Late Archaic Bison Hunters in Northern Colorado: 1997-1999 Excavations at the Kaplan-Hoover Bison Bonebed (5LR3953)

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ABSTRACT

Limited excavations at a Late Plains Archaic arroyo trap along the Cache la Poudre River near Windsor in northern Colorado have exposed the remains of an estimated 200 bison. The bonebed was uncovered during construction activities, which removed an estimated 4 m of sediment from above the upper surface of the bonebed. Partial excavation of an 18.5 m² cross-sectional portion of the arroyo has produced an assemblage of over 4000 bison bones. An AMS date on wood charcoal and a standard radiometric age from bone collagen provided statistically similar dates and yield an averaged uncalibrated radiocarbon age of 2724±35 RCYBP. The number of stone tools recovered is low, with only nine corner-notched projectile points and point fragments, several scrapers and flake tools, and over 120 resharpening flakes. Patterns of mandibular molar eruption and wear indicate a single early fall kill. Human utilization of many of the carcasses was limited, with very few of the marrow bones fractured or removed from the kill site. Based on skeletal element counts, the carcass segments most frequently taken from the kill were rib slabs, thoracic vertebrae, scapulae, femora, and lumbar-sacral units. Cutmark frequencies support this interpretation. The most common locations for butchering marks are on the thoracic spines, rib blades, and mandibular symphyses. After humans abandoned the site, carnivores extensively modified the remaining carcass segments. Subsequent burial of the bonebed included fluvial transport and re-orientation of many of the bones within the old arroyo. The project has emphasized incorporating public interaction and education into the research program.

Keywords: Bison hunting; bonebeds; central High Plains; Late Plains Archaic; taphonomy.

Bison hunting has traditionally been seen as one of the key components of aboriginal life on the North American Plains. For example, Wissler defined a "bison area," whose inhabitants he described "as Buffalo Indians, and no characterization could be more exact" (Wissler 1922:6). The excavation and analysis of bison bonebeds has been one of the hallmarks of northern Plains archaeology (Brown 1932; Kehoe 1967; Wheat 1972; Frison 1974). Despite this, archaeological evidence of post-Paleoindian human use of bison is limited in large areas of the Plains. Specifically, few Archaic or Late Prehistoric kill and/or processing sites have been intensively investigated in the Dakotas, Nebraska, Kansas, or Colorado. This paper gives preliminary results on research at a large, Late Archaic arroyo trap in northern Colorado. Our investigations are limited to an extensive test excavation of the bonebed. Current plans call for an additional five years of fieldwork and analysis. Initial results suggest that this site provides significant information about Archaic bison hunting on the central High Plains and warrants a preliminary interim publication. While we present a number

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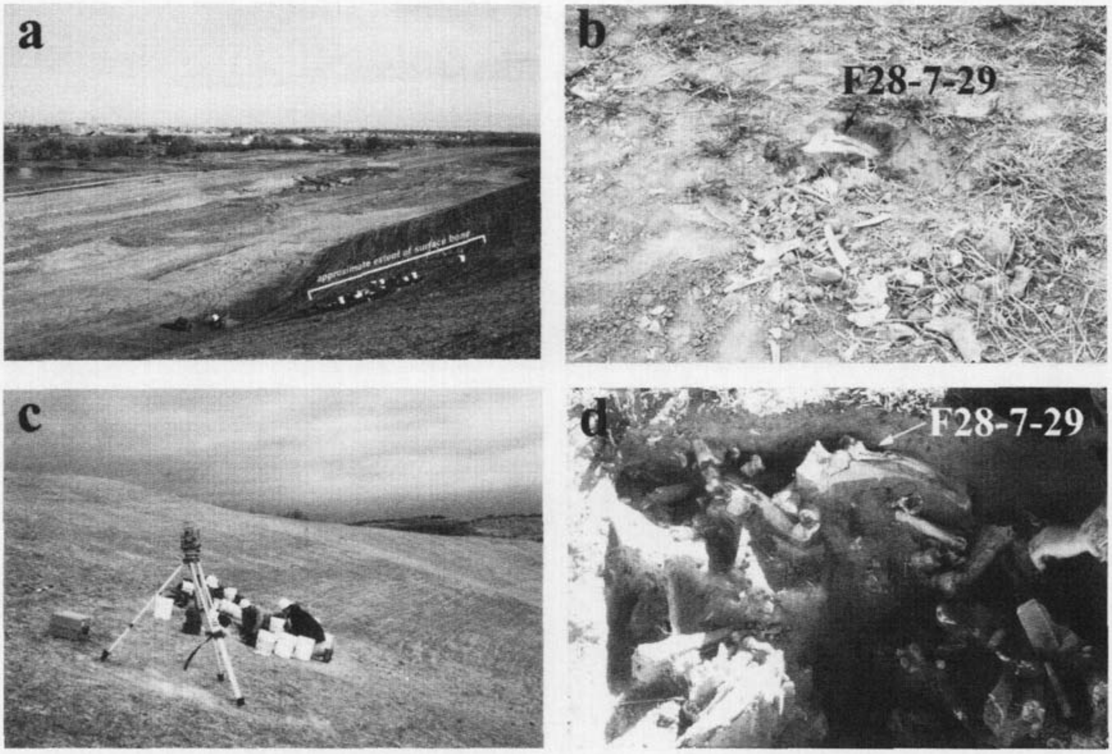

Figure 1. Initial investigations at the Kaplan-Hoover bonebed in 1997: (a) view to the east of construction area and bonebed location; (b) scattered bison bone on bladed surface; (c) test excavations (view to west); (d) bones uncovered in initial test units (view to the south – note the same radius-ulna exposed in 1b and 1d).

of initial interpretations, it should be stressed that these are closer to research questions to guide further investigations at the site than to final conclusions on Archaic bison utilization on the Colorado Plains.

Construction work associated with a large housing development project west of Windsor, Colorado, included cutting into terraces that form bluffs along the Cache la Poudre River, both for landscaping and to raise the level of the adjacent floodplain for house construction (Figure 1a). In late summer 1997, work on a north-facing slope cut into a bone deposit. After construction was completed and the slope had been reseeded, the site was brought to the attention of the Department of Anthropology at Colorado State University.[1] An initial visit to the site indicated that a linear north-south trending strip of well-preserved bison bones approximately 15 m long was exposed along the recently modified slope (Figure 1b). Although no stone tools were observed, a thoracic vertebra on the surface exhibited a series of cut marks along the dorsal spine.

The site is located in Larimer County, Colorado at an elevation of 1475 m. The current channels of the Cache la Poudre and Fossil Creek are about 800 m north of and 20 m lower than the bonebed. The floodplain has been heavily modified in the last 30 years by gravel quarrying and agriculture. The leveling and recontouring associated with the recent housing development (Figure 2, top) exposed the extremely friable upper members of the Upper Cretaceous Pierre shale bedrock along much of the slope (Figure 2, bottom). Given the bedrock exposure, it appeared that the Holocene fill containing the bone was restricted to an area of no more than 10 m east-west and an undetermined north-south dimension. Based on differences in elevations before and after the construction, it appears that approximately 4 m of sediments were removed from above the bonebed (Figure 2, bottom). Although a south-trending swale was present, there seems to have been little or no evidence of the buried arroyo on the surface, and it is unlikely that any portion of the site was exposed prior to construction.

