be a bone setting on top of a fence post. We stopped, got out and looked. "Walker," I said to my neighbor, "that looks like a small buffalo skull." We looked it over, all packed with mud and debris, then walked over and saw Michael working on the fence.

"How you coming, Mike," we asked. "I'm ok," he said, "just about finished." "What's the story on the buffalo head," we asked. Mike said, "Oh, it was tangled in the mud and brush down here, wonder it didn't wash away." "Well," we said, "we'll put it in the pickup and have it at home."

It was a couple of days before we could clean it up and wash the mud off. Examining it closly, we discovered it was a buffalo yearling heifer skull. Not only that, but it showed a very pronounced bullet hole in the right front part of the skull. Following the path of the bullet, there was no indication it had penetrated the brain. By running a pencil through the hole, it went on and evidently wound up by hitting the skull back of the horn and ricocheted off, no doubt dropping the animal with such a stunning blow. The caliber of the gun looked like a .44 in a pistol size. It looks like from the angle the bullet penetrated, the animal was looking up when dropped.

Next to unfold was the smashing wound to the frontal part of the forehead to keep the animal down. We surmise it might have been a white man because this frontal finishing wound was with an implement with a straight edge, like an axe or hatchet. It was no doubt a steel or iron blade. I am sure a flint or other stone tool would have left a jagged edge here.

We next tried to visualize what had happened. So looking it over some more, it was rather evident the brains were removed from behind the skull as the chopping marks here are straight edged.

Written by William P. Maycock

Submitted by
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EDITOR NOTE: These two short articles on Wyoming archaeological discoveries were written by William P. Maycock, a long-time member of the Wyoming Archaeological Society from Gillette. Mr. Maycock made the two discoveries over ten years ago and had planned on sending them to The Wyoming Archaeologist for some time, but passed away before he was able to do so. His wife, Audrey, sent them to us as a final tribute to the many years Bill had been working for the advancement of our knowledge on Wyoming archaeology.

The Wyoming Archaeologist
Volume 31, Nos. 1-2, 1988

THE ARROW AT POLECAT BENCH

DAN R. BAXTER

Lying below the south side of Polecat Bench is a large prehistoric stone arrow. It is as much an enigma as the various other stone arrows that have been found in and around the Bighorn Basin, and in one respect, is more so. Unlike most other stone arrows around the Basin, for example a smaller arrow nearby, and the Great Arrow near Meeteetse, this arrow does not point toward the Bighorn Medicine Wheel near Lovell. Instead, it points in the opposite direction, almost due west, toward the Polecat Bench itself, or perhaps beyond. One can merely speculate on the significance of the direction or the intention of the peoples who placed it there.

The arrow lies in the saddle of a high ridge extending from the bench in a southerly direction (Figure 1). It is eighteen feet, three inches (5.563 m) long, with the north and south arms of the point each eighty inches (2.032 m) in length, and nine feet (2.743 m) across at their tips. The arrow is composed of 56 stones, all Pleistocene terrace cobbles common to the locale. On the sixth stone down from the point on the south arm, there are two shallow, parallel scratch marks (Figure 1), possibly of human origin, four and one-eighth inches (10.48 cm) long, the last inch and one-eighth (2.86 cm) curving slightly to the northwest. On the second stone from the end of the shaft there is a deeper horseshoe-shaped mark (Figure 1), approximately an inch and one-eighth (2.86 cm) in diameter, of indeterminate origin. The arrow lies on the east side of the crown of the saddle, and appears to point upward toward the rim of the bench.

To the immediate west of the saddle lie three additional high ridges extending from the bench, products of erosion from run-off. An exploration of the ridges and their accompanying arroyos revealed running water in the western two arroyos. The source of this water was discovered to be meltwater from a recent snowfall. However, the extensive headward erosion of the two arroyos and the alluvial deposits downstream indicated steady amounts of discharge off the bench through the years. No tipi rings or other evidence of prehistoric occupation was found in this immediate area.

Northeast of the saddle lie three more ridges. Approximately seventy-five yards (68.6 m) from the big arrow, between the saddle and the first ridge, exploration revealed a second, smaller arrow. This arrow is eight feet, seven inches (2.616 m) long and four feet, eleven and one-half (1.511 m) wide at the tips of the point. This arrow was described by Breitweiser (n.d.) in an early article in the Powell Tribune. This arrow consists of forty-two stones, but an arch of approximately ten stones above it suggests that it was destroyed at one time and subsequently rebuilt (Figure 2). The arrow points in an easterly direction, almost directly at Cottonwood Canyon in the Bighorn Mountains below the Medicine Wheel. Between the second and third ridges, approximately one-eighth mile (200 m) from the bigger arrow, a group of ten or more tipi rings was found. This site was badly deflated. However, a brief survey of the area turned up a projectile point base (Late Prehistoric, possibly of Crow origin), several basalt scrapers, a few percussion flakes of material similar to the point base, and a large amount of pre-1900s glass fragments, which showed possible signs of knapping. Perhaps the arrows are associated with the tipi rings.

A survey of Polecat Bench immediately west of the big arrow in the direction

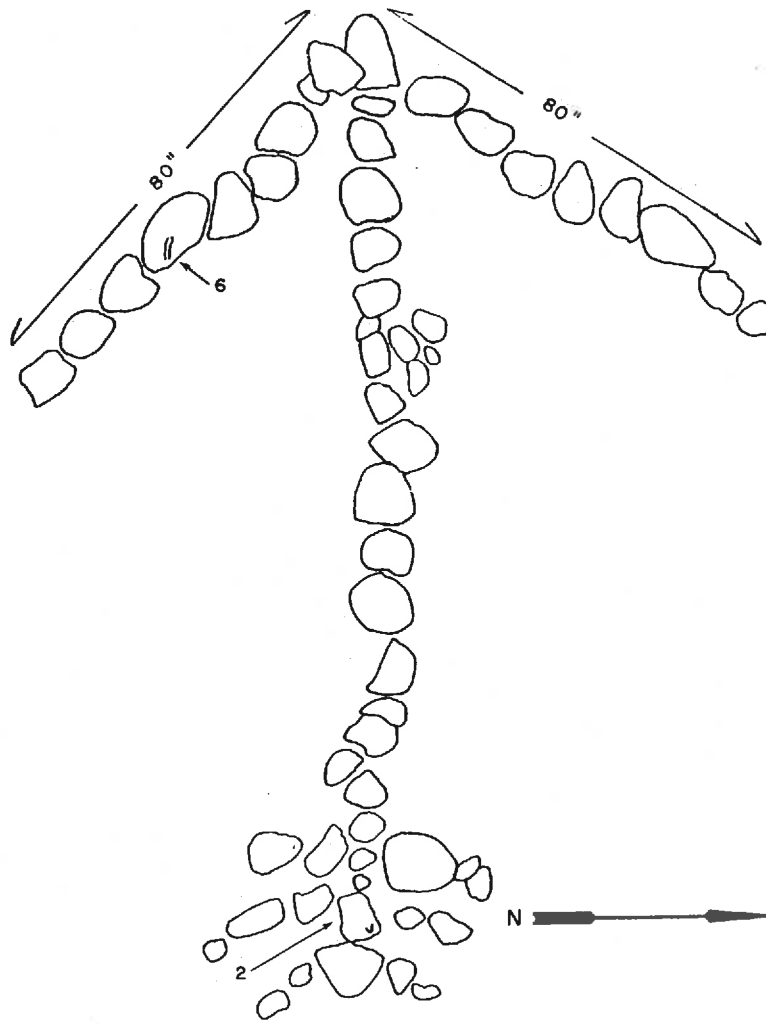

Figure 1: Stone arrow at Polecat Bench, Wyoming. Note position of marks on two rocks designated "2" and "6."

the arrow is pointing, revealed the remains of a rock cairn on the edge of the rim and two tipi rings nearby (Figure 3). Directly beneath the cairn (and in line with the arrow) were two successive terraces, approximately fifteen and thirty feet (4.572 and 9.144 m) below the edge of the rim, respectively. Both terraces and the cleft to the south were covered with tall, dead grass and short, green grass. The soil underneath was moist to the point of sponginess in some spots. The upper terraces dips to the east, however the lower terrace was concave, with a westward dip. This effectively formed a trough approximately seventy-five to one hundred feet (22.86 to 30.48 m) long. One striking feature of the trough was a crescent-shaped hollow that formed a basin twelve feet (3.658 m) long, six feet (1.829 m) wide, and over a foot (0.305 m) deep, in the bottom of which Pleistocene cobbles were visible. The lack of vegetation and moistness of the soil indicated it had until recently held water.

Beyond this crescent to the south were two more adjacent hollows, both bowl shaped. The evidence here and in the arroyos below suggests spring through fall retention of water from snowmelt and seepage in considerable quantity. Perhaps the hollows served as a water source for migrant bands of

Figure 2: Smaller stone arrow northeast of main arrow at Polecat Bench.

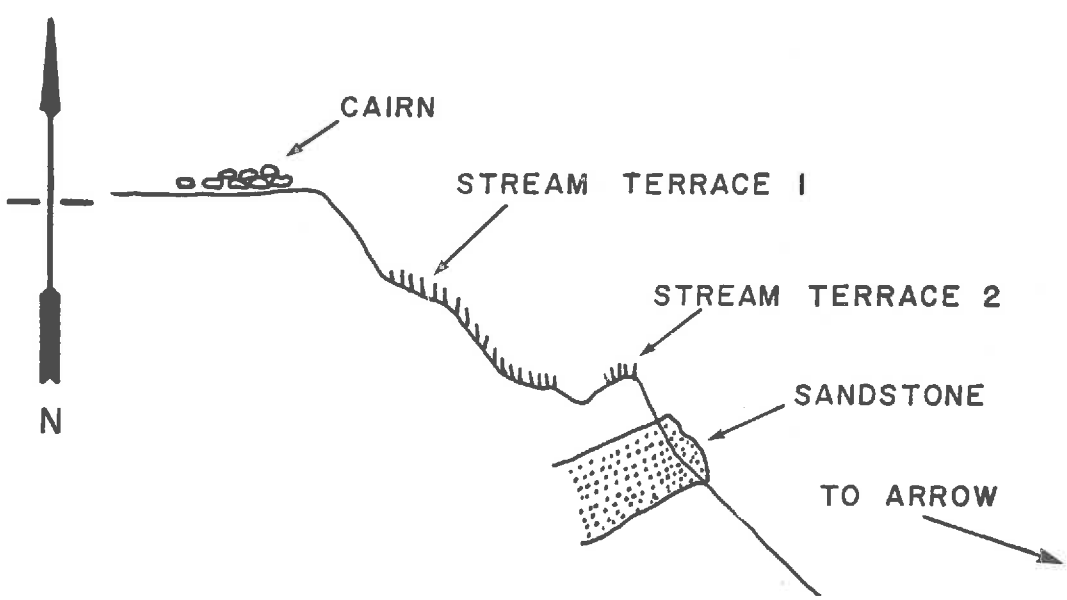

Figure 3: Cross-section of Polecat Bench showing location of cairn relative to stone arrow.

Indians crossing Polecat Bench. No permanent water sources exist on the bench except for a small spring on the west side. This might have provided a reason to mark the cleft location with an arrow, especially since there are so many similar clefts on that side of the bench.

It is also possible the Polecat Bench arrow was constructed to mark a trail. Several trails into the Bighorn Mountains, leading past the Medicine Wheel and branching north into Montana, south along the Bighorns and westward across the Bighorn Basin, are marked with stone cairns and arrows (Hunter 1986). Looking at topographical maps, one finds the heart of Yellowstone Park due west of the arrow beyond the bench. Hart Mountain and Clark's Fork Canyon also lie west of the arrow, but once on top of Polecat Bench, it seems unlikely that directional markers would be needed to find these two landmarks. Exploration, west along the bench from the cairn at the rim's edge above the arrow, turned up the remnants of several more cairns, all approximately one-quarter mile (401.6 m) apart, perhaps marking the continuance of a trail from the Bighorns to Yellowstone Park. It would stand to reason, however, that any trail blazed through trackless wilderness, from winter camps to summer hunting and gathering locations and back again, would necessarily need to pass water holes and other desirable rest locations. If these are few, as on Polecat Bench, trail markers may have been constructed to insure the best path was followed.

In summary, we may only speculate on the purpose of the arrow at Polecat Bench, or who constructed it. The fact it points away from the Medicine Wheel makes this arrow unique among the stone arrows known from the Bighorn Basin. It is possible to theorize about the existence at one time of a well-marked trail across the Basin, and perhaps future discoveries will prove this. If the arrow at Polecat Bench was part of that trail, or had some other purpose, its significance may not be that profound. However, until we know more, the existence of the arrow will remain infinitely mysterious.

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SUGGESTIONS FOR EVOLUTION OF ROCK ART GLYPHS

WM JACK HRANICKY

Perhaps the most positive aspect of anthropology and archeology is an insight to human physical and social evolution; however, this aspect has not been without a long history of argument among the practitioners of these social/scientific disciplines. To suggest art styles as being evolutionary probably will only refuel this topic's debate (and some agreement) in the literature. This paper will present an evolutionary scheme for American prehistoric rock art. Other forms of art, such as ceramic and clothing decoration, will not be discussed here. As such, art is defined here as "any type of graphic expression that was placed on boulders or cave walls." In viewing American prehistoric art, we can assume two basic factors about it, which are:

1 - Mankind migrated into the new world with this knowledge.
2 - Mankind developed it independently in the Americas and elsewhere in the world.

If the American Indian brought the knowledge and social use of art with him, then this gives us a good starting point from which to trace the development or evolution of American Indian art styles. On the other hand, and without this assumption, we are looking at the entire geo/chronological space of the Americas. Recent C-14 dates in South America that have an associated red ocher painted on shelter walls suggest that we may well be dealing with a period of over 20,000 years. For the scientific moment, there is no way to place a starting date on American rock art, although this author seems certain that rock art goes well back in prehistoric time and easily includes the Paleoindian Period. This leaves the only other area that we might well examine and, leastwise, make an attempt to define a set of developmental stages for rock art. This is the social development of producing glyphs, which I am calling an evolutionary scheme for rock art. This scheme does not imply any social change as the use of rock art glyphs was largely pan-Indian, and like technology, this information was available to Indians all over the United States. This social correlation probably cannot be demonstrated in contemporary archeology.

Stick-figures or line drawings are early forms of art development. Further, petroglyphic art is probably the older form of rock art and may well have disappeared by Early Woodland or ceramic times. The following is a suggested evolutionary schema for pictographic rock art. This is a generalized scheme which is based purely on observation of large amounts of glyph data and certainly needs more testing even by the author. Additionally, this scheme illustrates an analytical difference in our observations: namely, we tend to use two different sets of terminology for describing rock art -- pictographs and petroglyphs. This process weakens any analytical conclusions, but, for the moment, this distinction will be maintained by the author.

While most prehistoric art seems well developed, there would seem to be antecedents that must have occurred. To paint, draw, carve, etc., individuals need practice and development of skill to perform within a society as an art specialist. Also, these art methods would have been passed on from generation to generation. Collectively and as an example, the American Indian picked up the ideas of creating containers and developed them from plainwares to polychromes. Naturally, this development varied in the United States, but one can see sources or influence-areas in ceramics, which lead to a possible evolutionary schema. It is difficult to call plainware an artform, but a polychrome vessel certainly has an art applique. This argument is not far removed from what Leroi-Gourham (1968) was attempting when he argued for an evolution in art for the Paleolithic of Europe. By following those arguments, American prehistoric art seems to show the following developments.

Pictographic Scheme of Development

1. Outline Art - use of contours, bare outlines of objects, stick-figures, and lack of solid proportional figures. This type of art is the earliest and probably dates to the Archaic and may go back into the Paleo-Indian Period.
2. Solid Art - use of parallel strokes, cross-hatching, and solid figures. This type of art probably dates to the late Archaic/ Desert to middle ceramic periods in both western and eastern United States.
3. Dimensional Art - use of color, shading, geometric designs, and abstract symbols. This type of art probably dates to the late ceramic and contact periods in the eastern United States. This form is easily defined as present in any area where pottery is decorated.

Petroglyphic scheme of development

1. Shallow Outline Art - use of thin lines which usually outline animalistic type subjects. Dates at least to (Middle/Late Paleo-Indian ?) Desert/Archaic; however, this type of rock art is probably the oldest form.
2. Deep or Well Developed Art - use of sharper, better defined objects with occasional use of added elements in the glyph, such as cross-hatching. Art is not generally polished inside the glyph and usually shows cut or engraving marks. Dates probably into the all ceramic periods.
3. Volume Art - use of abrading tools to polish the internal parts of the glyphs and smooth the glyph's surrounding area. Glyphs tend to be three dimensional. Dates into the ceramic period where this form of art may have disappeared from common use.