In October 1997 a grid system was established, a contour map of the present site surface was created and surface bones were mapped and collected. Two m^2 test units were excavated by removing sediments from 50 x 50 cm quadrants in 5-cm arbitrary excavation levels (Figures 1c and 3). Bedrock was encountered within the first 5 cm in the easternmost unit (F28-7) and in situ bone, including several crania and articulated vertebral segments, was uncovered with depth below the surface increasing to the west (Figure 1d). The test units indicated

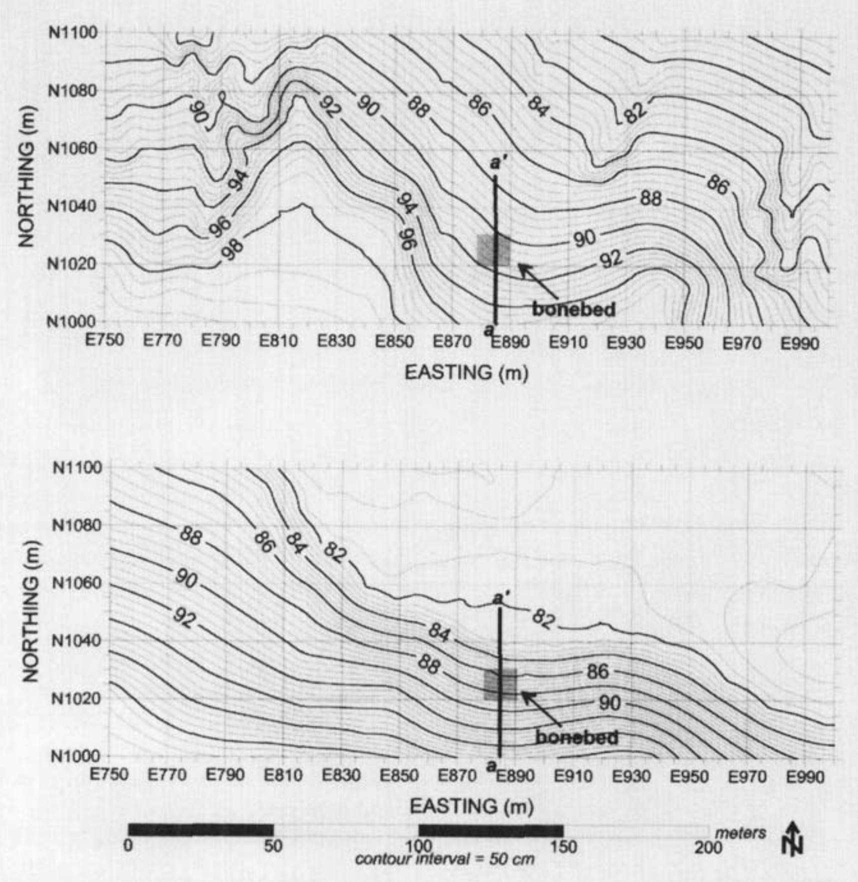

Figure 2. Kaplan-Hoover site area: (top) before housing development construction, and (bottom) after landscaping of terrace surface (a and a' are endpoints of cross-sectional view). The slope on which the bonebed is located was cut to grade for landscaping contours and the level area to the north was filled for housing construction. Horizontal coordinates and elevations reference the primary site datum.

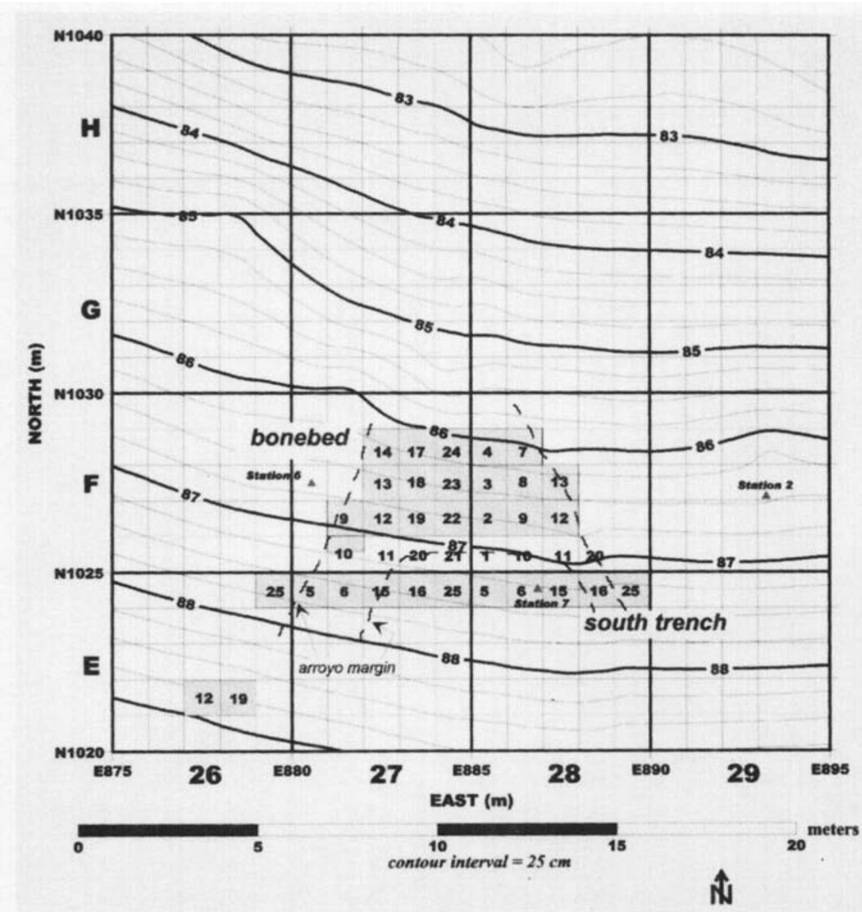

Figure 3. Locations of test and excavation units at the Kaplan-Hoover site (1997-January 2000).

season. Excavations for eight weeks from May-July, 1998, delineated the eastern and western margins of the paleoarroyo (Figure 4c), exposed the upper surface of the bonebed (Figure 4b), and began documentation and removal of bones from an 18 m^2 area (Figure 3). By the end of the summer field session, it was clear that the bonebed was at least a meter thick in the center of the arroyo and contained a complex mix of disarticulated bones, bone fragments, and articulated skeletal units. The bonebed was neither small nor simple.

Excavations with small crews continued throughout the winter until trenching and road construction

that a substantial bonebed remained in situ and arrangements were made for part of the 8-week Colorado State University (CSU) summer field school to conduct excavations. Excavations began in May 1998 and have been ongoing, although not full time. It is anticipated that fieldwork will continue for the next five years. The present report is a preliminary description of work in progress at the Kaplan-Hoover site.[2]

1998-1999 EXCAVATIONS

To protect the bonebed from the weather and also to provide limited security, a 6x10 m portable structure was placed over the central bonebed area at the beginning of the 1998 field season (Figure 4a). We initially expected fewer than 30 animals in a relatively simple bonebed, which we could probably completely excavate during a single field

stopped work on the bonebed in late April 1999. Scheduling conflicts prohibited fieldwork that summer. After discussions with the developer, an additional 11 m^2 trench was opened to the south of the main bonebed excavations (Figure 3, South Trench) in order to set the excavation enclosure deeper into the hill slope and provide a more stable, less obstrusive structure in which to conduct longer-term research. With the exceptions of the eastern meter and the western three meters, excavation of this trench uncovered north-sloping bedrock. These excavations indicate that the main bonebed is constrained at its southern end by either the knickpoint or a plunge pool in the paleoarroyo. Narrow tributary channels containing bone extend for an undetermined distance to the southwest and southeast of the exposed

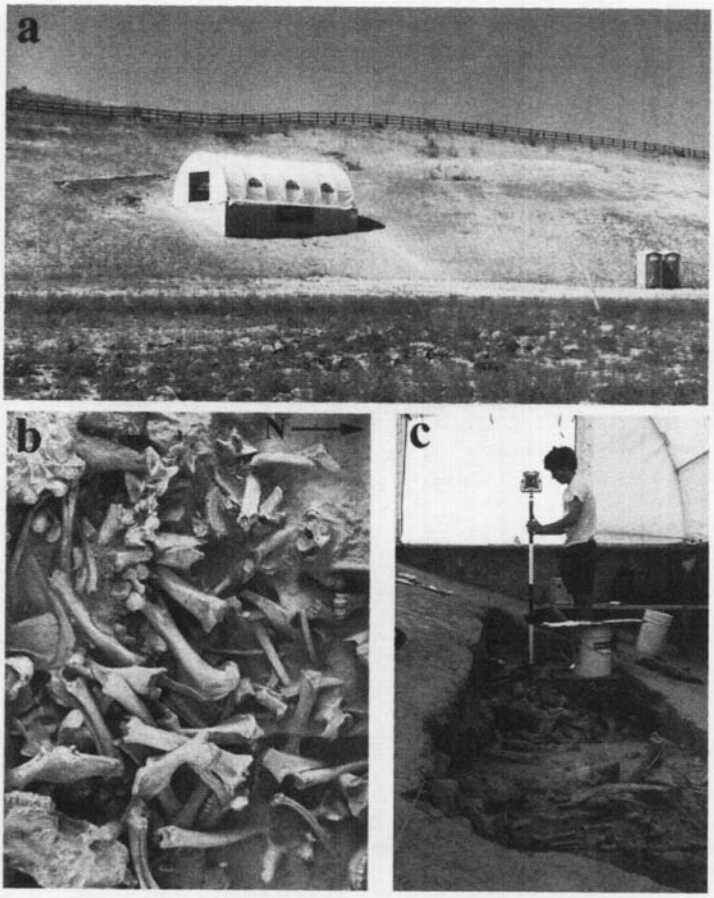

Figure 4. 1998 excavations at the Kaplan-Hoover site: (a) portable structure over central portions of the bonebed, view to the southwest (present ground surface heavily modified by construction – the original ground surface was approximately at the same elevation as the top of the bonebed enclosure); (b) upper surface of bonebed exposed in the central portions of the arroyo; (c) mapping bones along the western edge of the paleoarroyo.

bonebed (Figure 3). The southwestern tributary is the more substantial and contains the most bone. It is unknown whether the bison were herded into the arroyo from the Poudre floodplain to the north, or were driven over the edge of the higher terrace into the arroyo from the south.

Excavation Methods and Field Documentation

Basic field methods and documentation protocols used at Kaplan-Hoover are similar to those used at several other recently investigated bonebeds (e.g., Frison 1996; Todd and Rapson 1999). Students who participated in the 1998 CSU field school used the same basic documentation system (see Todd 1987c) at the Kaplan-Hoover, Hudson-Meng (Nebraska), and Vore (Wyoming) sites. That same year, excavations at the Folsom type site in New Mexico (Meltzer et al. 1998) also used a similar field documentation system. Thus, both site-specific information and data that will facilitate intersite comparisons are being collected. All items (bones, chipped stone, unmodified rocks, sediments for screening, charcoal samples, etc.) removed from a meter square are assigned a sequential number, point provenienced using an EDM total station, and documented using a standard set of procedures and descriptive codes. For more detailed description of the basic field data collection protocol, and additional data sets as they become available, see http://lamar.colostate.edu/~lctodd/5lr3953.htm.

As of January 1, 2000, 8454 items had been documented at the site and entered into the site database. In addition to the bison bones listed in Table 1, and the chipped stone discussed below, this total includes: 97 charcoal samples, 865 matrix samples from screening, 38 pollen-phytolith-sediment samples, 1165 unmodified stones, and a variety of unidentified bone fragments (most are probably bison). Non-bison bones are extremely rare: only five fragments of deer-pronghorn-sheep sized bones, 11 rodent bones, and one bird bone.

Classes and Public Education

The Kaplan-Hoover site is about 12 miles south of Fort Collins and Colorado State University. Given this location, the site has been ideal for both teaching university classes and for giving tours and workshops for school and public groups. University classes have included the 1998 archaeological

Table 1. Summary of bison bones from the Kaplan-Hoover site (5LR3953) 1997-April 1999. For a more detailed description of bone codes, see http://lamar.colostate.edu/~lctodd/coding.htm.