The major concern here -- the assumption that we are dealing with two sets of glyph-uses -- does concern this author, but stylistically, there does seem to be a distinct difference between the two sets of glyphs. Naturally, some overlap occurs in glyph use or preferences. The mud-cave art in Tennessee seems to indicate that there was no preference to the medium on which the glyphs were placed. Also, there has been little study about the location of the vehicle (medium or art carrier) that contains rock art. The preference seems to be an elevated area, but low elevation locations also exist, which leaves this research question open. Known rock art sites in the eastern United States easily cluster in high elevations and are absent in the coastal areas. Within the area of cluster, the Mississippian stylized rock art forms occur as well as sites that do not fit this pattern of art. This suggests a distribution, but one that needs quantifying.

Finally, a practical application to this type of scheme is a procedure that gets away from the classic archeological time periods, such as the Paleo-Archaic-Woodland model in the east. As I recently argued: if I can prove the existence of a glyph style that is found in both Wyoming and Virginia, what archeological time period should I assign it to if both glyphs appear to be late in prehistory. Another example is the classic thunderbird glyph which is found (in at least two versions) all over the Plains, Great Lakes, and New England areas of the United States. No answer to the problem of dating glyphs is apparent unless we establish some type of calendar that will accommodate glyph dates. I suggest that the calendar be based on style but with a simple sequence, such as:

I = First art to 8000 BC
II = 8000 BC to start of ceramics
III - Ceramics to European contact

Until more research is performed, the above suggestions for the evolution of rock art glyph are offered as a starting point for this topic.

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BISON HUNTING AND PROCESSING AT THE RIVER BEND SITE (48NA202)

DAVE F. MCKEE

ABSTRACT

The River Bend site, (48NA202), was a protohistoric campsite located along the North Platte River, near the city of Casper, in east-central Wyoming. A large amount of processed bison bone was recovered. Analysis of the bone was conducted to obtain evidence about bison hunting, butchering, transport, and processing strategies employed at the site. Seasonality data indicate bison were hunted through the fall and winter of a particular year. Metric analyses of limb bones show that hunters focused on female bison in hunting and processing. Bone frequency counts suggest a selection of high utility meat items for transport to camp. Bone counts also show a pattern of intense marrow processing and selection of high utility elements for bone grease production. It will be argued that length of occupation and patterns of bone transport and breakage are indicative of labor maximizing behavior and a secure food resource base.

INTRODUCTION

The River Bend site (48NA202) was a protohistoric base camp located along the North Platte river near Casper, Wyoming. Bison bone recovered from the site was subjected to a high degree of fragmentation for bone marrow and grease production. Despite the fragmentation, a variety of information was derived. From these data, insights into bison procurement, processing, anatomical unit transport, marrow extraction, bone grease production, and seasonality at River Bend were made.

Much of our knowledge concerning prehistoric bison hunting economies has been obtained through detailed analyses of bison kill sites (i.e., Frison 1971, 1974, 1978; Reher and Frison 1980; Speth 1983). Interpretation of subsistence patterns has, in part, been from the context of seasonal, communal bison hunting strategies. The River Bend site provides a unique opportunity to study bison procurement on the Northwestern Plains from a different perspective and context. The goal of this present analysis is to elucidate patterns of bison procurement and processing from the context of a fall/winter camp site, occupied over a period of time, and based on an economy of sporadic, yet continuous, bison procurement over a period of four to six months (McKee 1985) according to seasonality determinations.

METHODOLOGY

An early step in this analysis was to obtain an accurate count of the number of bison represented in the collection. A Minimum Number of Individuals Present count (MNI) was used. Epiphyseal fusion stages and tooth eruption schedules aided in establishing age categories and refining MNI counts.

Sex identification analyses were performed on adult bison humeri and tibiae. Descriptive statistics, and scatter plots were used to define and illustrate the male/female ratio for adult bison. Student's T-test was used to place unidentified specimens in the male or female group. Data on sex ratios will be used in a discussion of bison procurement strategies used at the site.

Minimum Number of Element counts (MNE) and Minimum Number of Animal Unit percentages (MAU) were calculated to discuss patterns in carcass transport to the site for further processing. Survival frequencies for major limb bones were then tabulated to ascertain patterning in bone breakage from bone marrow and bone grease production. Other processes which cause bone destruction, such as carnivore activity and bone weathering, were examined. These various analyses provided insights into subsistence strategies employed at the site. Ethnographic and archaeological evidence will be used to interpret bison procurement and processing at the River Bend Site.

THE RIVER BEND SITE (48NA202)

The River Bend site was a Protohistoric campsite located near the city of Casper in east-central Wyoming (Figure 1). The site was situated on the flood plain along the south bank of the North Platte River (Figure 2). Excavations were conducted over several years through the combined efforts of the Wyoming Archaeological Society, The Wyoming Recreation Commission (Office of the Wyoming State Archaeologist), The Department of Anthropology, Casper College, and the Department of Anthropology, University of Wyoming. During the period of investigation 420 square meters were excavated. Buff (1983) presented an initial report on the site.

Identification of the site as Protohistoric (A.D. 1650 to A.D. 1750, approximately) is based on the presence of several pieces of metal and a horse (Equus caballus) skull. A wide variety of stone tools and weaponry were recovered including side-notched and tri-notched projectile points, end scrapers, arrow shaft abraders, grinding stones, and steatite vessel fragments. Bone artifacts include antler knapping tools, fleshers, awls, and bone tube beads. Shell pendants and shell pendant blanks were also recovered. One interesting characteristic of the site was the wide range of animal species represented in

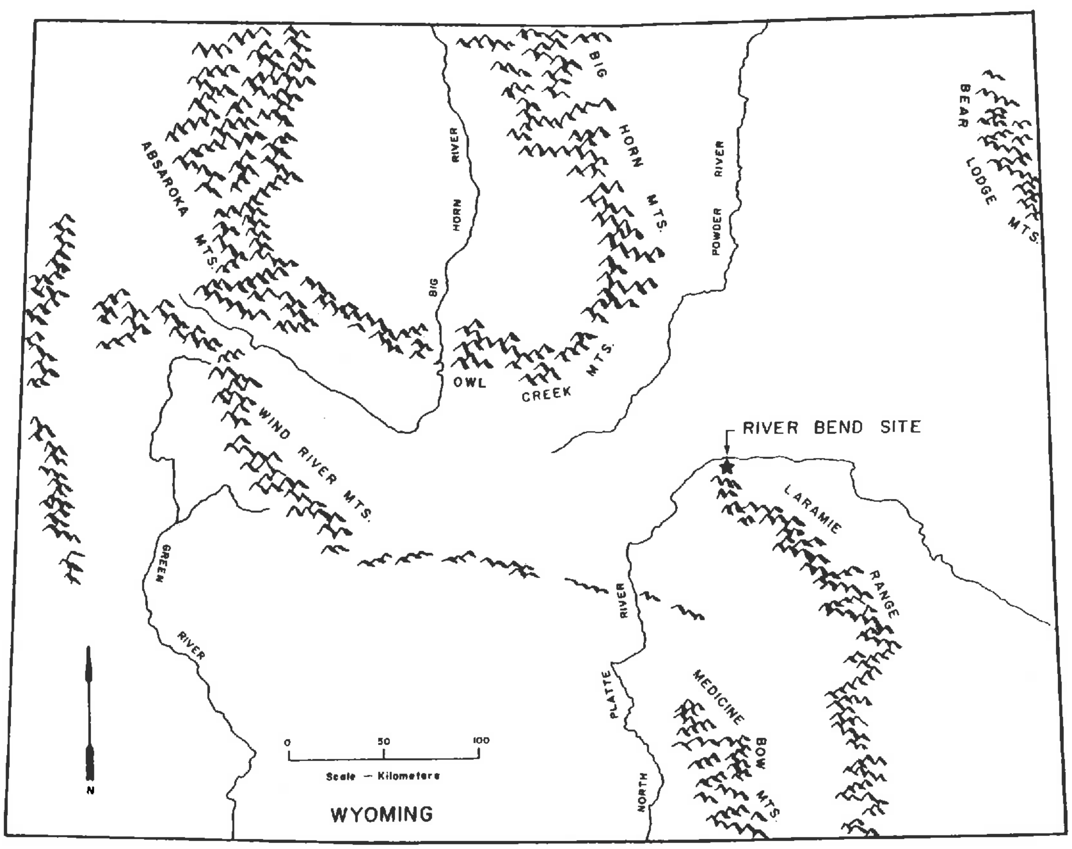

Figure 1: Map of Wyoming, showing general location of River Bend site (48NA202) along North Platte River near Casper.

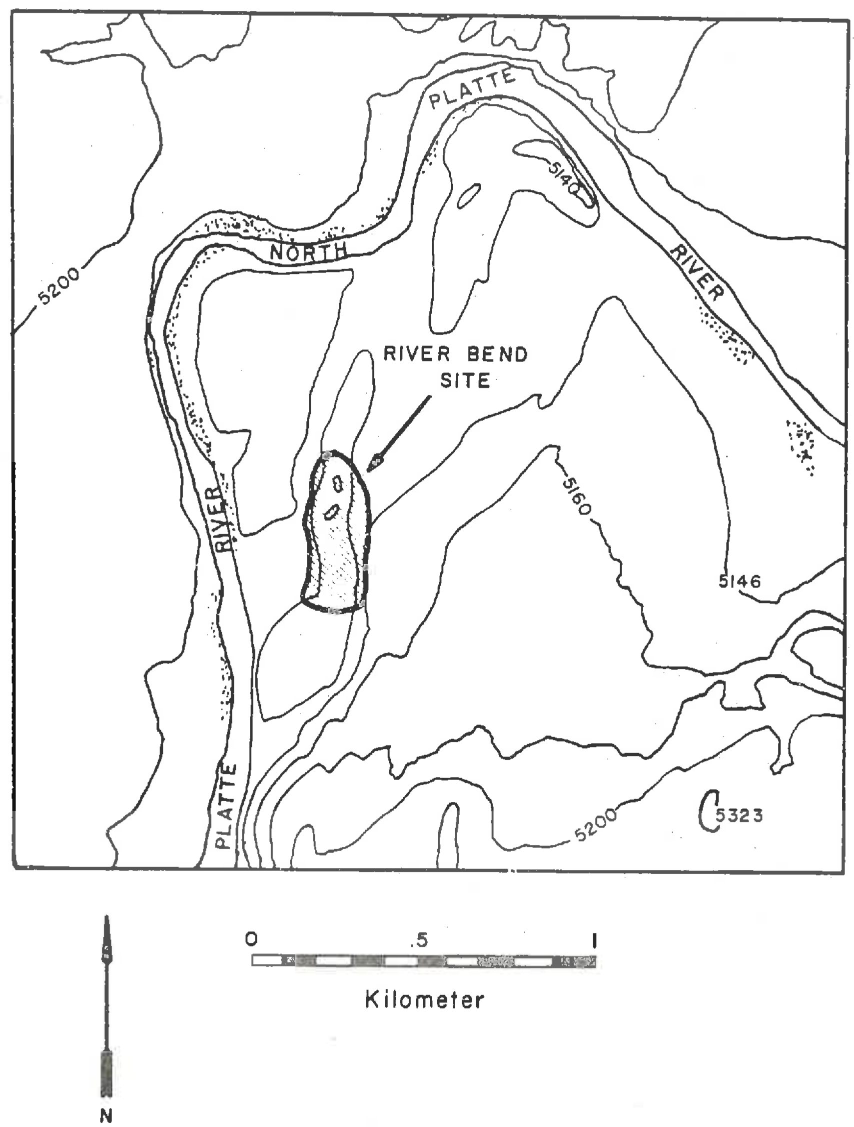

Figure 2: Generalized topographic map along North Platte River in vicinity of River Bend site (48NA202).

the faunal collection including several small mammals, fish, shellfish, amphibians, reptiles, birds, and large game animals.

SEASONALITY

An earlier study determined season of occupation at the site (McKee 1985). Tooth eruption schedules and tooth cusp wear patterns were used to age bison calf mandibles. Ages were based on tooth eruption and tooth wear schedules developed over the past twenty years (i.e., Frison 1970; Frison and Reher 1970; Frison et al. 1976; Reher and Frison 1980; Frison and Stanford 1982; Wilson 1980). Results of the dental analysis showed calves ranged in age from four to seven months suggesting a fall occupation of the site.

Aging techniques developed by Wilson (1974; Frison et al. 1978) were applied to fetal bison bones recovered from the site. Periosteal strata were counted on fetal femora from the University of Wyoming, Department of Anthropology, Comparative Osteological Collection and the River Bend sample (McKee 1985).

These counts showed the River Bend material ranged from six to nine months in pre-natal age. This indicated a winter occupation of the site as well as the fall occupation.

Seasonality data thus suggested a long-term occupation of the site during fall and winter of a particular year. The age ranges shown by calf mandibles and fetal elements may represent extended birthing and calving seasons. However, others have shown these seasons to be limited (Haugen 1974; Reher and Frison 1980; Frison and Stanford 1982). Thus the range in ages of the River Bend material suggests continuous procurement of bison over the fall and winter seasons.

MINIMUM NUMBER OF BISON PRESENT

An initial step in the analysis was to determine the Minimum Number of Individual bison represented in the collection. A standard MNI count based on complete bone elements, element portions, and side of element was used. Due to the fragmentary condition of the bison bone, additional bone fragment categories were used in the count such as: nutrient foramina of all major limb bones, vertebral processes and spines, deltoid tuberosity of the humerus, trochlear notch of the ulna, and supracondyloid fossa of the femur. Results of MNI tabulations indicated a minimum number of 34 adult bison based on both distal right humeri and distal left tibiae, 2 yearlings from partially fused distal humeri, 13 calves based on complete right mandibles , and 13 fetal bison based on left radii.

SEXUAL DIMORPHISM OF ADULT BISON HUMERI AND TIBIAE

Determination of sex profiles can support discussion of overall bison procurement strategies (Frison 1974:18, 1978:298). Male and female bison differ in physical condition over the course of a year. Male bison may be in better condition during the early spring and hence preferred at this time (Speth 1983:165). Females are in prime condition during the late summer, fall, and early winter (Frison 1978:327), and possibly preferred over males. The size of a bison herd, time of year, and presence or absence of males will dictate the use of different handling or hunting techniques (Frison 1970, 1974, 1978).

Sex identification of bison from metric attributes of various bone elements has been demonstrated in several studies (Bedord 1974; Peterson and Hughes 1980; Speth 1983; Speth and Parry 1980; Todd 1983). Sex identification of the River Bend sample was based on measurements of 51 distal humeri and 68 distal tibiae, the most numerous bison elements present. Three measurements were taken on the humeri: Breadth of the Distal Articular Surface (HM7), Greatest Depth of Distal End, Medial (HM11), and Least Depth of Distal End, Medial (HM14). Three measurements were taken on the distal tibiae: Greatest Breadth of Distal End (TA7), Greatest Depth of Distal End (TA10), and Breadth of Distal Articular Surface (TA14). Measurement definitions and procedures are from Todd (1983). Some measurements could not be taken on highly fragmented or weathered specimens. Measurements were taken on specimens with light damage if a high degree of accuracy was expected (within 1 mm.). Those measurements taken on slightly damaged bone are used in the analysis and denoted with an asterisk in the accompanying tables.

In any sex identification analysis some overlap is size between the two groups is expected and often acceptable. However, for this paper Students T-test was used to place unassigned specimens into the sex group of closest fit.