ELEMENT	NISP[a]	MNE[b]	MAU[c]	MAU%[d]
cranium CRN	160	44	44.0	100.0
mandible MR	164	61	30.5	69.3
hyoid HY	24	13	6.5	14.8
atlas AT	30	29	29.0	65.9
axis AX	31	25	25.0	56.8
cervical CE	212	115	23.0	52.3
thoracic TH	268	121	8.6	19.6
lumbar LM	150	84	16.8	38.2
sacrum SAC	24	19	19.0	43.2
caudal CA	26	22	1.5	3.3
ribs RB	731	193	6.9	15.7
costal cartilage CS	6	2	0.1	0.3
scapula SC	42	27	13.5	30.7
humerus HM	71	-	-	-
proximal humerus HMPR	-	11	5.5	12.5
distal humerus HMDS	-	61	30.5	69.3
radius RD	71	-	-	-
proximal radius RDPR	-	56	28.0	63.6
distal radius RDDS	-	57	28.5	64.8
ulna UL	76	53	26.5	60.2
radial carpal CPR	47	47	23.5	53.4
intermediate carpal CPI	49	49	24.5	55.7
ulnar carpal CPU	39	39	19.5	44.3
fused 2nd and 3rd carpal CPS	54	54	27.0	61.4
4th carpal CPF	46	46	23.0	52.3
accessory carpal CPA	14	14	7.0	15.9
metacarpal MC	82	-	-	-
proximal metacarpal MCPR	-	67	33.5	76.1
distal metacarpal MCDS	-	67	33.5	76.1
5th metacarpal MCF	14	13	6.5	14.8
os coxae IM	67	52	26.0	59.1
femur FM	78	-	-	-
proximal femur FMPR	-	33	16.5	37.5
distal femur FMDS	-	26	13.0	29.5
patella PT	15	15	7.5	17.0
tibia TA	115	-	-	-
proximal tibia TAPR	-	54	27.0	61.4
distal tibia TADS	-	82	41.0	93.2
lateral malleolus LTM	53	53	26.5	60.2
talus AS	77	77	38.5	87.5
calcaneus CL	96	78	39.0	88.6
fused central and 4th tarsal TRC	78	75	37.5	85.2
1st tarsal TRF	22	22	11.0	25.0
fused 2nd and 3rd tarsal TRS	59	59	29.5	67.0
metatarsal MT	95	-	-	-
proximal metatarsal MTPR	-	77	38.5	87.5
distal metatarsal MTDS	-	73	36.5	83.0
2nd metatarsal MTS	17	17	8.5	19.3
1st phalanx PHF	255	241	30.1	68.5
2nd phalanx PHS	204	201	25.1	57.1
3rd phalanx PHT	177	171	21.4	48.6
proximal sesamoid SEP	106	106	6.6	15.1
distal sesamoid SED	66	66	8.3	18.8
dew claw DC	17	17	2.1	4.8

[a] Number of Identified Specimens
[b] Minimum Number of Elements
[c] Minimum Animal Units
[d] Percentage MAU

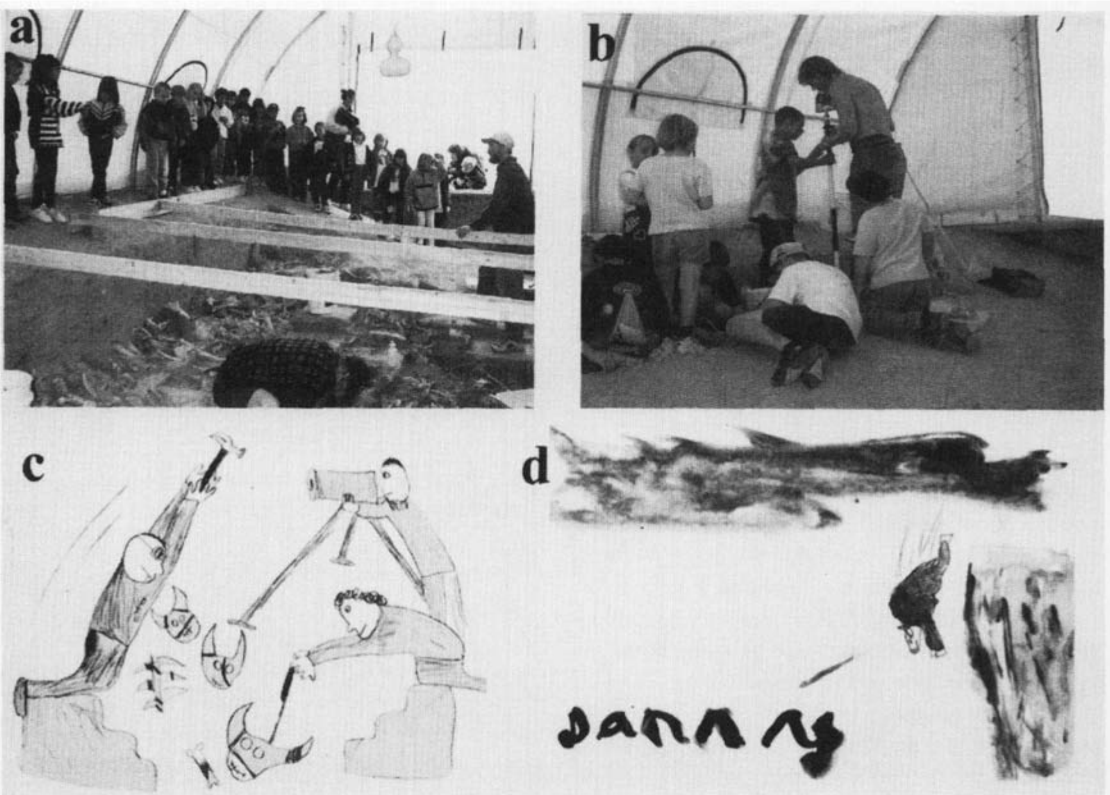

Figure 5. School group tours at Kaplan-Hoover: (a) question and answer session; (b) hands-on exercises; (c) child's interpretation of use of EDM (hammer use is actually *not* part of the bonebed excavation); (d) a young visitor's view of a bison kill.

field school and upper-level undergraduate practicum classes during both semesters of the 1998-1999 and 1999-2000 academic years. This has been an excellent opportunity to introduce a variety of students to archaeological field and laboratory research. Student research projects have been a major component of our investigations of the site. In addition to term papers, a number of these projects were prepared for presentation at the 57th Plains Anthropological Conference (Byerly 1999; Burnett 1999a, 1999b; Grutt 1999; Hurtado et al. 1999; Hurtado and Todd 1999; Larson 1999; Slessman and Gantt 1999; Walker and Egeland 1999; Wallick 1999; Wann and Todd 1999). We have also incorporated weekend tours of the site into several of our other archaeological lecture classes, providing students from a wide range of academic disciplines who have had at least some firsthand experience with archaeological research.

In addition to the university classes, over the last several years more than 2000 grade school, middle school, and high school students from Windsor and Fort Collins have been given tours of the site and the laboratory (Figure 5). Depending on the size of groups and the time available, these tours are either lecture and question-answer presentations (Figure 5a) or hands-on activities (Figure 5b). While the younger students may take away an interesting set of perspectives on the site (Figures 5c, 5d), most are very interested in the specific activities at the site, area prehistory, and the science of archaeological research. Visits by the general public have also been common. In May 2000, the Fort Collins chapter of the Colorado Archaeological Society organized and advertised an open house at the site. Nearly 1500 people toured the site in a single day. All tours stress that: (1) documentation (context) is more important than discovery (artifacts); (2) archaeological sites have the potential to contribute to a wide range of paleoecological research questions; and (3) archaeological research and development and construction activities are not necessarily antagonistic endeavors. Cooperative arrangements are sometimes possible.

RADIOCARBON DATES AND ARTIFACTS

The first point found at the site (Figure 6: F28-7-1), before CSU excavations began, indicated a Late Plains Archaic (Frison 1991:194-211; Frison et al. 1996:22-26) age for the bonebed. Excavation has yielded additional artifacts and radiocarbon dates that substantiate this interpretation.