Fifty-one distal humeri were sexed by metric and visual comparison (Table 1). Forty humeri for which measurements HM7 and HM11 could be taken were analyzed in greater detail. Females fell into size ranges of 64 mm to 82 mm with a mean of 76.9 mm for HM7 and 87 mm to 100 mm with a mean of 87.55 for HM11. Males fell into size ranges of 87 mm to 100 mm with a mean of 92.1 mm for HM7 and 100 mm to 108 mm with a mean of 104.5 mm for HM11. Descriptive statistics (Table 2) and a scatter plot (Figure 3) describe charac-

CAT. NUMB.	SIDE	MAXIMUM LENGTH	HM7	HM11	HM14	SEX
37	R	84	80.3	85.4	00.0	F
55	R	180	74.9*	84.5	40.3	F
107	L	203	74.7	86.5	36.5	F
591	R	160	80.0	91.4	39.9	F
603	L	178	75.2	86.6	36.3	F
676	R	90	76.0	84.4	37.0	F
855	R	128	93.0	107.0	47.6	M
856	R	109	0.0	0.0	0.0	F
1044	R	162	80.2	92.1	40.0	F
1114	R	192	93.0	107.0	42.2	M
1233	R	100	75.2	0.0	35.5	F
1242	R	146	76.2	86.5	37.3	F
1252	L	183	81.0	91.4	42.0	F
1265	L	110	80.3	100.0	41.2	F
1266	L	93	0.0	0.0	39.2	F
1271	L	200	99.5	106.3	46.5	M
1272	R	118	78.3	90.0	40.4	F
1306	R	141	90.8	101.5	43.0	M
1307	R	85	82.2	92.0	37.4	F
1323	L	90	78.2*	81.3*	35.2	F
1339	R	89	77.6	83.9*	37.4	F
1529	R	127	0.0	0.0	37.4	F
2175	R	190	0.0	90.8*	40.7	F
2209	R	163	64.8	78.5	36.2	F
2408	L	152	78.0	90.2	39.5	F
2716	R	85	0.0	0.0	38.1	F
2717	R	160	78.2	86.3	37.7	F
2858	R	130	95.2	104.8	46.9	M
3005	L	122	81.0	94.2	41.2	F
3035	L	106	76.7	84.9*	40.0	F
3050	L	110	71.0*	83.6	40.2	F
3244	R	105	92.2	101.2	44.4	M
3262	R	204	0.0	83.1	39.9*	F
3264	R	115	77.7	87.5	39.5	F
3292	R	120	77.0	88.3	38.0	F
3324	L	116	74.5	83.5	36.4	F
3333	L	78	75.0	86.0	37.2	F
3357	L	114	74.6*	0.0	37.1	F
3385	R	103	80.5*	92.4	40.2	F
3386	R	120	87.1	101.3	43.1	M
3469	R	219	90.5	104.3	43.8	M
3502	R	268	92.5	107.1	45.2	M
3503	L	200	91.7	106.8	43.0	M
3504	R	174	87.0*	100.2	44.0	M
3519	R	100	92.2	105.3	47.7	M
3520	L	200	93.5	108.0	45.0	M

Table 1: Distal humerii measurements from River Bend site (48NA202). All measurements in millimeters. N = 52. * = estimate of measurement to within 1 mm. I = immature animal with partially fused epiphysis.

CAT. NUMB.	SIDE	MAXIMUM LENGTH	HM7	HM11	HM14	SEX
3521	L	100	94.1	0.0	44.2	M
3572	L	242	67.2	73.7	31.7	I
3573	R	153	0.0	88.4	36.5	F
3605	L	214	70.5	82.1	36.3	F
3606	R	182	92.4*	102.4	44.8	M
3607	R	146	0.0	0.0	0.0	M

TABLE 1: (continued).

STATISTIC	HM7 FEMALE	HM11 FEMALE	HM7 MALE	HM11 MALE
MEAN	76.9231	87.5115	92.1857	104.514
STD. DEV.	3.85012	4.56564	3.08267	2.68668
VARIANCE	14.8234	20.8450	9.50285	7.21823
STD. ERROR OF MEAN	0.75507	0.89539	0.82387	0.71805
COEF OF VARIATION	5.00516	5.21719	3.34398	2.57063
MEDIAN	77.6500	86.5000	92.3000	105.050
MODE	78.2000	86.5000	92.2000	107.000
MINIMUM	64.8000	78.5000	87.0000	100.200
MAXIMUM	82.2000	100.000	99.5000	108.000
RANGE	17.4000	21.5000	12.5000	7.80000
SKEWNESS	-1.30299	0.62723	0.39112	-0.32212
KURTOSIS	5.03575	3.54623	3.99275	1.56227

Table 2: Descriptive statistics for distal humeri from River Bend site. N = 42.

teristics of each group and illustrate differences between the two.

Results of the humeri analysis separated specimens into male and female groups with one exception (specimen #1265). The MDIFF test and probability T-test were used to compare measurements of the unknown humerus to mean scores of the male and female groups. T-tests suggested that the unknown specimen had a greater chance of being classified female from measurements HM7 and HM14 (Table 3), and had a greater chance of being classified male from measurement HM 11. Specimen #1265 was placed in the female group for this analysis.

Male humeri clustered tightly within a given size range while female humeri were more dispersed (Figure 3, Table 2). Much of this dispersion can be attributed to the presence of one small cow (HM7 = 64 mm, HM11 = 100 mm) and one large cow (HM7 = 81 mm, HM11 = 100 mm). Measurements on modern bison of known sex (Todd 1983:307) compared closely to the River Bend bison with group means of 76.2 mm on HM7 for females, 90.0 for HM7 on males, 88.2 mm on HM11 for females, and 104.2 on HM11 for males (Table 4). Results of this analysis indicated 35 females and 16 males are present in the sample of 51 distal humeri. This translates to a sex ratio of 69% females and 31% males.

A total of 68 distal tibiae were analyzed with metric and observational

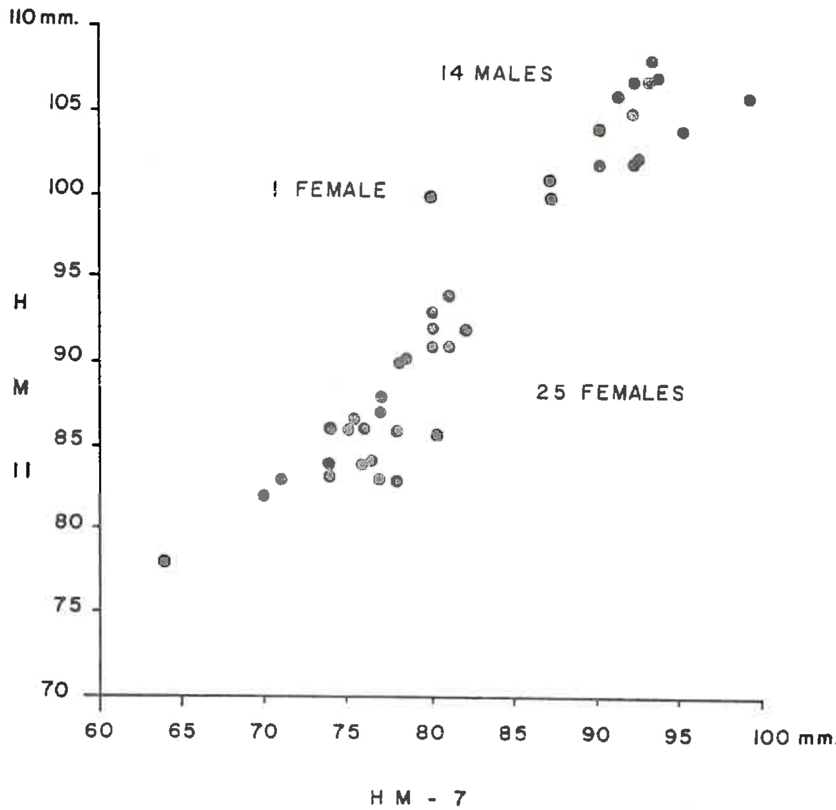

Figure 3: Bivariate scatterplot of River Bend site Bison humerus greatest breadth of distal articular surface (HM-7) and humerus greatest depth of distal end (HM-11), showing separations between males and females. Note position of single large female.

techniques (Table 5). Sixty-four mature tibiae, for which both TA7 and TA10 could be taken were analyzed in greater detail. Female tibiae fell into size ranges of 60 mm to 69 mm with a mean of 65.5 mm for TA7 and 45 mm to 53 mm with a mean of 49.2 mm for TA10. Males ranged in size from 71 mm to 82 mm with a mean of 75.8 mm for TA7 and 50 mm to 62 mm with a mean of 54.8 mm for TA10. Descriptive statistics (Table 6), and a scatter plot (Figure 4) illustrate the relationship within and between the two sex groups.

The analysis separated tibiae into male and female groups with five exceptions (specimens 26, 42, 44, 3536, and 3504). The MEANT test and probability T-test were used to compare the group means of the unknown, male and female groups. The T-tests suggest that the unknown group had a better chance of being male for measurements TA7 and TA14 (Table 3), and closer to the female mean for measurement TA10. The group of five tibiae were classified as male for this analysis.

More overlap in size occurred for tibiae than humeri. This was particularly true for measurement TA10 overlapping in the 50 to 53 mm range (Figure 4). Possibly tibia measurements are less sensitive to sexual dimorphism. It may also be harder to distinguish immature males and large cows on the distal tibiae. Measurements on modern tibiae (Todd 1983:313) compare closely with the River Bend sample. Modern females had means of 64.2 for TA7 and 48.4 for TA10. Modern males had means of 72.4 for TA7 and 54.0 for TA10 (Table 4).

Analyses of the tibiae indicated the presence of 46 females, 20 males, and 2 immature specimens in the sample of 68 specimens. The bison sex ratio based on tibiae was 70% females to 30% males.

ELEMENT	COMPARISON	MEASUREMENT	T-SCORE
Humerus	Male-Female	HM7	0.00001
Humerus	Male-Unknown	HM7	0.00329
Humerus	Female-Unknown	HM7	0.39143
Humerus	Male-Female	HM11	0.00001
Humerus	Male-Unknown	HM11	0.14177
Humerus	Female-Unknown	HM11	0.00363
Humerus	Male-Female	HM14	0.00001
Humerus	Male-Unknown	HM14	0.08391
Humerus	Female-Unknown	HM14	0.17499
Tibia	Male-Female	TA7	0.00001
Tibia	Male-Unknown	TA7	0.03342
Tibia	Female-Unknown	TA7	0.00378
Tibia	Male-Female	TA10	0.00001
Tibia	Male-Unknown	TA10	0.01139
Tibia	Female-Unknown	TA10	0.12682
Tibia	Male-Female	TA14	0.00001
Tibia	Male-Unknown	TA14	0.10490
Tibia	Female-Unknown	TA14	0.01598

Table 3: T-Test results for distal humeri and distal tibiae from River Bend site.

ELEMENT	MEASUREMENT	SEX	MIN.	MAX.	MEAN	SD
humerus	HM7	female	72	81	76.2	3.06
humerus	HM11	female	85	93	88.2	2.42
humerus	HM14	female	36	40	37.7	1.25
humerus	HM7	male	85	94	90.0	3.39
humerus	HM11	male	101	107	104.2	2.68
humerus	HM14	male	42	44	43.2	0.84
tibia	TA7	female	60	67	64.2	2.08
tibia	TA10	female	45	50	48.4	1.39
tibia	TA14	female	38	47	42.7	2.39
tibia	TA7	male	70	77	72.4	3.05
tibia	TA10	male	50	57	54.0	2.55
tibia	TA14	male	45	51	47.6	2.41

Table 4: Descriptive statistics for modern bison humeri and tibiae from University of Wyoming Anthropology Comparative Collection. Data from (Todd 1983:134, 137).

CAT. NUMB.	SIDE	MAXIMUM LENGTH	TA7	TA10	TA14	SEX
1	R	260	64.3	46.0	0.0	I
26	L	107	72.0	52.0	45.5	M
28	L	104	69.0	51.0	47.0	F
42	L	156	72.0	51.0	48.0	M
44	L	120	74.0	51.0	45.3	M
56	L	145	68.0	52.0	43.5	F
119	R	138	68.0	49.0	43.1	F
504	L	63	63.0*	49.0	42.0	F
575	L	104	64.0	47.0	42.3	F
576	L	162	80.0	58.0	51.3	M
628	R	172	63.0	49.0	45.1	F
677	R	140	68.0	48.0	46.4	F
742	R	130	65.0	50.0	41.1	F
936	L	180	64.0	47.0	43.0	F
950	L	130	68.0	49.0	43.0	F
951	R	145	67.0	48.0	44.2	F
974	L	99	75.0	55.0	48.5	M
1124	R	108	62.0	45.0	43.0	F
1226	R	192	67.0	51.0	43.3	F
1282	L	143	66.0	50.0	42.1	F
1312	R	121	66.0	48.0	43.5	F
1313	L	123	82.0	60.0	51.6	M
1377	L	128	63.0	50.0	42.4	F
1430	R	120	63.0	46.0	40.5	F
1443	R	155	76.0	57.0	47.3	M
1493	L	90	65.0	50.0	42.1	F
1971	R	113	65.0	49.0	43.2	F
2153	R	111	64.0	49.0	43.2	F
2281	R	207	77.0	56.0	50.2	M
2374	R	95	68.0	51.0	44.2	F
2385	L	92	60.0	46.0	44.1	F
2490	R	131	66.0	50.0	44.2	F
2572	L	200	67.0	47.0	44.6	F
2593	R	104	63.0	47.0	41.3	F
2614	L	140	76.0	56.0	46.4	M
2621	L	137	68.0	52.0	44.0	F
2692	R	92	65.0	52.0	42.6	F
2712	L	100	69.0	53.0	46.2	F
2793	L	70	62.0	48.0	42.0	F
2896	R	130	65.0	50.0	43.3	F
2897	R	175	74.0	53.0	45.1	M
3071	L	98	62.0	47.0	39.5	F
3263	L	120	81.0	62.0	51.1	M
3267	L	110	67.0	51.0	43.4	F
3293	R	142	69.0	52.0	43.6	F
3311	L	110	69.0	52.0	44.2	F

Table 5: Distal tibiae measurements from River Bend site (48NA202). All measurements in millimeters. N = 68. * = estimate of measurement to within 1 mm. I = immature animal with partially fused epiphysis.

CAT. NUMB.	SIDE	MAXIMUM LENGTH	TA7	TA10	TA14	SEX
3317	L	142	79.0	54.0	48.1	M
3319	L	145	75.0	57.0	46.0	M
3320	R	100	61.0	45.0	42.0	F
3356	L	155	67.0	50.0	45.1	F
3367	R	99	67.0	49.0	43.8	F
3397	L	100	67.0	51.0	42.4	F
3398	R	102	67.0	51.0	45.0	F
3402	R	58	0.0	0.0	40.1	I
3452	L	210	74.0	57.0	47.2	M
3455	L	113	63.0	48.0	42.4	F
3506	R	200	78.0	54.0	48.0	M
3536	R	121	71.0	51.0	44.0	M
3575	R	132	73.0	54.0	44.9	M
3601	L	150	74.0	55.0	47.1	M
3602	R	154	63.0	49.0	44.1	F
3603	R	108	66.0	46.0	44.1	F
3604	L	78	75.0	50.0*	47.8	M
3608	L	115	65.0	50.0	44.4	F
3610	R	140	78.0	53.0	50.1	M
3613	R	111	68.0	51.0	45.1	F
3614	R	200	0.0	0.0	0.0	F
3615	L	48	67.0	51.0	44.0	F

Table 5: (continued).

STATISTIC	TA7 FEMALE	TA10 FEMALE	TA7 MALE	TA10 MALE
MEAN	65.5333	49.2444	75.8000	54.8000
STD. DEV.	2.39886	2.03554	3.07109	3.15561
VARIANCE	5.75545	4.14343	9.43158	9.95789
STD. ERROR OF MEAN	0.35760	0.30344	0.68671	0.70561
COEF OF VARIATION	3.66052	4.13355	4.05157	5.75842
MEDIAN	66.0000	49.0000	75.0000	54.5000
MODE	67.0000	49.0000	74.0000	51.0000
MINIMUM	60.0000	45.0000	71.0000	50.0000
MAXIMUM	69.0000	53.0000	82.0000	62.0000
RANGE	9.00000	8.00000	11.0000	12.0000
SKEWNESS	-0.36622	-0.31980	0.45055	0.46686
KURTOSIS	2.11379	2.28298	2.32077	2.70299

Table 6: Descriptive statistics for distal tibiae from River Bend site. N = 64.