Radiocarbon Dates

Ninety-seven small charcoal fragments (average length = 9.5 mm) have been mapped in situ within the Kaplan-Hoover bonebed. These pieces are dispersed throughout the bones, and so far no discrete clusters or hearth features have been identified. It seems unlikely that fires would have been built within the confines of the paleoarroyo. Thus, the charcoal pieces in the bonebed probably washed in as the arroyo filled with sediments subsequent to the kill. Sources of such charcoal might include pieces from hearths built along the banks of the paleoarroyo and background pieces unrelated to the use of the arroyo as a bison trap. Because over 4 m of sediments have been removed from above the site (Figure 2, bottom), and the bonebed is contained in a small pocket of Holocene sediments within the paleoarroyo inset into bedrock, any remnants of possible arroyo margin hearths or processing areas in the immediate vicinity have been destroyed, and it is unlikely that intact hearths will be encountered. We have therefore chosen several of the individual chunks from the bonebed for AMS dating rather than aggregating a large number of pieces to get a sample large enough for standard radiometric dating. As research continues, we anticipate submitting a greater number of individual pieces to get a clearer idea of the range of charcoal ages.

Samples F27-13-102 and F27-24-248 are both portions of larger pieces of charcoal recorded in situ. F27-13-102 was a solid 21 mm long wood charcoal chunk from near the western edge of the bonebed. F27-24-248 was a segment of a 7 mm long, 3 mm diameter, extremely well preserved burned twig found in the bonebed almost exactly in the center of the paleoarroyo. No wood identification has yet been completed for either sample, but both archive segments and SEM photos of each are available. Both were AMS dated, and yielded significantly different age estimates of 2740±40 and 860±40 RCYBP (Table 2).

Sample F28-4-286 was a complete right bison metatarsal (air-dried weight = 303 g). The bone was unweathered (stage 1) with root etching covering less than 10% of the cortical surface. The marrow cavity was empty; no sediments had entered the interior of the bone. The metatarsal was part of a group of four bones in anatomical association (metatarsal and three tarsals) recovered near the center of the paleoarroyo. Collagen extracted from the metatarsal was dated by standard radiometric methods and yielded a conventional ^{14}C age of 2690±60 RCYBP with a calibrated age of 825 BC (Table 2). Given the date on this bone, we assume that the date of 860±40 RCYBP for charcoal sample F27-24-248 is considerably too young to have been associated with the kill event. The fragment of sample F27-13-102 dated to 2740±40 RCYBP may

Table 2. Radiocarbon dates from the Kaplan-Hoover bonebed.

Sample	Lab Number	Dating Method	Material	$\delta^{13}C$	Conventional ^{14}C Age (1 Sigma)	Intercept	Calibration 2 Sigma
F28-4-286[a]	Beta-125434	standard radiometric	bone collagen	-12.3	2690±60 BP	cal BC 825	cal BC 930-790
F27-13-102[b]	Beta-125435	AMS	charcoal	-26.4	2740±40 BP	cal BC 855	cal BC 940-815
F27-24-248[c]	Beta-125436	AMS	charcoal	-25.6	860±40 BP	cal AD 1205	cal AD 1045-1105 & cal AD 1115-1265

[a] north 1028.920 m, east 885.905 m, elevation 85.590 m
[b] north 1027.632 m, east 882.397 m, elevation 86.286 m
[c] north 1028.484 m, east 884.664 m, elevation 85.640 m

Table 3. Projectile points from Kaplan-Hoover (all measurements in mm).

Catalog Number	Portion	Max. Length	Max. Basal Width	Max. Blade Width	Max. Blade Length	Max. Basal Length	Max. Blade Thickness	Max. Basal Thickness	Neck Width	Material Type[a]	Weight (G)
E26-19-4	Blade	-----b	-----b	-----b	-----b	-----b	3.46	-----b	-----b	QT	1.8
E27-16-22	Complete	41.72	16.34	23.45	38.3	3.5	4.17	2.91	14.27	FT	3.1
E28-5-9	Complete	40.95	17.53	21.07	34.36	5.64	3.75	3.33	14.82	QT	3.1
F27-24-421	Base	-----b	12.81	16.77	-----b	5.11	3.77	2.95	10.31	QT?	1.3
F28-12-138	Blade	-----b	-----b	-----b	-----b	-----b	3.71	-----b	-----b	FT	1.4
F28-4-519	Complete	47.06	12.95	17.44	42.28	4.78	3.97	2.84	11.31	HV	2.6
F28-13-394	Base	-----b	16.08	18.89	-----b	5.4	4.56	3.43	11.33	FT	2.2
F28-7-1	Complete/ reworked	27.85	15.09	20.58	23.11	5.84	3.95	3.12	13.13	QT	2.4
F28-8-136	Nearly complete	40.01	11.57	17.79	34.03	4.98	3.43	3.24	10.48	HV?	2.2

a - Raw material types: FT, Flat Top; HV, Hartville; QT, quartzite.
b - broken, no measurement possible

have been the result of human actions associated with the bonebed.

Averaging (weighted) uncalibrated radiocarbon ages of the two most comparable dates (samples F28-4-286 [bone collagen] and F27-13-102 [wood charcoal]) gives a date of 2724±35 RCYBP, the current best estimate for the age of the site.

Projectile Points

Nine projectile points have been recovered, including seven with complete bases and two blades (Figure 6). Although this number is low given the estimated number of animals at Kaplan-Hoover, we have yet to uncover more than the upper portions of the bonebed in most areas of the site and anticipate that the artifact count will increase as we get deeper into the deposit. Typologically, the small sample is quite diverse. Several of the points are similar to those from comparably dated Yonkee sites from northern Wyoming and southern Montana (Figure 6:E28-8-136, F28-4-519, E26-19-4, F27-24-421, and F28-7-1), while others (e.g., E27-16-22 and F28-13-394) are not. An average neck width at the notches for the seven points with complete bases is 12.2 ± 1.8 mm. All of the points except F27-24-421 exhibit some basal grinding (Table 3). Excluding point F28-7-1, which has clearly been reworked, the average length of the four nearly complete points is 42.4 mm. Until a larger sample of projectile points is recovered, is seems premature to attempt typological classification of the assemblage.

Three of the points are made from Flattop chalcedony from northeastern Colorado, three may be from the Hartville Uplift in Wyoming, and the rest are fine-grained quartzites for which the source area is unknown (Table 3). Both of the Flattop points with complete bases (E27-16-22 and F28-13-394) are morphologically distinct from the rest of the as-

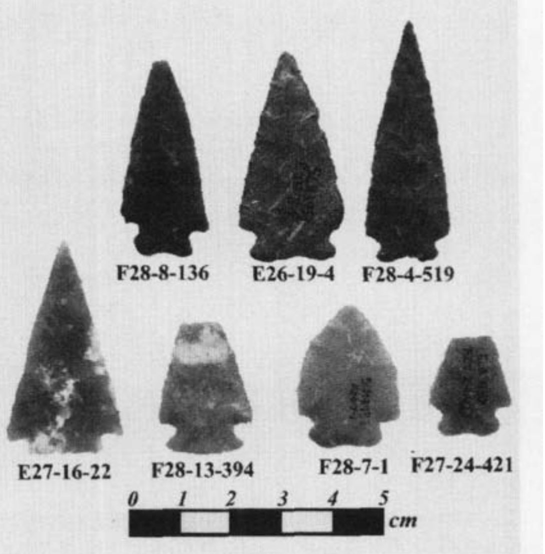

Figure 6. Late Plains Archaic projectile points from the Kaplan-Hoover bison bonebed.

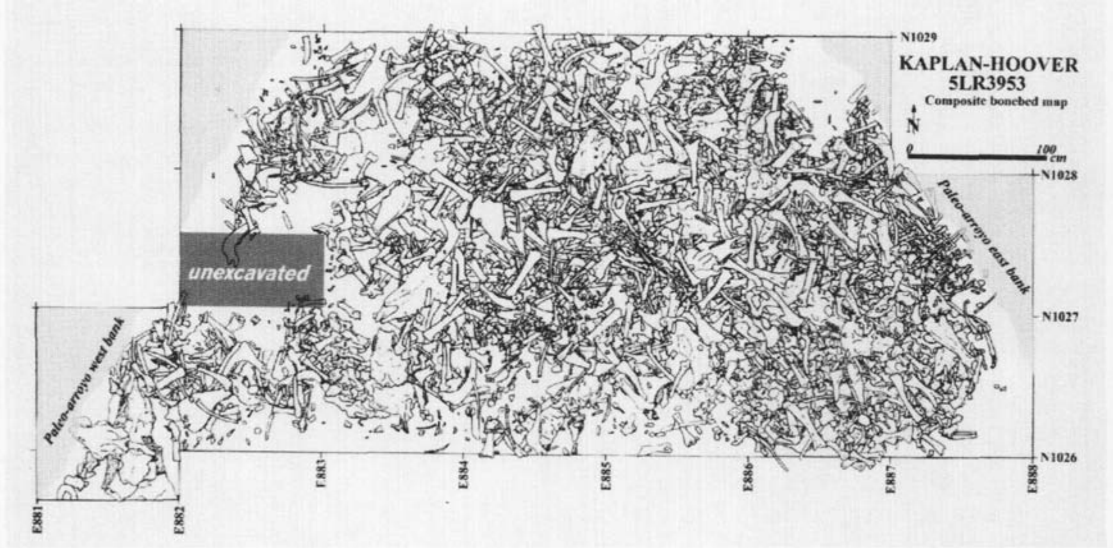

Figure 7. Composite map of all bones and bone fragments removed from the main excavation area within the Kaplan-Hoover paleoarroyo.

semblage, which includes several points made from Hartville Uplift raw materials. As more artifacts are recovered, relationships between point morphology and raw material type may prove interesting.

Other Chipped Stone Artifacts

The most common chipped stone item class from Kaplan-Hoover is unmodified debitage. Twenty-four small, unmodified flakes (average maximum length = 12.9 mm) have been recovered in situ in the bonebed. An additional 102 pieces of debitage, mostly small retouch flakes (average maximum length = 5.5 mm), have been recovered from waterscreening of 453 liters of sediment[3] (McKittick and Nordstrom 1999). The two largest flakes (E27-15-112 and F28-15-112; 60 and 42 mm respectively) both show edge modifications consistent with their use as butchering tools (flake scars less than 3 mm long) and are both Hartville chert. One endscraper and two quartzite biface fragments complete the chipped stone collection.

THE BISON BONEBED

Bison bones first called our attention to the site, and the extensive bonebed represents the single most dramatic feature of Kaplan-Hoover. In the bonebed excavation area (Figures 3 and 7), a dense accumulation of bone 4-5 m wide and at least 1 m thick fills the bottom of the paleoarroyo. Although over 4000 identifiable bones have been removed from the site (Figure 7), we have yet to reach the bottom of the arroyo, and the full depth of the deposit is as yet undetermined. Some of the bones on the upper surface and along the margins of the bonebed are moderately weathered, but bone preservation is generally excellent with cortical surface intact. The number and size of articulated bone groups seem to increase as we excavate deeper into the arroyo. If this pattern holds, as the bottom of the arroyo is reached, nearly complete skeletons will be present as at Olsen-Chubbuck (Wheat 1972). We also anticipate that other aspects of the site discussed here, such as degree of carnivore modification, cutmark frequency and placement, and bone condition will all be influenced by depth within the arroyo. At present, no stratigraphic separation within the bonebed is indicated. Based on the tightly grouped dental age cohorts, our current interpretation is that the site represents a single use of the arroyo.

Bone preservation is generally excellent with most bones showing few or no weathering cracks, indicating that burial took place soon after the animals' deaths. There do, however, seem to be differences in post-depositional deterioration in bone. In some areas of the site, bone is solid and stable, while in others it is much more fragile. Some

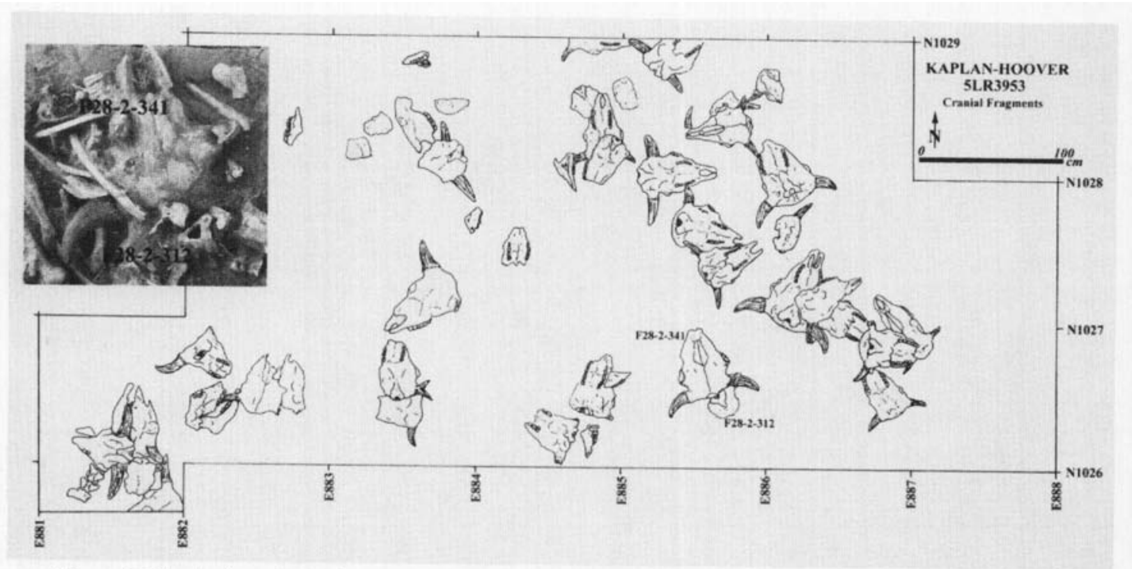

Figure 8. Distribution of complete crania and larger cranial fragments removed from the Kaplan-Hoover site.

of the differences in bone condition may be the result of percolation of water along the course of the paleoarroyo after it had been filled with sediment. As analysis continues, we will need to develop more reliable ways to differentiate subaerial weathering from subsurface diagenesis (Lyman and Fox 1989). Preliminary results of studies of bone surface area to weight ratios (Burnett 1999b; Hurtado et al. 1999) and use of image analysis software to quantify the degree of surface modification (Slessman and Gantt 1999) are encouraging and may provide some useful new zooarchaeological methods for bonebed analysis.