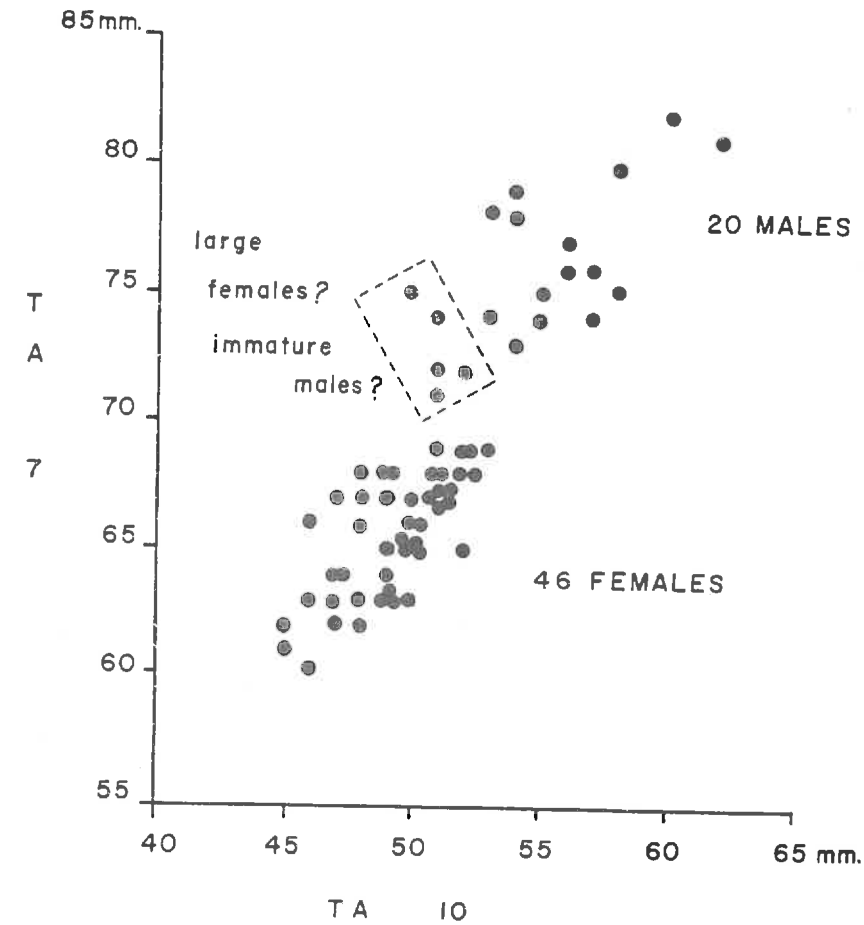

Figure 4: Bivariate scatterplot of River Bend site Bison tibia greatest breadth of distal end (TA-7) and tibia greatest depth of distal end (TA-10), showing separations between males and females. Note also overlap area of either large females or immature males.

EVIDENCE FOR, AND INTERPRETATION OF, BISON PROCUREMENT STRATEGIES

Data on season and length of site occupation, and bison sex ratios can be used to form interpretations about bison procurement at the River Bend site. Seasonality data suggests a four to six month occupation of the site. Age profiles for bison calves and fetal material indicate bison were hunted continuously over this period of time and not procured in one or two communal hunts. Sex ratios indicate a preference for cows in procurement or processing.

Any number of hunting techniques could have been used to obtain bison meat. The use of arroyo traps (i.e., Frison et al. 1976; Wheat 1972), jumps (i.e., Forbis 1962; Kehoe 1967; Reher and Frison 1980), parabolic dune traps (Frison 1974), and corrals (Frison 1971) are well documented in the archaeological literature. Pursuit of bison on horseback has been described in many historic accounts of Plains Indians (i.e., Grinnell 1923; Ewers 1955).

Of particular interest is procurement of bison during early and mid winter. Different strategies are needed to hunt small herds or individual animals wintering in sheltered areas such as river bottoms than to hunt large, congregated herds on open ground during the fall. Small, cow-calf nursery herds and single animals wintering along the North Platte would have been ideal targets for small hunting parties or individuals working out of a nearby base camp.

Ethnographic data suggest several different strategies would have been effective in a winter camp situation. In several accounts, corrals were built near base camps and used to trap bison through the winter months (i.e., M'Gillivray 1929:49; Simpson 1843:402; Kurtz 1937:145). The Blackfoot used such a system:

> "Although the fall hunting season may be considered as ending with the establishment of the winter camp, the Blackfoot continued to hunt buffalo and prepare meat for eating in the severe winter months of November or December or until heavy snows and bitter cold restricted this activity. In the years prior to about 1850 they employed drives over cliffs or into pounds constructed in the vicinity of the winter camp in this early winter hunting." (Ewers 1955:129)

Another technique was to chase bison into snow drifts where they would founder and be easily killed (Denig 1930:535; Simpson 1843:405). In an account of Cheyenne bison hunting, Grinnell noted that:

> "...when they lived in a country of heavy snow fall, they followed them in winter on snow shoes and chased them into snow drifts in ravines. When they had driven buffalo into such drifts, they set the dogs free to worry them, and ran up and killed them with the lance..." (Grinnell 1923:268)

Individual hunters could successfully stalk bison using snow or the thick brush along the river for cover (Ewers 1955:166; Hood 1967:11).

Arthur's (1975) review of historic accounts argues that communal hunts of large bison herds took place throughout the year including winter. However, hunting techniques used would depend on number of people, bison, and type of topographic relief available.

The 70% female to 30% male sex ratio for the River Bend bison indicates either a focus on nursery herds in procurement or a preference for female bison bones in marrow and grease production. Ethnographic references indicate cows were generally preferred over bulls, due to their higher fat content and better over all physical condition especially at certain times of the year (Arthur 1975:99; Wilson 1924:245,249). Also:

> "Except in the summer season when bulls were prime, Blackfoot hunters, confident of the speed and ability of their horses, generally by-passed the running bulls to get to the cows." (Ewers 1955:158)

The predominance of females at River Bend could also result from hunting mixed herds and selection of female bones for marrow and grease production. It has been argued (Speth 1983), that males will be selectively butchered and transported in the spring when they are in better condition and carrying a greater amount of fat reserves in the bone cavities than cows.

Cows may have been preferred for the fetuses many were carrying through the winter. Ethnographic accounts show bison fetal meat was considered a delicacy among plains groups (Clark 1885:85; Grinnell 1923:255; Wissler 1910:25-26). The skin of fetal calves was prized for construction of berry bags by the Blackfoot (Ewers 1955:151), and corn bags by the Hidatsa (Wilson 1924:273). The large number of fetal bones at River Bend and the presence of cut marks on many of these demonstrates the use of this resource at the site.

ANATOMICAL UNIT TRANSPORT PATTERNS

The large body size of a bison dictates primary field butchering and selection of anatomical units for transportation to a camp site will occur. The number and type of bones in a campsite are a reflection of decisions to transport selected units for meat, marrow, and grease consumption. In Binford's study of the Nunamiut, this decision process was characterized as maximization behavior (Binford 1978:44). If game is plentiful, labor is maximized and units of greatest meat, marrow, and grease utility are transported to camp

(Binford 1987:44). If game is scarce, food resources are maximized at the expense of labor costs with units of less utility transported. Analysis of bison anatomical unit frequencies provided insight into such maximizing behavior at River Bend.

Numerous factors can influence patterns of anatomical unit transport for bison (Frison 1974, 1978; Speth 1983; Wheat 1972), and other large game animals (Binford 1978). Differences in size between different age bison (i.e., adult vs. calves), dictates different patterns in choice of units to be transported. Units such as limbs may receive preferential treatment over skulls or vertebral columns because of a higher utility for bone marrow and grease. On the other hand, scarcity of bison during a given time of year may dictate transport of less desirable anatomical units to a camp. Distance from a kill site to a base camp and availability of people, dogs or horses to haul food resources are logistical factors which also dictate whether less desirable units are transported.

Minimum Number of Element counts (MNE) and derived Minimum Animal Unit percent frequencies (MAU) (Todd 1983) were used to ascertain patterns in unit transport strategies at River Bend. Bison bone was placed into three age categories: adult, six month calves, and fetal. An MNE count was conducted for each age group. Complete elements, complete element portions (such as proximal and distal ends), and identifiable element landmarks (such as nutrient foramina) were used in combination to obtain element counts. Side of element was disregarded in this count. An MAU value was obtained for each element by dividing the MNE by the number of a given element in a complete skeleton. For example, an MNE of four adult tibiae would receive a MAU value of two. A MNE of four complete skulls would receive an MAU value of four. A final adjusted MAU % is obtained by multiplying each MAU value by 100 and dividing by the highest MAU value obtained for the skeleton. For adult bison, tibiae were most numerous with 70 specimens. The MAU value for tibiae was 35. Tibiae were assigned an adjusted MAU value of 100 %. All other element MAU adjusted percentages were calculated using the tibia MAU value of 35.

Results of these tabulations showed interesting differences in anatomical unit transport for different age groups. The adult group exhibited a great degree of unit selectivity with higher MAU %s for limb units and lower frequencies for elements with lower meat, marrow or grease utility such as vertebrae, skulls, and phalanges (Table 7, Figure 5).

As expected, the smaller fetal specimens exhibited less selectivity, suggesting transport of a greater portion of the entire animal to the site (Table 8, Figure 6). Low frequencies for fetal crania and vertebrae may be due to unit transport strategies or destruction due to their thin and delicate bone structure. Absence of fetal phalanges, tarsals, carpals, sesmoids, and caudal vertebrae may be due to a combination of their extremely small size, post-mortem destruction, and excavation procedures.

Finally, fifty-two identified bison calf bones were analyzed. Mandibles, crania, and metacarpals were the only elements present in any great number (Table 9). The small calf sample prevents making explicit assumptions about transport strategies for this age group. The presence of low utility items such as mandibles and crania may indicate transport of complete calf carcasses. However, these elements may have simply survived bone marrow and grease processing because of low utility for these products.

To identify maximizing behavior of the Nunamiut, Binford compared observed anatomical unit frequencies to explicit meat, marrow, and grease values per anatomical unit for caribou and domestic sheep (Binford 1978:44). In the River Bend analysis explicit unit values for bison are not used. It is assumed for the River Bend data that limb units generally have higher food values than other anatomical units. Given this

ELEMENT	MNE	MAU VALUE	ADJUSTED MAU %
cranium	4	4.0	11.4
hyoid	3	1.5	4.3
mandible	4	2.0	5.7
atlas	1	1.0	2.9
axis	1	1.0	2.9
cervical vertebra	4	0.8	2.3
thoracic vertebra	24	1.7	4.8
lumbar vertebra	7	1.4	4.0
sacrum	2	2.0	5.7
caudal vertebra	14	0.7	2.0
ribs	88	3.1	8.8
scapula	7	3.5	10.0
humerus	52	26.0	74.3
radius	40	20.0	57.1
ulna	30	15.0	42.8
metacarpal	17	8.5	24.3
ulnar carpal	10	5.0	14.3
intermediate carpal	8	4.0	11.4
radial carpal	7	3.5	10.0
fused 2nd & 3rd carpal	4	2.0	5.7
fourth carpal	3	1.5	4.3
accessory carpal	1	0.5	1.4
innominate	19	9.5	27.1
femur	31	15.5	44.3
patella	35	17.5	50.0
tibia	70	35.0	100.0
lateral malleolus	42	21.0	60.0
metatarsal	13	6.5	18.6
2nd metatarsal	1	0.5	1.4
calcaneus	7	3.5	10.0
astragalus	15	7.5	21.4
central tarsal	1	0.5	1.4
centroquartral tarsal	9	4.5	12.8
fused 2nd & 3rd tarsal	5	2.5	7.1
first tarsal	2	1.0	2.9
first phalanx	34	4.3	12.3
second phalanx	43	5.4	15.4
third phalanx	27	3.4	9.7
proximal sesmoid	19	1.2	3.4
distal sesmoid	8	1.0	2.9

Table 7: MAU values for adult bison bones from River Bend site.

assumption, several interpretations may be expressed.

The MAU%'s for bison fetal bone show that almost complete fetuses were returned to the site and therefore food potential maximized. A strong prefer-

ELEMENT	MNE	MAU VALUE	ADJUSTED MAU %
cranium	2	2.0	20.0
mandible	6	3.0	30.0
atlas	2	2.0	20.0
cervical vertebra	7	1.4	14.0
thoracic vertebra	34	2.4	24.0
lumbar vertebra	9	1.8	18.0
sacral vertebra	7	1.4	14.0
caudal vertebra	3	0.17	1.7
ribs	96	3.4	34.0
scapula	17	8.5	85.0
humerus	15	7.5	75.0
radius	20	10.0	100.0
ulna	14	7.0	70.0
metacarpal	13	6.5	65.0
femur	16	8.0	80.0
tibia	12	6.0	60.0
metatarsal	19	9.5	95.0
calcaneus	7	3.5	35.0
fused 2nd & 3rd tarsal	1	0.5	5.0
first phalanx	10	1.3	13.0
second phalanx	12	1.5	15.0
third phalanx	6	0.75	7.5
distal sesmoid	1	0.125	1.25

Table 8: MAU values for fetal bison bone from River Bend site.

ence for fetal meat or easier transport of the smaller carcasses may have contributed to this pattern.

In contrast, adult carcasses were selectively transported, with high utility units returned in greater frequency. This maximization of labor in handling mature animals may be due to an abundance of bison near the camp. However, the need to transport food over a longer distance to camp could also cause labor maximization regardless of species abundance. Finally, absence of low utility items does not necessarily mean they were excluded as a food item. For example, Nunamiut snacked on bone marrow at hunting stands and other activity areas outside the base camp (Binford 1978).

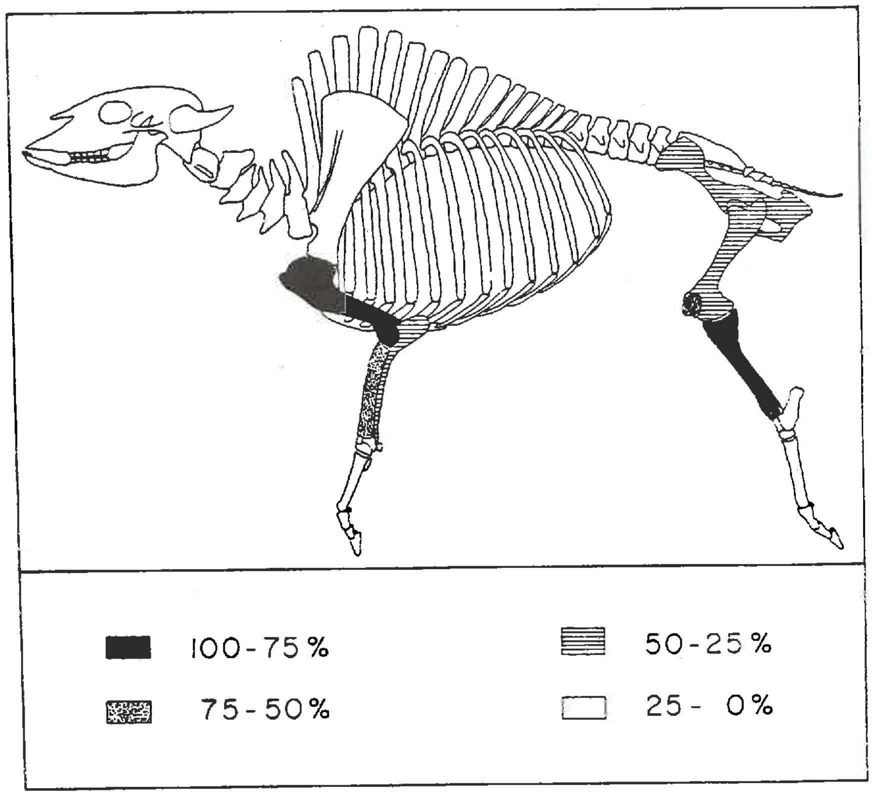

Figure 5: Schematic representation of MAU%'s (Minimum Animal Unit Percentage) for adult bison elements from River Bend site (48NA202).

ELEMENT	MNE	MAU VALUE	ADJUSTED MAU %
cranium	3	3.0	37.5
mandible	8	4.0	100.0
humerus	1	0.5	6.25
metacarpal	4	2.0	25.0
metatarsal	2	1.0	12.5
cervical vertebra	1	0.2	2.5
sacral vertebra	1	1.0	12.5

Table 9: MAU values for 6 month old bison calves from River Bend site.

PATTERNS OF BONE MARROW AND GREASE PRODUCTION

Adult bison limb bone frequencies were tabulated to ascertain patterns of destruction by marrow and grease processing. Patterns of bone destruction from these processes can be used to support interpretation of maximizing behavior at River Bend.

Marrow production would destroy diaphyses (Binford 1981), and consequently result in lower frequencies of complete bones. This pattern is demonstrated at River Bend with no complete humeri, tibiae, or femora present. Only a small number of complete radii, metatarsals, and metacarpals were recovered (Table 10).