Although laboratory analysis has begun on the sample bone removed from the site, and most has been washed, numbered and sorted by skeletal element, additional documentation must be completed before we can make any final statements on the site. This description is based on laboratory examination of samples of the bones and on the basic data on bone descriptions recorded in the field. As more bones are removed and more time is spent in the laboratory, the finer details of the following discussion will no doubt change, although the more general interpretations should hold.

Minimum Number of Animals

At present, the total number of animals represented at the site can only be roughly estimated. The 44 excavated crania (Table 1) represent the best current minimum number of individual (MNI) estimate for the excavated portions of the site (Figure 8). Most of the crania are complete. On some of the more poorly preserved, the horn cores are partially deteriorated and are extremely soft and fragile. The count of 44 is clearly an extremely low estimate since we have yet to reach the bottom of the arroyo. Nearly as many crania are now exposed in the bonebed as have already been removed. Based on the frequency of crania per meter square and estimates of the amount of bone remaining in the arroyo, we estimate that as many as 170 crania may remain within the excavation area currently being studied (Figure 7). The dense bone continues for at least another meter to the south and perhaps 3-4 meters north. Given these considerations, we estimate more than 200 bison in the Kaplan-Hoover arroyo.

Skeletal Element Frequency

The identified bison bones from Kaplan-Hoover are summarized in Table 1. Obviously, as with the MNI estimates, these data will change as research continues. These counts are based primarily on identification and coding of bones in the field, although for some of the skeletal elements field identifications have been checked in the laboratory. The number of identified specimens (NISP) column (Table 1) tabulates total number of all fragments recorded. For the long bones (humeri, radius-ulnae, metapodials, femora, and tibias), NISP values are listed only for the skeletal elements and not for the proximal and distal portions.

The minimum number of elements (MNE) column represents our evaluation of the various fragments included in the NISP counts in terms of how many individual bones of that type are represented in the collection. All long bones have MNE values listed for their proximal and distal ends since a number of processes can create differences in the values of long bone ends due to differences in bone density (Brain 1980; Binford 1981; Kreutzer 1992, 1996). Minimum animal unit (MAU) values (Binford 1984) are derived by dividing the MNE counts by the total number of that skeletal element in a complete skeleton. For example, since each skeleton has only a single cranium, the MNE of 44 (Table 1) for Kaplan-Hoover is divided by 1 for an MAU value of 44; since there are two mandibles in a bison skeleton, the MNE count of 61 is divided by 2, yielding an MAU of 30.5; and since there are a total of 16 proximal sesamoids, the MAU for proximal sesamoids is 6.6 (106/16).

MAU counts are further modified by relating the values of all bones in the assemblage as percentages of frequency of the bone with the greatest MAU value. For this tabulation of Kaplan-Hoover bones, the crania have the highest MAU count; therefore they have an MAU% of 100 (Table 1). Mandibles have an MAU% of 69.3 (30.5 is 69.3% of 44) and proximal sesamoids have an MAU% value of 15.1 (6.6 is 15.1% of 44).

The relative frequencies of parts of the Kaplan-Hoover bison skeletons are illustrated in Figure 9. The most common bones (MAU%≥75) are the crania, metapodials, distal tibiae, and tarsals. Heads and lower limbs are generally low utility portions of a carcass that would be expected to be left at a kill (Binford 1978; Emerson 1993; White 1952, 1953, 1954). A second group of well represented bones (MAU% values between 50-74) includes the mandibles, cervicals, distal humeri, radius-ulnae, carpals, first and second phalanges, os coxae, and proximal tibias (Figure 9). This is an interesting group since it includes all the upper limb bones except the femur, which is the single highest general food utility bone in a bison carcass (Emerson 1993:Figure 8.2). This pattern of skeletal element

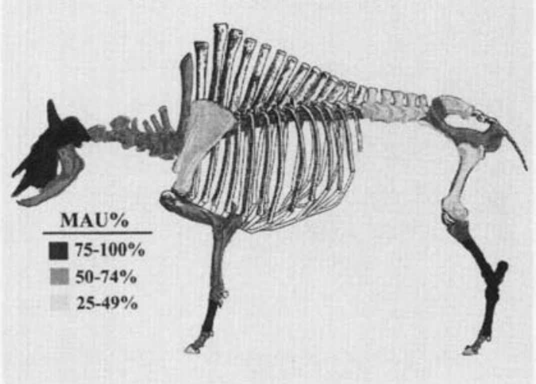

Figure 9. Relative frequencies of skeletal elements documented at the Kaplan-Hoover site 1997-1999 (unshaded elements have MAU% values <25%).

frequency suggests either that muscle masses were being stripped from most of the legs and the limb bones discarded at the kill, or that many of the legs (minus some femora) were being left at the site without processing. As discussed below, the paucity of cutmarks on the limb bones supports the second hypothesis.

In addition to the femur, other underrepresented bones (MAU% 25-49) include scapulae, lumbar vertebrae, sacra, and third phalanges. With the exception of the toes, all these bones are associated with large meat packages and may well have been removed for processing elsewhere. Third phalanges seem out of place in this group. Other things being equal, we would expect third phalanges to group with the other toe bones as part of the low food value lower legs. However, several lines of evidence suggest that the relative frequencies of toe bones are not primarily the result of human food-value mediated processing decisions. First, there are relatively high numbers of first phalanges (MAU%=68.5), a moderate number of second phalanges (MAU%=57.1), and a lower number of third phalanges (MAU%=48.6). These percentages suggest a preservational gradient corresponding with the density values of the phalanges (Kreutzer 1992). The first phalanges have the highest density, the seconds have moderate densities, and the thirds are the lowest density toes. This suggests that some bone density-dependent preservational processes (other than human selection) influenced the toe bone frequencies. A second observation on the phalanges provides a clue to the nature of at least one of these processes. Examination of samples of 100 each of first and third phalanges indicates that carnivore modification is more common on third phalanges (8%) than on the first phalanges (2%). As discussed below, this is consistent with interpretations that carnivore modification has resulted in a very high degree of destruction of some parts of the Kaplan-Hoover bison bones.

The final group (MAU%<25) includes bones that could well have been selected for removal from the bonebed because of the high food values of the associated soft tissues (ribs and thoracics), as well as bones whose lower frequencies probably resulted from other processes (sesamoids, proximal humeri, patellae, and caudal vertebrae). The ribs and thoracics both have very high food values in a bison carcass (Emerson 1993). The relative differences in frequencies of proximal and distal humeri (as well as the differences between the proximal and distal tibiae) may mean that, as with the phalanges, bone density may have played a significant role in producing the observed patterns. Evidence of carnivore modification (discussed below) supports this interpretation.