Bone grease production would destroy articular ends which have less dense bone structure and greater potential for grease (Binford 1981:159). Proximal ends of limbs would also be expected to be selectively destroyed first, as they contain greater potential for grease. Analysis of the River Bend material clearly shows this pattern of bone grease production (Table 10). Humeri and tibiae exhibit destruction of high yield proximal ends and high survival frequencies of distal ends. Preference for proximal and distal femora is also seen. Twenty-eight femur heads have

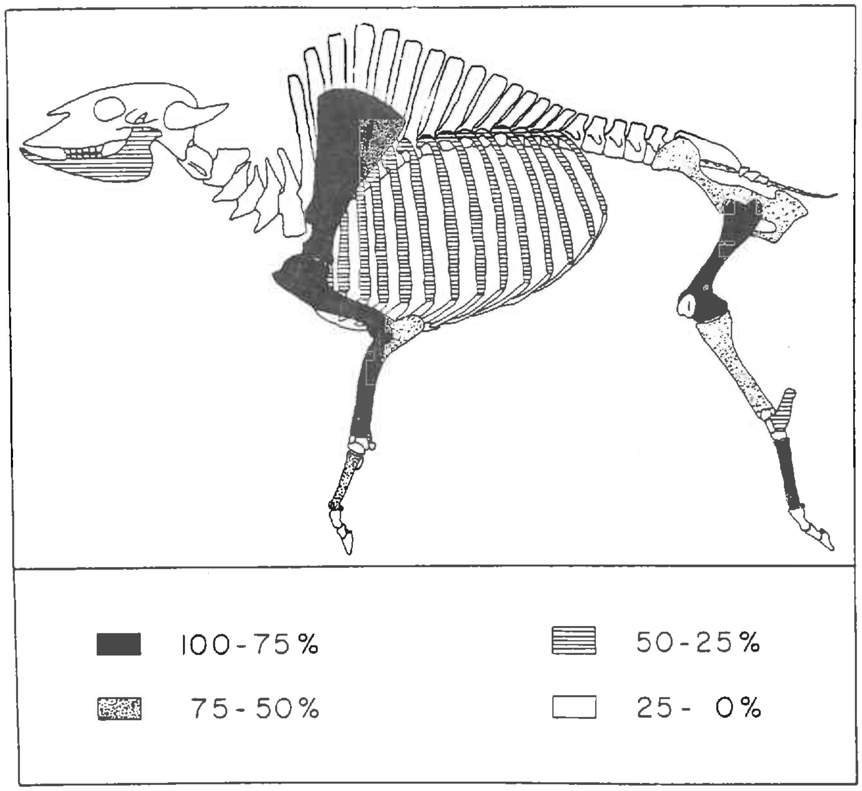

Figure 6: Schematic representation of MAU%'s (Minimum Animal Unit Percentage) for fetal bison elements from River Bend site (48NA202).

been identified in the collection, indicating the high degree of femora fragmentation. Survival frequencies for proximal and distal radii are bout the same indicating equal preference for both in grease production. The total number of radii portions indicates a greater preference for other element portions such as femora, proximal humeri, and proximal tibiae.

In general, marrow extraction was extensive, with few complete elements surviving. It would seem that food potential is maximized in this extraction process. Grease production patterns indicate a preference for certain bone elements and proximal articular ends. Extraction of grease may require expenditure of more energy than marrow extraction or may yield significantly less returns. In either case, the emphasis in grease production is on maximizing labor productivity.

OTHER PROCESSES AFFECTING
BONE FREQUENCY COUNTS

The study of processes affecting a bone assemblage between death and archaeological recovery has been defined as taphonomy (Efremov 1940). Numerous studies of specific taphonomic processes have been conducted (Behrensmeyer 1978, 1982; Binford 1981; Binford and Bertram 1977; Hanson 1980; Haynes 1983; Hill 1980; Voorhies 1969). Several factors other than human activity affect bone frequency counts. These factors include carnivore gnawing, post-depositional breakage, weathering, and fluvial sorting, among others.

Carnivore destruction of the same element portions destroyed in grease production (such as proximal tibiae) could be expected. However, examination of River Bend bison bone revealed little carnivore damage to long bone shafts or articular ends. A high frequency of

ELEMENT	PORTION	NUMBER
Humerii	Distal	54
Humerii	Proximal	0
Humerii	Complete	0
Radii	Distal	35
Radii	Proximal	31
Radii	Complete	1
Metacarpals	Distal	16
Metacarpals	Proximal	9
Metacarpals	Complete	1
Femora	Distal	1
Femora	Proximal	2
Femora	Complete	0
Tibiae	Distal	69
Tibiae	Proximal	13
Tibiae	Complete	0
Metatarsals	Distal	5
Metatarsals	Proximal	11
Metatarsals	Complete	1

Table 10: Major limb bone survival frequencies for adult bison from River Bend site.

gnawing was present on patellae, phalanges, and rib blades. These elements would be less desirable for bone grease production and may have been selectively given to camp dogs. An ethnographic study of the Nunamiut showed that people selected certain bone elements for consumption by camp dogs while holding back more desirable elements for human consumption (Binford 1978:197). Breakage patterns and carnivore gnawing frequencies for the River Bend assemblage are highly suggestive of this type of behavior.

A small amount of the bison bone exhibits characteristics of extreme weathering. Bone exhibiting this degree of weathering was recovered from recent road cuts in the site locality. Otherwise, bone preservation was excellent with dense and more delicate bone surviving equally well (i.e., large numbers of fish scales were recovered). Post-depositional breakage and fluvial transport are thought to be of minimal influence at River Bend. Finally, excavation sampling designs influence number and type of bone present. The River Bend block excavations were concentrated in the area of greatest bone density. For this study, the assumption was made that primary areas of bison processing were uncovered and that the bone sample represents the entire bone population.

CONCLUSIONS

Analyses of the Protohistoric River Bend site bison bone were conducted to obtain information concerning procurement and processing strategies used at the site. MNI counts indicate a minimum of 34 adult, 13 calves, and 13 fetal bison present in the River Bend site faunal assemblage. Sex discrimination analyses of distal humeri and distal tibiae indicate selection for females in procurement activity. Minimum element frequencies suggest different strategies were implemented for transport of bison carcasses to the site. Adult bison anatomical units with highest potential for marrow and grease content were selected and transported with greater frequency. A larger portion of complete fetal carcasses were transported to the site. Patterns in bone breakage indicate intense marrow and grease processing with predictable destruction of high yield articular ends.

Several inferences can now be made about subsistence at the River Bend site. Seasonality data from bison calf mandibles and fetal bones indicate occupation of the site during the fall and winter seasons of a particular year. These data also indicate bison were taken continuously over this period of time and not in one or two large communal hunts. Therefore, bison may have been plentiful and available for procurement on a consistent basis. In general, the inhabitants of River Bend may have had a high level of food resource security which would be is supported by labor maximization patterns in bison procurement and processing. The River Bend bison assemblage shows a clear pattern of selection for female bison, high utility meat units in transport, and high utility bones in grease production.

A variety of additional factors would have increased the food security of the group. Primarily the large number of small game animals and rodents in the assemblage would have added to a secure food base. Plant resources would also have provided a significant portion of the diet and added to a secure food base but are not discussed or considered here. Additional studies of the entire River Bend site artifact assemblage are needed before definitive statements can be made about total subsistence strategies at River Bend.

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HUNTER-GATHERER LAND USE AND LITHIC PROCUREMENT IN THE CENTRAL BIG HORN BASIN, WYOMING

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ABSTRACT

In the central Big Horn Basin of northwestern Wyoming, archaeological materials are scattered almost continuously along Pleistocene terraces containing large quantities of quartzite, chert, and basalt cobbles. This present research demonstrates that while little variability exists in location, quality or quantity of these lithic resources from one portion of the central Big Horn Basin, prehistoric lithic procurement behavior was variable. It is concluded that this variability, as indicated in the archaeological record, is due to long term land use strategies of hunter-gatherers differentially utilizing ecologically distinct portions of their environment for subsistence and lithic resource acquisition.

INTRODUCTION

This paper is concerned with relationships between prehistoric land use and lithic technological organization in the central Big Horn Basin of northwestern Wyoming. Previous research on this topic has focused exclusively on lithic procurement strategies resulting in few conclusions regarding overall hunter-gatherer settlement and subsistence strategies. Light and Church (1980) have suggested that cobbles on Polecat Bench in the northern Big Horn Basin were exploited for purposes of intensive core and flake exportation. Other researchers (Albanese 1980; Francis 1983), working primarily in the central Big Horn Basin, have argued that secondary source cobble resources were procured in a "casual" manner with little curational behavior. These conclusions suggest fundamentally different strategies of lithic technological organization regardless of lithic raw material quality. Further, it seems likely that, given the evidence for these substantially different strategies, either the related settlement and subsistence strategies from these areas were different or that similar overall strategies produced variable archaeological assemblages perhaps as a result of differential exploitation of superficially similar, but ecologically variable environments.

Actually, both hypotheses may have some relevance, given spatial and temporal differences in prehistoric lithic resource utilization. Exploring these possibilities will require research which considers different time periods, broad geographic areas and integration of ecological and archaeological data.

This study provides a preliminary approach to the problem by considering the interrelationships between spatial properties of archaeological and ecological patterning and archaeological assemblage composition. The goals of the research are to first, develop tentative explanations regarding some of the causes of variability in central Big Horn Basin lithic resource utilization by integrating data on grasslands ecology with lithic assemblage data from the perspective of surficial archaeological remains in a 12,000 acre study area. Second, we demonstrate that archaeological remains with seeming low integrity, such as Big Horn Basin "cobble sites," may provide critical data regarding aboriginal settlement and subsistence strategies.

The research concentrates primarily on debitage as an indicator of both core reduction and tool production strategies. Archaeological research is applied to assemblages defined in a geographic or "distributional" (Ebert 1986) perspective. The underlying structure of the surface assemblages located in the study area are examined using a multivariate analysis of assemblage composition. Interpretation is enhanced utilizing information generated by experimental research and through a consideration of theoretical ideas regarding the interrelationships between hunter-gatherer lithic technology, mobility, and land use patterns.

HUNTER-GATHERER LITHIC TECHNOLOGY AND LAND USE

Research discussed in this paper concerns hunter-gatherer lithic technological organization, mobility and land use patterning as discerned from surface scatters of lithic artifacts. Interpreting these archaeological remains requires the use of ideas on how lithic artifacts are related to hunter-gatherer behavior. It is necessary, therefore, to present a brief discussion of current theory regarding hunter-gatherer land use and resource exploitation and its manifestations in the archaeological record.

Mobility strategies are integral to hunter-gatherer lithic technological organization. Hunter-gatherer mobility may be defined as the means by which hunter-gatherer move about their landscape (see Binford 1980). Mobility strategies have been described as residential and logistical (Binford 1980) within a continuum of settlement and subsistence adaptation. Highly mobile residential groups are called foragers while those less mobile with a higher rate of logistical or special task group movement have been defined as collectors (Binford 1980). Binford (1980:349-350) has argued that among largely egalitarian hunter-gatherers, residential mobility decreases while logistical mobility increases along a gradient measured by effective temperature. Adaptation to low effective temperature (measuring a short growing season with low solar radiation) environments typically entails low residential mobility and high logistical mobility, while adaptation to high effective temperature (long growing season and intense solar radiation) normally involves higher residential mobility with corresponding low logistical mobility (see Binford 1980; Kelly 1983).

Foragers typically operate in situations where biotic resources are spatially unpredictable while collectors operate in situations of temporal constraint, where resources are easily located spatially, but are only available for short time periods. It has also been suggested that logistical organization may be conditioned by growth in socio-political complexity linked to population growth and access to highly reliable seasonal resources [see Binford (1983) and Hayden (1986) for different views on collector-forager causation).

The organization of lithic technology is largely conditioned by perceived future needs or anticipatory planning in the context of mobility strategies (Torrence 1983; Binford 1977; Kelly 1985). Planning is often conditioned by the structure of lithic and biotic resources in the environment, as demonstrated in the following examples. In situations where both lithic and biotic resources are common, but spread out, a flexible technology based on expedient core reduction and flake tool use might be expected, as is the case with the Ngatatjara and Pintupi of western Australia (Gould et al. 1971; Parry and Kelly 1986). On the other hand, given the opposite situation where biotic resources are only found in short time periods, and lithic resources are spatially discrete, a strategy of formalized lithic reduction oriented towards specialized tools is often found, as in many Eskimo groups (Kelly 1985). An important point to be considered here is that hunter-gatherers must balance lithic raw material transport costs with lithic tool manufacture costs. In other words, decisions must be made regarding how much raw material is to be transported and in what form that transport should occur (see Parry and Kelly 1986: 299).

Long term land use under different hunter-gatherers mobility strategies may leave distinctive intersite archaeological patterning. Foragers produce an extremely low level of intersite variability. Only two types of sites are produced: procurement locations and camps. Reoccupation of sites is typically rare. When it does occur, increase in assemblage variability is still low. Tethered foragers, or those following a foraging system constrained to camping at particular locales (Taylor 1964), produce a similar archaeological pattern to that of other foragers except for greater accumulations of debris at particular locations such as water holes. In general, both foragers and tethered foragers tend to produce geographically dispersed, but homogeneous archaeological scatters of artifacts and features.

The opposite of this pattern is true for collectors. Here, residential sites are typically occupied for long periods with a single location providing for many needs. Likewise, logistical sites are chosen for specific activities, such as hunting stands or kill sites. These types of sites all may be reoccupied often and not always for the same purpose. For example, a residential site may be reused as a hunting camp and vice versa. Thus, the archaeological record produced may be variable in intersite patterning and substantially different from that of foragers (see Binford 1980, 1982; Kelly 1985).

ENVIRONMENTAL AND CULTURAL CONTEXT

The West Side Irrigation Project (approximately 12,000 acres) was chosen as the study area, because of its location along Pleistocene cobble terraces west of the Big Horn River (Figure 1). The entire study areas falls within the 5-9 inch precipitation zone of the central Big Horn Basin.

No chronometric dates are available for the archaeological materials found in the study area. Collected projectile points indicate clustering in the Late Plains Archaic and Late Prehistoric periods. Radiocarbon dates from archaeological sites within a 30 mile radius of the study area [except for the Colby Mammoth site (Frison and Todd 1985)] cluster tightly between approximately 2500 yrs B.P. and 1000 yrs B.P., placing the focus of the archaeological record in the Late Plains Archaic and early Late Prehistoric periods (Table 1). Unfortunately, these dates come from CRM projects, dealing with surface or shallow buried contexts. Nevertheless, given the predominant projectile points found and the distribution of radiocarbon dates, we expect the archaeological record, at least as it exists on the surface, to be primarily the result of Late Plains Archaic and Late Prehistoric occupations. Assuming the majority of the surface archaeological materials date to the last 2500 yrs and that climate during the past 2500 yrs was not substantially different from that of recent historic times (Anteves 1955; Baerreis and Bryson 1965; Greiser 1985), environmental considerations derived directly from modern data should be relevant to the study of hunter-gatherer behavior during this time.

Lithic raw materials occur ubiquitously throughout the project area, as well as much of the central Big Horn Basin and consists of quartzite, basalt, and occasional chert cobbles located on Pleistocene terraces of the Big Horn and Nowood Rivers (Francis 1983:39). Little variation was observed in amounts or quality of lithic materials in any portion of the study area.

Even though the three portions of the study area fall within the same environmental zone, there are several differences from area to area. Soils in the northern area consist primarily of saline uplands interspersed with rock outcrop. The central area is somewhat more diverse with roughly equal amounts of loamy soil and saline uplands. The southern area contains a great diversity of soil types, including saline uplands, loamy soil, sandy soil, gravelly soil, and shale soil.

Important vegetation types in the central and southern areas include bluebunch wheatgrass (Agropyron spicatum), needleandthread grass (Stipa comata), blue gramma (Bouteloua gracilis), and Indian ricegrass (Oryzopsis hymenoides). Vegetation in the northern area consists primarily of Gardner's saltbush (Atriplex gardneri), Indian ricegrass, and bottlebrush squirreltail (Sitanion hystrix).

Ephemeral drainages dissect all portions of the study area, the largest of which runs through the northern portion. This drainage carried a substantial seasonal flow of water before intense siltation occurred during the last 50 yrs.

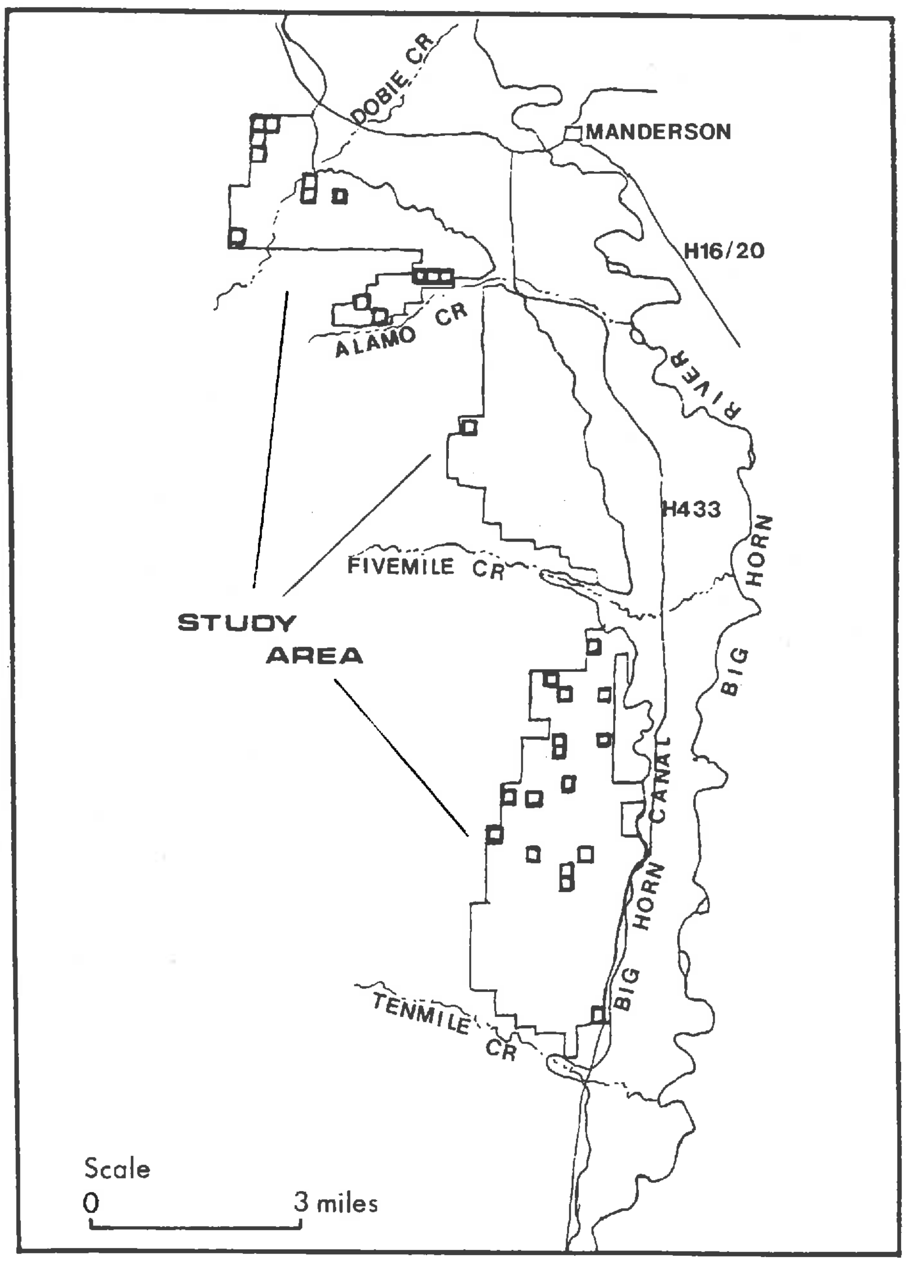

Figure 1: Study area location.

Lab. No.	Date	Site Number	Assumed Cultural Period
Beta-5538	1000±70	48WA276	Late Prehistoric
RL-1322	1010±100	48WA48	Late Prehistoric
RL-1312	1020±110	48WA40	Late Prehistoric
Beta-4368	1060±70	48WA274	Late Prehistoric
Beta-12634	1070±50	48BH988	Late Prehistoric
Beta-5539	1150±70	48WA276	Late Prehistoric
RL-979	1150±110	48WA54	Late Prehistoric
RL-1001	1210±110	48WA46	Late Prehistoric
RL-1326	1220±90	48WA46	Late Prehistoric
Beta-12009	1230±90	48WA636	Late Prehistoric
RL-973	1260±100	48WA48	Late Prehistoric
RL-969	1270±110	48WA47	Late Prehistoric
RL-1327	1270±120	48WA72	Late Prehistoric
RL-1085	1280±100	48WA167	Late Prehistoric
RL-1076	1310±130	48WA73	Late Prehistoric
RL-1315	1310±100	48WA47	Late Prehistoric
RL-1330	1320±100	48WA47	Late Prehistoric
RL-1066	1330±110	48WA46	Late Prehistoric
Beta-2506	1350±110	48BH473	Late Prehistoric
Beta-2507	1360±90	48BH473	Late Prehistoric
UG-3432	1465±115	48BH418	Late Prehistoric
RL-1075	1470±110	48WA73	Late Prehistoric
RL-968	1490±110	48WA49	Late Prehistoric
RL-1077	1520±110	48WA79	Late Plains Archaic
RL-1328	2340±130	48WA72	Late Plains Archaic

Table 1: Radiocarbon dates on archaeological sites within 30 miles of the project area (dates expressed B.P.)

Area	Percentage of Plants Available For Human Consumption	Vegetative Diversity
North	47	0.34
Central	48	0.749
South	48	0.896

Table 2: Ecological diversity and percentage of edible plants.

A number of ecological indices were calculated to further examine environmental differences between the different portions of the study area. Primary forage production and percentages of plant types available for human consumption, for each portion of the study area, were calculated utilizing range site data, available at the Bureau of Land Management, Worland District Office. These data predict range quality without any effects of heavy utilization, regarding soil types, vegetation types, and primary forage production (air dry weight) for favorable, median, and unfavorable years (based on rainfall). Percentages of plant types in climax, available for human consumption, by range site do not indicate any substantial difference between the three portions of the study area (Table 2).

Substantial variability exists in primary forage production between the different portions of the study area. With acreages adjusted so all portions of the study area are of equal size, total primary forage production scores are similar, although slightly larger in the central and southern portions. Quantification of grazer preferred forage (grass species only) indicates a different pattern, with primary production estimates in the central and southern portions almost double those of the northern portions.

Forage production can be better understood by looking at the fauna it may support. Therefore, as a heuristic device, we calculated carrying capacity for large ungulates, here bison (Bison bison), for each area (Table 3). This was accomplished by dividing the preferred (grazers) and total primary forage production rate (expressed in kilograms) by the forage production requirements of 3629 kg per animal unit year (AUY) (Reher and Frison 1980:42). Not unexpectedly, little substantial variability was encountered when the total primary forage production rate was utilized, while, for preferred (grazers) primary forage production, bison carrying capacity indices are much higher in the southern and central portions.

Vegetative diversity was calculated using range site distributions (hectares) in each area with the Shannon-Weiner diversity index (Pielou 1974). It was found that the central and southern areas were over twice as diverse as the northern area (Table 2). It should be noted here that the southern and central portions, besides being the most diverse, contain by far the greatest amount of C4 (Hatch-Slack plants typically found in xeric environments) grasses (ratio of 10:1 primary production estimate between the southern and northern portions of the study area), demonstrated to be important conditioners of bison feeding locations (Chisholm et al. 1986; Peden et al. 1974) (Table 3).

It has been demonstrated that large ungulates will typically seek out locations of highest quality forage, especially in a grasslands environment (Bamforth 1987). Since ecological diversity is far greater in the central and southern portions and quantity of preferred forage (grazers) is substantially greater in the central and southern portions, it seems likely that highest quality forage for grazers such as bison (Burt and Grossenheider 1976; Nelson 1965) would not typically be found in the central and southern portions of the study area. Thus it might be expected that higher seasonal aggregations of bison would be found in the central and southern portions than in the northern portion of the study area.

To place the study in the context of some recent studies of hunter-gatherer ecology (Binford 1980; Kelly 1983), primary forage production data were utilized to predict primary forage biomass scores. Using Kelly's (1983:286) regression formula for prediction (arid environments) of primary biomass given primary production, it was predicted that primary forage biomass scores would fall between 0.7 to 1.0 (kg/mile^2). No estimation was made of effective temperature. However, Kelly (1983:285) provides an effective temperature score for the Crow, whose historic territory extended into the Big Horn Basin (Denig 1953), at 13.0, indicating an environment with great seasonal variability. This score is used for general comparative purposes.

DATA COLLECTION

Data collection proceeded in two stages: experimental and archaeological. Controlled experiments were conducted to aid in interpretation of the archaeological materials. The experimental research as been reported in detail elsewhere (Prentiss et al. 1986). To summarize, the purpose of the lithic experimentation was not to recreate technologies or conduct tool replication studies (see Thomas 1986). Instead, it was to generate independent information regarding patterning in debitage assemblages resulting from specific forms of behavior. This was accomplished by

		Favorable	Moderate	Unfavorable
NORTH	Total Production	950,226.7	708,623.2	468,177.7
	AUY	261.8	195.3	129.0
	Preferred Production	494,117.9	368,484.1	243,452.4
	AUY	136.2	101.5	67.1
	C4 Grass Production	2,850.7	2,125.9	1,404.7
CENTRAL	Total Production	1,246,555.8	871,045.7	525,897.0
	AUY	343.5	240.0	144.9
	Preferred Production	797,795.7	557,469.3	336,574.1
	AUY	219.8	153.6	92.8
	C4 Grass Production	19,944.9	13,936.7	8,414.4
SOUTH	Total Production	2,305,608.4	1,566,412.6	923,364.9
	AUY	635.3	431.6	254.4
	Preferred Production	1,590,869.0	1,080,824.7	637,121.8
	AUY	438.4	297.8	175.6
	C4 Grass Production	55,334.6	37,593.9	22,160.8

Adjusted to Northern Size

		Favorable	Moderate	Unfavorable
CENTRAL	Total Production	1,196,692.8	836,203.9	504,861.1
	AUY	329.8	230.4	139.1
	Preferred Production	765,883.4	535,170.5	323,111.1
	AUY	211.1	147.5	89.0
	C4 Grass Production	19,147.1	13,379.2	8,077.8
SOUTH	Total Production	1,291,140.0	877,191.1	517,084.3
	AUY	355.8	241.7	142.5
	Preferred Production	890,886.6	605,261.9	356,788.2
	AUY	245.5	166.8	98.3
	C4 Grass Production	30,987.4	21,052.6	12,410.0

Table 3: Total, preferred, and C4 grasses primary forage production (expressed in kilograms) and associated bison carrying capacities [Animal Unit Years (AUY)].

knapping debitage for several assemblage types. Several avenues of behavioral variability were explored and an attempt was made to simulate effects of erosion induced size sorting on assemblages. Assemblage attributes were selected with these research goals in mind.

Debitage was recorded using the method developed by Sillivan and Rozen (1985) [see also Ferg et al. (1984)] and a size analysis. Flakes were initially sorted into large (L) and small (S) categories based on a median size of four square centimeters. Using the Sullivan and Rozen method, flakes were categorized as whole flakes (WF), proximal fragments (PF), medial/distal fragments (MDF), split flakes (SF), and nonorientable fragments (NF). To accompany the debitage analysis, a similar method was developed for core categorization. It is based on a simple hierarchical key (Figure 2) with two dimensions of variability: number of facets and facet orientation. This results in three core categories: faceted cobble (FC), uniform core (UC), and random core (RC). Facet number refers to the number of flake removals on a core. If only one flake has been removed, then the core is classified as a faceted cobble. When flaked more than once, the facet orientation dimension is considered. If the facets are oriented in the same direction from a single working edge, is considered to be uniform. It is classified as random when facets are oriented in several directions from one or more working edges.

Archaeological data were collected from a "nonsite" (see Thomas 1977) survey conducted northwest of Worland, Wyoming. The project area was placed in a grid system, consisting of 291 consecutively numbered, 40 acre quadrants. Thirty random digits between one and 291 were generated using the EPSTAT statistics package for the IBM PC. Each random number indicated a quadrant within the study area. Thirty meter wide transects were walked in each quadrant until an artifact was encountered. Transect width then shifted to three to five meters to record all possible artifacts. All debitage and cores were recorded using the typology described above. All lithic tools located were simply designated modified flakes, bifaces, hafted bifaces or unifaces [see Prentiss et al. (1986) for further discussion].

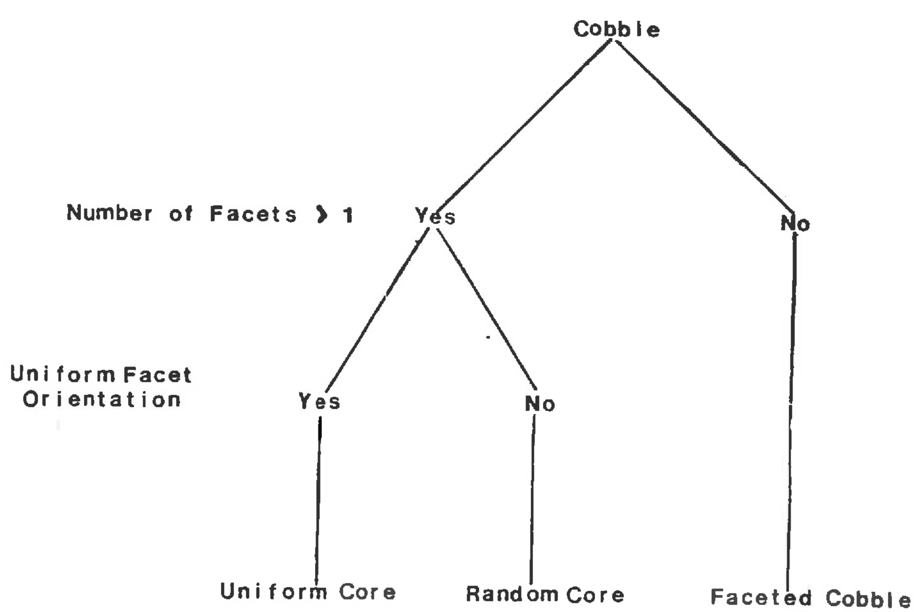

Figure 2: Core technology key.

All raw data from both the experimental and archaeological studies were standardized on a ratio scale which arrays all values between 100 and 0. This is not a percent score in the sense that the "array is constrained" (Binford 1981:263). The purpose is to emphasize proportions of variables while eliminating the problem of different sample sizes (Binford 1978).

ANALYSIS AND INTERPRETATIONS

Archaeological data collection resulted in a complex matrix of 30 cases by seventeen variables (see Table 4). Factor analysis was chosen as a technique to identify structure in the data which might have been missed had analysis proceeded case by case. Factor analysis refers to a series of statistical techniques used to reduce a high number of variables to a lower number of potentially easier to interpret variables (Kim and Mueller 1978). Ratio scale data were used in two analyses [Binford (1981:263) and Todd and Frison (1986:86) discuss the suitability of percentage ratio assemblage data of this type in factor analysis].

All data were converted to ratio scale scores as previously discussed. Nine cases and eight variables were dropped due to extremely low artifact counts. Variables dropped included the tool categories, the faceted cobble category, and the small debitage categories. Elimination of the variables was expected to have little effect on subsequent analysis, since the focus of the analysis was on cores and debitage and that small artifacts seemed to have been selectively removed through size sorting associated with sheetwash erosion (see Prentiss et al. 1986). The final matrix consisted of seven variables and 21 cases (Table 5).

Recognition of patterning in factor analysis results was facilitated by experimental research which focused on simulating what assemblages of debitage might look like given different technological strategies and levels of sheetwash erosion (Prentiss et al. 1986).

Two patterns were defined by screening debitage assemblages through 1/4 and 1/2 inch screens. The 1/4 inch assemblages simulated those having undergone little erosion and small artifact loss. The 1/2 inch assemblages represented those where substantial sheetwash erosion or soil mixing would have removed most small artifacts (Tables 6 and 7). Because of the close resemblance between the experimental 1/2 inch patterning and the archaeological data (Table 6), the 1/2 inch patterning was given priority in all archaeological pattern recognition. From the analysis of the experimental 1/2 inch patterning, it was concluded that both tool production and core reduction assemblages were dominated by large whole flakes. Large tool production was indicated by high numbers of proximal and medial/distal fragments and low numbers of nonorientable fragments. Core reduction assemblages were best identified by high nonorientable fragment scores and low numbers of proximal and medial/distal fragments (Prentiss et al. 1986).

An "R" mode principal components factor analysis was first conducted to discern if identifiable variability did exist in the assemblages, using the SPSS/PC+ FACTOR program (Norusis 1986). To summarize the results briefly (Tables 8-10), three factors were produced and rotated with an oblimin rotation using a standard Kaiser normalization. Factor one, because of the high loadings on large whole flakes, large proximal fragments, and large medial/distal fragments, was interpreted as a large tool production factor. Factor two loaded heavily on random cores and large nonorientable fragments and moderately on large medial/distal fragments. This was interpreted as representing large flake production and probable removal, indicated by the lack of large whole flakes. Factor three was more difficult to interpret. Heavy loadings were found on large split flakes and large medial/distal fragments. This may have been related to some form of core reduction, although core reduction type is at present unknown (see Prentiss et al. 1986 for additional discussion).

Study Area Location	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Inventory Quadrant	1	2	3	4	5	6	7	LSS	8	9	LSS	LSS	10	11	12
FC	5	7	8	13	7	8	0	1	17	5	1	9	12	14	2
RC	8	7	6	12	14	22	6	2	15	9	2	4	19	6	6
UC	0	6	1	6	8	13	2	1	8	1	0	5	13	6	1
LWF	11	17	10	7	25	24	5	2	25	11	1	2	33	16	9
SWF	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
LPF	2	2	0	1	1	4	1	1	4	6	0	0	7	2	2
SPF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
LMDF	3	10	1	1	4	4	2	0	9	5	1	1	16	7	3
SMDF	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
LNF	6	9	8	14	20	28	4	2	19	4	3	10	29	32	3
SNF	1	0	0	0	7	0	1	0	4	0	0	0	3	0	0
LSF	2	5	0	3	5	4	0	0	5	2	1	0	16	4	5
SSF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BIFACE	0	3	0	0	0	0	1	0	4	1	0	0	3	2	0
UNIFACE	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
HAFTED BIF.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
MOD. FLAKE	0	0	2	4	6	0	1	2	1	9	0	1	0	7	4

Study Area Location	S	S	N	N	N	N	N	N	N	N	N	N	N	N	C
Inventory Quadrant	LSS	13	14	15	LSS	LSS	16	17	18	19	LSS	LSS	20	21	LSS
FC	0	0	4	0	0	0	0	0	0	1	0	0	0	1	0
RC	0	7	13	3	1	0	8	3	3	2	0	0	2	2	0
UC	0	8	18	7	1	1	4	3	1	3	0	1	1	9	0
LWF	0	34	82	39	2	0	24	20	8	8	0	0	14	3	0
SWF	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0
LPF	0	14	22	9	0	1	6	3	1	4	0	0	1	0	0
SPF	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
LMDF	0	14	22	4	1	0	9	2	4	1	1	0	3	0	0
SMDF	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
LNF	0	17	30	12	2	1	7	3	5	5	0	0	3	7	0
SNF	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0
LSF	0	9	24	12	0	0	5	4	3	0	0	0	5	2	0
SSF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BIFACE	0	2	1	3	0	0	1	1	0	0	0	0	0	0	0
UNIFACE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
HAFTED BIF.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
MOD. FLAKE	0	8	15	6	2	0	4	5	2	3	0	0	2	4	0

Table 4: Archaeological raw data matrix (LSS = Low Sample Size; S = southern area; C = central area; N = northern area.

	1	2	3	4	5	6	7	8	9	10
RC	74.67	42.00	60.55	87.00	56.42	78.41	100.00	60.45	84.00	57.49
UC	00.00	36.00	10.09	43.50	32.24	46.33	35.33	32.24	9.33	39.53
LWF	100.00	100.00	100.00	50.75	100.00	85.54	88.33	100.00	100.00	100.00
LPF	18.67	12.00	00.00	7.25	4.03	14.26	17.67	16.12	56.00	21.29
LMDF	28.00	60.00	10.09	7.25	16.12	14.26	35.33	36.27	46.67	48.65
LNF	56.00	54.00	80.73	100.00	80.61	100.00	70.67	76.57	37.33	88.18
LSF	18.67	30.00	00.00	21.75	20.15	14.26	00.00	20.15	18.67	48.65

	11	12	13	14	15	16	17	18	19
RC	18.77	66.00	20.21	15.86	7.92	33.00	15.00	36.33	24.22
UC	18.77	11.00	23.09	21.96	18.48	16.50	15.00	12.11	36.33
LWF	50.04	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
LPF	6.26	22.00	40.42	26.83	23.75	24.75	15.00	12.11	48.44
LMDF	21.89	33.00	40.42	26.83	10.56	37.13	10.00	48.44	12.11
LNF	100.00	33.00	49.08	36.59	31.67	28.88	15.00	60.55	60.55
LSF	12.51	55.00	16.98	29.27	31.67	20.63	20.00	36.33	00.00

	20	21
RC	14.5	22.00
UC	7.25	100.00
LWF	100.00	33.00
LMDF	7.25	00.00
LMDF	21.75	00.00
LNF	21.75	77.00
LSF	36.25	22.00

Table 5: Converted archaeological data matrix.

	BF	ES	C1	C2	C3	C4	CP1	CP2
LWF	100.00	00.00	100.00	100.00	100.00	100.00	100.00	100.00
SWF	34.00	12.11	2.45	7.28	15.24	25.02	19.78	29.18
LPF	36.00	00.00	29.39	18.19	28.29	50.04	32.97	28.29
SPF	36.00	00.00	00.00	3.64	2.18	9.38	3.30	2.18
LMDF	32.00	00.00	31.84	9.10	15.24	31.28	37.87	15.24
SMDF	18.00	100.00	00.00	1.82	6.53	3.13	9.89	6.53
LNF	4.00	12.11	71.03	36.39	41.35	43.79	34.06	58.76
SNF	8.00	00.00	9.80	3.64	13.06	15.64	8.79	15.24
LSF	12.00	00.00	51.43	23.66	15.24	56.30	29.67	15.24
SSF	2.00	00.00	00.00	00.00	8.70	00.00	1.10	8.70

Table 6: Total 1/2 inch screen experimental converted data matrix. BF = biface production; ES = end scraper production; C1 = core 1 (random core reduction with biface blanks removed); C2 = core 2 (random core reduction without biface blanks removed); C3 = core 3 (uniform core reduction with end scraper blanks removed); C4 = core 4 (uniform core reduction without end scraper blanks removed); CP1 = complex assemblage 1 (random core reduction and biface production); CP2 = complex assemblage 2 (uniform core reduction and end scraper production.

	BF	ES	C1	C2	C3	C4	CP1	CP2
LWF	18.52	00.00	53.57	25.77	42.99	28.30	30.26	32.86
SWF	44.91	100.00	60.71	9.79	33.64	17.94	54.27	60.72
LPF	9.07	00.00	15.48	19.70	13.09	11.33	11.84	10.00
SPF	61.06	57.17	15.48	13.64	27.10	10.38	55.25	40.72
LMDF	7.05	8.17	27.38	15.15	13.09	13.21	13.81	12.86
SMDF	100.00	63.29	59.52	25.77	67.29	45.28	100.00	73.57
LNF	2.76	16.33	20.24	7.73	18.69	8.49	7.90	36.40
SNF	31.12	67.38	100.00	100.00	100.00	100.00	53.61	100.00
LSF	2.36	2.04	28.57	21.22	14.95	16.04	9.87	12.15
SSF	5.91	2.04	00.00	6.06	12.15	9.43	6.91	10.00

Table 7: Total 1/4 inch screen experimental converted data matrix. BF = biface production; ES = end scraper production; C1 = core 1 (random core reduction with biface blanks removed); C2 = core 2 (random core reduction without biface blanks removed); C3 = core 3 (uniform core reduction with end scraper blanks removed); C4 = core 4 (uniform core reduction without end scraper blanks removed); CP1 = complex assemblage 1 (random core reduction and biface production); CP2 = complex assemblage 2 (uniform core reduction and end scraper production.

	RC	UC	LWF	LPF	LMDF	LNF	LSF
RC	1.00000						
UC	.00839	1.00000					
LWF	-.00610	-.66842	1.00000				
LPF	.00121	-.26204	.42838	1.00000			
LMDF	.18983	-.31823	.47239	.34861	1.00000		
LNF	.43910	.48596	-.54410	-.39951	-.17246	1.00000	
LSF	-.16532	-.10532	.16738	-.06959	.35554	-.30905	1.00000

Table 8: "R" mode principal components analysis correlation matrix.

Variable	Communality	Factor	Eigenvalue	Percentage of Variation	Cumulative Percentage
RC	1.00000	1	2.77811	39.7	39.1
UC	1.00000	2	1.38045	19.7	59.4
LWF	1.00000	3	1.10901	15.8	75.3
LPF	1.00000	4	.77549	11.1	86.3
LMDF	1.00000	5	.42193	6.0	92.4
LNF	1.00000	6	.29311	4.2	96.5
LSF	1.00000	7	.24192	3.5	100.0

Eigenvalue Criterion: 1.0
Kaiser-Meyer-Olkin Measure of Sampling Adequacy: .61270

Table 9: "R" mode principal components analysis initial statistics.

Variable	Factor 1	Factor 2	Factor 3
RC	-.01833	.90918	-.10794
UC	-.77207	.04170	-.22164
LWF	.86877	.00945	.31443
LPF	.71160	.05054	-.08579
LMDF	.54286	.42029	.62142
LNF	-.67305	.59844	-.32368
LSF	.07888	-.19214	.93075

Table 10: "R" mode principal components factor pattern matrix.

The "R" mode factor analysis demonstrated that structure exists in assemblage composition and that variability could be assumed to exist across geographic space where artifact scatters are seemingly homogeneous. The "Q" mode factor analysis was then designed to indicate the location of the variability within the study area. Again, the SPSS/PC+ FACTOR program (Norusis 1986) was utilized to generate a principal components factor analysis. The original data matrix was inverted such that the cases became the "variables" and the variables became the "cases." A three factor solution was produced (Tables 11-13) and an oblimin rotation performed with a standard Kaiser normalization. Artifact frequency histograms for each case were produced for the purposes of better understanding the factor pattern matrix (Figure 3).

Five inventory quadrants from the southern portion and all inventory quadrants, except for one, from the northern portion of the study area loaded on factor one. Assemblages loading on this factor contain equal numbers of random and uniform cores, high numbers of whole flakes and roughly equal numbers of proximal fragments, medial/distal fragments, nonorientable fragments and split flakes. Factor one assemblages (Figure 4) are similar to experimental complex assemblage 1 (large flake production from random cores and biface production). Factor one is interpreted to represent both large and small flake production. With the high numbers of proximal and medial/distal fragments, it seems likely that some large tools such as bifaces were also produced.

All except three of the quadrants from the southern portion of the study area loaded on factor two. Factor two assemblages are similar to experimental core 1 assemblages (large flake production from random cores) (Figure 5), and typically contain high numbers of random cores, whole flakes, and nonorientable fragments, with low numbers of uniform cores, proximal fragments, medial/distal fragments, and split flakes. Factor two assemblages are interpreted to be the result of cobble testing and random core reduction oriented towards production of large flakes. It should be noted here that, although not include in the factor analysis, faceted cobbles are almost exclusively represented in quadrant assemblages loading heavily on this factor, further supporting the conclusion that cobble testing was important in forming assemblages loading on factor two.

One quadrant from the southern portion and one quadrant from the northern portion of the study area loaded on factor three. These assemblages are notable in that they contain low numbers of whole flakes and even lower numbers of proximal or medial/distal fragments. If whole flake scores were low and associated with high medial/distal and proximal scores, trampling could be considered a likely cause (Prentiss and Romanski n.d.). However, given the data at hand, it seems more likely that these assemblages are the product of random and uniform core reduction and removal of flakes for future use as tools or cores.

CONCLUSIONS

Several major patterns are immediately obvious from an examination of the above data. First, two general strategies of lithic procurement are evident: a strategy of cobble testing and expedient core reduction (factor one faceted cobble and random core reduction) and a strategy of more intensive and specialized core reduction (factor two and

Quadrant

	1	2	3	4	5	6	7
1	1.00000						
2	.75062	1.00000					
3	.91575	.76504	1.00000				
4	.56542	.27735	.75679	1.00000			
5	.84991	.78742	.97772	.75260	1.00000		
6	.74794	.56130	.93073	.92394	.93021	1.00000	
7	.85945	.61972	.88372	.77385	.82030	.87434	1.00000

	1	2	3	4	5	6	7
8	.90162	.85978	.98539	.67935	.97709	.88946	.86250
9	.87483	.56491	.66407	.23358	.54192	.44385	.72853
10	.81734	.86045	.92291	.63299	.94985	.81502	.69276
11	.47178	.49914	.73731	.70289	.74707	.77284	.48837
12	.86005	.70222	.67189	.24858	.66050	.43480	.56271
13	.68483	.81686	.69307	.08509	.67903	.44879	.45100
14	.67608	.82667	.66402	.06654	.69922	.41656	.37968
15	.62645	.73842	.62588	.07320	.69797	.40238	.31148
16	.80580	.88507	.71138	.09719	.69999	.43844	.55666
17	.70194	.79418	.64776	.07414	.68616	.41168	.43074
18	.82967	.93475	.81495	.32099	.81640	.57978	.57374
19	.63049	.61684	.74773	.33369	.74288	.64421	.54961
20	.70106	.83682	.62456	.04947	.66925	.35617	.35864
21	-.13109	.08154	.24557	.54158	.38699	.51030	.17348

	8	9	10	11	12	13	14
8	1.00000						
9	.65223	1.00000					
10	.94594	.47065	1.00000				
11	.71737	.09541	.79237	1.00000			
12	.68649	.76463	.68431	.14462	1.00000		
13	.75169	.64298	.70488	.46623	.59639	1.00000	
14	.72758	.57785	.73362	.37410	.73231	.94457	1.00000
15	.67391	.51091	.69767	.34625	.72383	.88962	.98384
16	.77812	.77868	.71840	.27450	.82479	.92196	.94220
17	.70650	.64145	.67577	.22629	.80365	.88073	.97322
18	.87029	.60797	.92295	.59806	.79339	.83769	.85998
19	.75521	.56668	.64067	.54365	.42361	.88508	.81192
20	.69228	.57569	.74002	.27452	.85727	.83775	.95823
21	.25004	-.45123	.27362	.48359	-.28827	-.04952	-.00480

	15	16	17	18	19	20	21
15	1.00000						
16	.88592	1.00000					
17	.96847	.95024	1.00000				
18	.79873	.87980	.80057	1.00000			
19	.79932	.74926	.77418	.62847	1.00000		
20	.94737	.92986	.95891	.88499	.63417	1.00000	
21	.04551	-.16998	-.02288	-.04672	.24834	-.10163	1.00000

Table 11: "Q" mode principal components analysis correlation matrix.

Variable	Communality	Factor	Eigenvalue	Percentage of Variation	Cumulative Percentage
1	1.00000	1	14.09736	67.1	67.1
2	1.00000	2	3.55832	16.9	84.1
3	1.00000	3	1.68592	8.0	92.1
4	1.00000	4	.75688	3.6	95.7
5	1.00000	5	.57108	2.7	98.4
6	1.00000	6	.33043	1.6	100.0
7	1.00000				
8	1.00000				
9	1.00000				
10	1.00000				
11	1.00000				
12	1.00000				
13	1.00000				
14	1.00000				
15	1.00000				
16	1.00000				
17	1.00000				
18	1.00000				
19	1.00000				
20	1.00000				
21	1.00000				

Minimum Eigenvalue Criterion: 1.0
Kaiser-Meyer-Olkin Measure of Sampling Adequacy: .96307

Table 12: "Q" mode principal components analysis initial statistics.

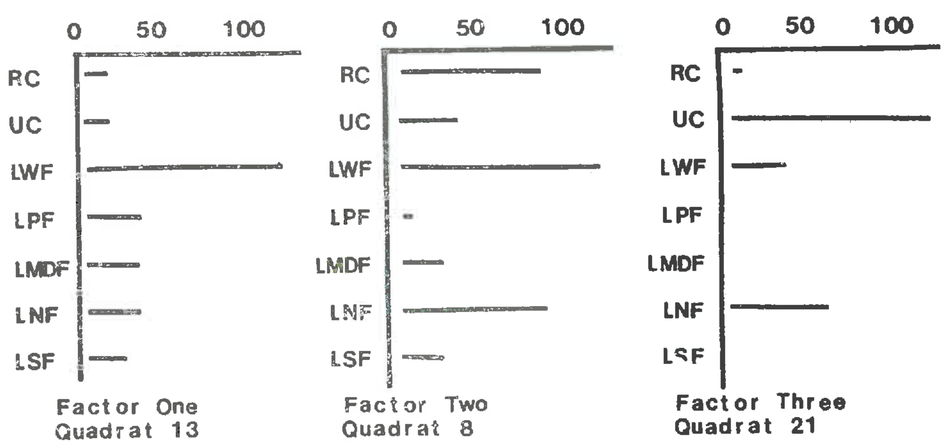

Figure 3: "Q" mode principal components analysis artifact frequency histogram examples.

three uniform core reduction) and limited formal tool production (factor two biface reduction).

Second, there is a distinct spatial pattern in assemblage variability across the different portions of the study area. The southern portion of the area contains predominantly expedient core reduction and only occasional more intensive raw material use. The northern portion contains comparatively intense raw material utilization with core reduction and biface production. A similar pattern, although not considered in

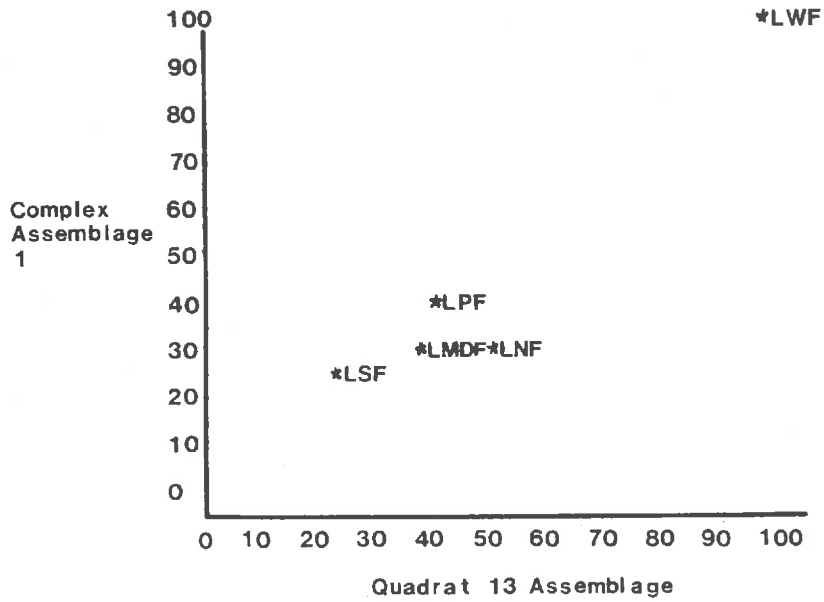

Figure 4: Comparison of experimental complex assemblage 1 and quadrant 13 archaeological assemblage.

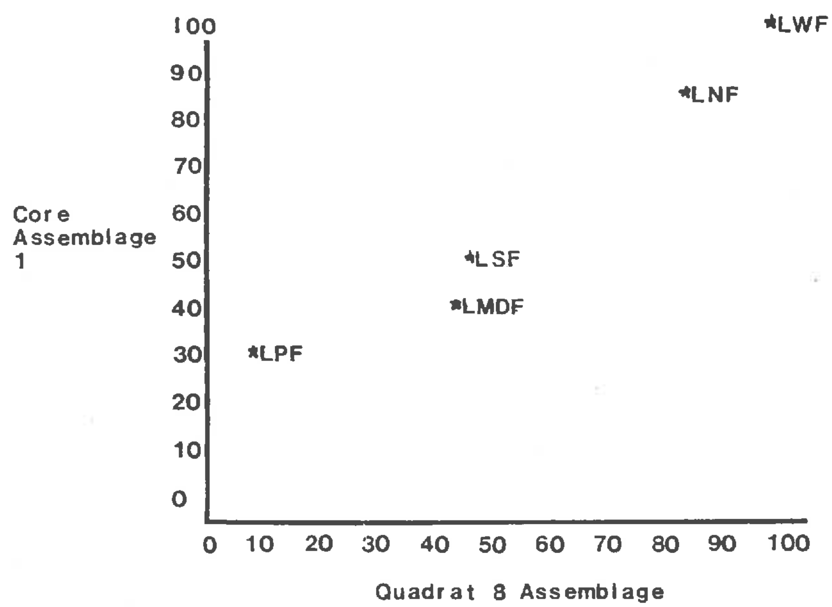

Figure 5: Comparison of experimental core assemblage 1 and quadrant 8 archaeological assemblage.

detail in this paper, was noted in fire-affected rock distributions. Fire-affected rock scatters and fire pit or hearth distributions are different between the northern and southern portions of the study area. Much of the northern portion of the area is dominated by scatters of fire-affected rock and clusters of fire pits covering hundreds of acres. The southern portion of the study area contains only small spatially discrete scatters of fire-affected rock.

Variable	Factor 1	Factor 2	Factor 3
1	.32937	.69408	-.41117
2	.75761	.24484	-.02265
3	.35643	.77686	-.01675
4	-.32627	1.05744	.16899
5	.45460	.69065	.13501
6	.07765	.92825	.17631
7	-.04953	.96878	-.26787
8	.46993	.68231	.00980
9	.25935	.46328	-.70371
10	.55902	.55513	.14360
11	.24428	.59392	.50533
12	.52947	.29197	-.50100
13	.96078	-.02172	.01650
14	1.05341	-.02172	.01650
15	1.05648	-.15644	.08837
16	.87816	.06823	-.25143
17	.98443	-.07514	-.08608
18	.76143	.27565	-.07736
19	.75532	.19169	.20359
20	.98741	-.09815	-.10539
21	.03804	.27999	.86524

Table 13: "Q" mode principal components factor pattern matrix.

Producing a theoretical explanation of the above patterning requires a return to the ecological data and theoretical concerns discussed earlier. The effective temperature score provided by Kelly (1983:285) for the Crow indicates an environment with extreme seasonal variability. This conclusion should come as no surprise. As Frison (1978:7) has stated, in a discussion of the Northwestern Plains environment, "Long cold winters and short summers lead to a short growing season..." Hunter-gatherer occupations within this region could certainly fall within the realm of what has been called a "biseasonal settlement pattern" (Gilman 1987:560). In this context, hunter-gatherers could be expected to be sedentary during winter months and mobile during many of the warmer months of the year. This argument is echoed by Kelly (1983) in an assessment of monitoring requirements where, as is the case in the central Big Horn Basin, seasonal variations are great and primary forage production and primary forage biomass are low, mobility is critical to monitor availability of certain important resources. Residential mobility could only be low in this context when a storeable resource is present such as in arctic caribou herds or large plains bison herds.

We suggest here that while the central Big Horn Basin (elevation below 5000 ft.) certainly contained bison and other large ungulates (c.f., Haines 1965; Hauser and Stewart 1876) and during especially wet years could have contained them in significantly increased numbers (see Frison 1978:348), it probably did not contain the large herds which could be reliably utilized from year to year for procurement of long term stored resources (e.g., winter storage). Thus, utilization of the central Big Horn Basin would have typically required a high rate of residential mobility.

Returning to the patterning discussed above, it should be noted that most intense expedient lithic resource utilization falls within the portion of the study area predicted to have had greatest environmental diversity and bison aggregation potential. The northern area, with its greater lithic resource utilization intensity and extensive fire-altered rock scatters, is predicted to have been substantially lower in environmental diversity and bison aggregation potential. Assuming fire-altered rock scatters primarily represent camps and probably to a lesser extent, specialized procurement localities, we argue that more intensive utilization is associated with the residential occupations clustered in the northern portion and distributed sparsely in the southern portion. Lithic procurement evidence associated with these residential areas indicates a strategy of both core reduction and production of tools or cores for immediate, more specialized use or for removal from the immediate area. Expedient lithic resource utilization located in the southern portion of the study area seems to be most likely the result of foraging behavior by small groups or individuals perhaps working from nearby residential sites.

This archaeological pattern is remarkably similar to that described for certain ethnographic forager settlement systems where season camps cluster around water sources and dry season camps are more dispersed (see Kelly 1985:152-154). It provides some insight into the relationship between archaeological patterning and some specific human adaptations. We suggest that this patterning is most likely the result of a system of seasonal high residential mobility where locations of residential occupations were often conditioned by proximity to water sources and riparian habitat to cover a wide range of needs, but more important, choice of residential locations was conditioned by access to aggregations of large ungulates such as bison. Thus, groups often returned to locations along margins of preferred bison habitat to increase ease of access to a critical resource while not camping in the midst of the animals and potentially frightening them off, a practice well documented ethnographically (Ewers 1955; Grinnell 1923; Hassrick 1964). Actual resources procured may have varied greatly from season to season and year to year. Shortages of ungulates may have resulted in regular, more intensive use of plant and smaller animal resources. This however, does not negate the importance of planning for the procurement of larger game, minimally on an encounter basis.

Highly accessible lithic resources made an expedient technology based primarily on flake tool use the most economical lithic technological strategy, residentially or logistically. Some "gearing up" (Binford 1979) activities in the northern area could have preceded either extended logistical trips or residential moves. This would be especially important if moves were made east of the Big Horn River, where lithic resources are generally sparse and patchy until the foothills of the Bighorn Mountains are reached.

This explanation for lithic resource utilization variability in the central Big Horn Basin is offered as a means of generating questions about adaptations to guide future data collecting. As Soffer has stated,

> "...our only hope for obtaining better data - data more suitable for questions about human adaptations, lies in asking new questions - questions that call for something other than the kinds of information we have on hand" (Soffer 1985: 17).

The data utilized in this study come from highly eroded surface scatters often thought to be of little research value. We argue, however, that data from these scatters are crucial to the understanding of long-term land use strategies of the hunter-gatherers who inhabited this area. We concur with Todd and Hofman (1980:20) in that lithic surface scatter research should focus on "the organizational properties responsible for the observed archaeological record" as opposed to individual archaeologists' perceptions of what the archaeological record should look like.

Further research should focus on testing and refining these conclusions. Both excavation and detailed surface collection data are required. Since this study has considered only a small area of the central Big Horn Basin, studies which encompass larger regions and more focused time periods would also be immensely valuable in addressing problems of hunter-gatherer resource use and settlement.

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BOOK REVIEWS

Prehistoric Ceramics of the Mesa Verde Region. DAVID A. BRETERNITZ, ARTHUR H. ROHN, JR., AND ELIZABETH A MORRIS (COMPILERS). Museum of Northern Arizona, Ceramic Series No. 5. 1974. [Second edition, 1984 published by INTERpark, Cortez, CO; available from University of New Mexico Press]. 70 pages, 32 figures, 1 table. $9.95 (paper).

Prehistoric Ceramics of the Mesa Verde Region is the fifth book in a series from the Museum of Northern Arizona attempting to present ceramic descriptions from various regions within the southwest cultural region in a similar format, thus enabling all such ceramic types to be compared. The Museum of Northern Arizona began disseminating printed information on pottery in 1930. Dr. Harold S. Colton, in 1955, under the series title of Museum of Northern Arizona Ceramic Series, began revising and expanding the information known on the ceramic types of the Southwest. In 1958, Paul S. Martin and Dr. Colton started annual seminars to discuss ways to classify these ceramics and their cultural significance. This initial work resulted in the first four publications in the series.

At the ceramic conference in 1972, a decision was made to revive the series. Prehistoric Ceramics of the Mesa Verde Region is the first publication in this rejuvenated series. Since this publication's original printing, the Mesa Verde region has undergone intense study as a result of a few large, and numerous smaller archaeological projects. This has resulted in the refinement of the ceramic classifications for the area and a second printing of the book to include the new information.

The book begins with a brief description of the prehistory of the Mesa Verde Region, centering on previous ceramic studies. The introduction describes problems encountered when trying to classify these various ceramics, and ends by stating a format for type descriptions agreed upon by all researchers which would facilitate ceramic identifications.

The remainder of the book discusses the 16 ceramic types presently thought to occur within the area. Each type is described by construction technique, shape, decoration, variation, function, and date. The book goes on to list additional names given to the pottery type, compares the particular type with other types, and lists bibliographic references. Accompanying each description is a distributional map, black and white photographs of representative vessels and profile drawings of rim shapes. For ceramic types containing painted pottery, type specific design motifs are also illustrated.

The publication is well formatted to be used as a reference book for ceramics of the Mesa Verde region, and can be updated as new information is acquired. Archaeologists (both avocational and professional) would find it useful in identifying ceramics in museum collections, and in those rare instances to help identify Southwestern ceramics found in Wyoming that may be a result of trade or migration. More important, this book exemplifies a format that can improve the dissemination of knowledge on ceramics, and this can aid research in Wyoming.

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Teeth. SIMON HILLSON. Cambridge Manuals in Archaeology, Cambridge University Press, Cambridge. 1986. 376 + xix, 19 Plates, 110 Figures, 38 Tables, 4 Appendices, Bibliography. $44.50 (cloth).

This book is an excellent addition to the series of archaeological, or archaeologically related, books Cambridge University Press has published. Speaking as a person whose primary research interests are mammalian teeth, this book was a long time coming. Anything and everything you need to know concerning teeth can be found in the volume, ranging from chapters on tooth form and function, dental microstructure, ageing, size and shape, and dental disease. The book can quickly be described as a comprehensive collection and literature review of a topic with which the author (Hillson) is highly familiar. If there is one fault with the book, it is too detailed in some discussions for all but serious students of teeth. The average archaeologist might (and probably would) soon be overwhelmed by some of the data presented.

The book begins with a discussion on how important teeth can be to most archaeological site interpretations, stressing examples of studies on human teeth, and concluding with a section on how to properly collect dental material from archaeological sites.

This is followed by a detailed chapter of general tooth morphology, including an historical overview of dental nomenclature, the various functions of teeth, and a discussion of tooth morphology of all major mammalian taxonomic groups. This latter discussion constitutes almost one quarter of the entire book. Most mammalian families are summarized, with diagnostic tooth characteristics both discussed and illustrated. One minor fault I noticed here was the lack of representation in these groups of many strictly New World families. However, while not specifically stated, the reason for this is obviously clear. Hillson was discussing and illustrating those groups for which he was familiar and readily had comparative specimens available. I have seen this same orientation in North American zooarchaeologists who discuss teeth or osteological characters where North American taxonomic groups are stressed. Regardless, this was an interesting chapter to me because I could see many tooth types illustrated which I had not had the opportunity to see before. The chapter is an excellent example of how animals have adapted to various habitats, as revealed by their teeth. It will show the non-specialist just how involved the study of teeth can be.

The next chapter is a presentation on dental histology, or the "study of the microscopic structure of dental tissues." The chapter begins with the inorganic component of teeth (calcium phosphate minerals, iron oxides, calcium carbonate minerals and various trace elements), followed by a discussion of the organic component, (collagen, ground substance and enamel protein). The rest of the chapter is devoted to the three portions of teeth most archaeologists are familiar with: enamel, dentine, and cementum. These are the portions of teeth that we all see. The last section of this chapter is a discussion of preparation techniques for studying teeth through transmitted light microscopy, incident light microscopy, microradiography and scanning electron microscopy.

Chapter Three is devoted to tooth growth and ageing; beginning with a discussion of teeth and how they appear in mammalian embryos, followed by tooth eruption schedules and then concluding with a discussion of how and why teeth wear as the animal grows old. The next major portion of this chapter begins with an excellent discussion of human tooth growth, replacement and wear. This section concludes by reviewing similar schedules for most mammalian groups found in archaeological sites, including many domestic forms found throughout the Old World. The chapter ends by discussing the use of dental circum-annular layers in cement and dentine and how these can be used in archaeological studies.

Chapter Four reviews population variation in tooth size and shape. Hillson illustrates this primarily with examples of such variations in human populations, but the techniques used are also directly applicable to other groups as well. Hillson begins with measurable variation, (that variation which can be quantified), including techniques on how we can look at such features as tooth size inheritance, dental asymmetry, sexual dimorphism, population differences, species differences, and domestication processes. Non-metrical variations in human dentition is the focus of the next section of this chapter, including genetic variations seen in incisors, canines, premolars, and molars. The last section of the chapter is devoted to occlusion and malocclusion, or how upper teeth contact with lower teeth, again primarily using examples in human teeth.

Chapter Five is the chapter that reminded me of an aspect of teeth I normally have tried to forget: diseases and injuries. Many of the discussions in this chapter "hurt" as I read them: dental plaque, dental caries (coronal, root surface, and dentine), lesions, dental calculus (tarter), periodontal disease (gingivitis, periodontitis), infections (pulpitis, periapical periodontitis, acute osteomyelitis, actinomycosis), trauma (fractured teeth, fractured jaws, damage to developing teeth, problems of teeth of persistent growth), and, finally, odontomes (cysts and tumors). Reading this chapter makes one appreciate dentists and all they do for us.

The book concludes with four appendices, the first devoted to two quantifiable techniques for ageing human teeth, the next on dental attrition age estimation of cattle, sheep/goat, and pigs. The third appendix reviews another technique for estimating age by dental attrition in sheep/goat mandibles, and the last appendix reviews eruption schedules and attrition of horse teeth.

For the serious student of teeth, either archaeological, paleontological or zoological, this book is a must. It is a comprehensive literature review and compilation on every aspect of teeth. If a person is going to study teeth, this book contains information that one must at least be aware of, if not infinitely familiar. Hillson must be commended for the work accomplished compiling this information as concise and succinct as it is. It is a job well done.

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