The skeletal element frequency data (Figure 9) suggest several hypotheses about the formation of the Kaplan-Hoover bonebed. First, processing seems to have focused on only the highest food utility portions of the carcasses, with an emphasis on acquiring large quantities of meat. Second, food products such as bone marrow and brains were given little attention. Third, after human processing was completed, the carcass remnants were used as food sources by other large scavengers such as wolves, coyotes, or bears. As discussed below, evidence from the preliminary cutmark and carnivore modification data provides partial support for each of these skeletal element frequency based interpretations.

Seasonality

Based on eruption and wear of mandibular molars, the Kaplan-Hoover bison died during the early fall (Walker and Egeland 1999). The youngest age cohort (Group 1) is well represented with 11 calf mandibles documented. Most of the first molars (70%) of the Kaplan-Hoover Group 1 mandibles are unworn, and the M_1s average 4.6 mm below the level of the dP_4s. The few M_1s with wear are lightly worn on facets I and II (see Frison 1991: Figure 5.8). This corresponds with the descriptions of tooth wear patterns from the Glenrock site (Reher 1970) and indicates an age at death of 0.4-0.5 years. Although the calving season at 3000 BP may have differed slightly from today's, a 0.4-0.5 year age at death of modern bison calves would indicate death in September-October.

Other age cohorts are also generally well represented. All the dental eruption and wear evidence indicate the site represents a single catastrophic mortality. This suggests that the bonebed was produced during a single event and is the result of one kill, which could have produced a very large quantity of meat and hides. Although temperatures would probably be cool, it is unlikely that nighttime temperatures would have been constantly below freezing. This implies that warm temperatures could have created definite time constraints for butchering and processing the carcasses.

Herd Composition and Body Size

Initial osteometric analysis has been conducted on four skeletal element groups: crania (Byerly 1999), calcanea (Burnett 1999b), humeri (Hurtado and Todd 1999), and carpals and tarsals with single centers of ossification (Hurtado et al. 1999). These data (Table 4) suggest that the Kaplan-Hoover herd contained skeletally mature (complete epiphyseal union; humerus and calcaneus data) cows and bulls. For the carpals and tarsals without any epiphyseal union, it may be possible to identify mature bulls, but not to separate the smaller animals, which are grouped as cows and calves (Morlan 1991).

Depending upon which bone is used, we estimate that 33-39% of the animals were bulls and 61-67% were cows (Table 4; crania, humeri and calcanea). For the carpals and tarsals that can be identified only as bull or cows/calves, the range is greater (31.3 to 50% bulls), which may be an indication of some differential removal of some carcass segments based on the animal's sex. Additional investigations are needed to evaluate whether bulls and cows were processed differently (Speth 1983). If Speth's fat-selection model or a preferential selection of cowhides were applicable to Late Plains

Archaic groups, the Kaplan-Hoover cow carcasses should have been exploited more fully than the bulls. However, the skeletal frequencies at Kaplan-Hoover indicate that processing may have emphasized meat procurement, with limited concern for fat acquisition. Osteometric analysis of the femora, which are the only limb bones that seem to have been selectively removed from the site, will be particularly interesting in evaluating the degree to which differential processing may have occurred.

Holocene diminution of bison has been well documented (e.g., Bedord 1974; McDonald 1981; Todd 1987c; Wilson 1978). Although both cranial and postcranial size reductions have been demonstrated, the most commonly cited data set for describing the temporal change is Wilson's (1978) horn core tip-to-tip pattern (e.g., Frison 1991:Figure 5.5). Data on postcranial osteometrics also confirm the same chronoclinal trend, but with some potentially interesting differences (Figure 10). In addition to the well-documented mid-Holocene size reduction (Wilson 1978), measurements of distal humeri suggest another, late Pleistocene to early Holocene rapid change in rate of body size reduction (Figure 10). Changing climate and foraging options were no doubt important factors in this change in bison size. In addition, as Wilson (1978:17) has suggested, early Holocene human predation may have significantly shaped the genetic structure of bison populations. One component of the early Holocene rapid size reduction may be these top-down processes. Advances in ancient DNA extraction and analysis from bison bonebeds (Chambers 1998; Grutt 1999) seem to offer the potential to begin untangling some of the complex sets of forces that have influenced recent bison evolution. Grutt's (1999) preliminary studies of the Kaplan-Hoover bison have begun with an investigation of the potential for autochthonous contamination[4] within a mass death setting by examining multiple DNA extractions from articulated skeletal element groups. Further analysis should reveal a clearer picture of the genetic structure of this bison deme, which can then be compared to both earlier and later populations as more sites are investigated.

Butchery

The skeletal element frequency data suggest some selective removal of carcass segments. If selective processing occurred, butchering evidence should not be uniformly distributed on the bones left at the site. Although any processing areas adjacent to the arroyo would have been removed by recent construction, leaving only the bones discarded in the arroyo bottom (or subsequently washed or rolled back into the arroyo), preliminary studies indicate differences in butchering intensity (Wann and Todd 1999). None of the crania recovered show any evidence of brain removal, although this is a common practice in Late Prehistoric kills. This is consistent with the general northern Plains Archaic pattern described by Frison (1998:152) where "the opening of bison brain cases appears not to have been common until late prehistoric times, and even then may reflect ritualistic instead of economic activities."

The front limb bones are relatively abundant in the bonebed. Of these, humeri, radii, and ulnae have been examined for cutmarks. A relatively large number of cutmarks would be expected if the meat had been stripped from the front legs and the limb bones discarded in the arroyo. Of the 37 humeri examined, none have cutmarks or impact fractures. Only 3 (6.7%) of the 45 radii and 1 (6.3%) of 16 ulnae exhibit cutmarks. One radius was fractured by multiple impacts on the cranial surface of the proximal end adjacent to the radial tuberosity. This is in marked contrast to the frequencies of cutmark and impact fractures on the Casper site (Frison 1974) front limb bones, where some on-site processing and muscle stripping took place. At Casper, 10.6% of the humeri had cutmarks and 18.1% were impact-fractured, and 9.1% and 20.7% of the radii were cut and impact-fractured respectively (Todd et al. 1997: Table 1). Since cortical surface condition is excellent at both sites, differences in frequency of cutmarks cannot be attributed to bone surface modifications or post-depositional processes. The extremely low number of cutmarks on the Kaplan-Hoover forelimb bones supports the interpretation that many of these carcass segments were abandoned in the arroyo without having been fully processed for either meat or marrow. The number of impact-fractured bones in the bonebed is very low and perhaps resulted from assessing the animal's nutritional condition (Binford 1978:187) rather than systematic marrow extraction.

Table 4. Osteometric esimates of herd composition.

Skeletal Element	Bulls		Cows		Cows/ Calves		Reference
	N	%	N	%	N	%	
crania (CRN)	7	38.9	11	61.1	--	--	Byerly 1999
humeri (HM)	9	37.5	15	62.5	--	--	Hurtado and Todd 1999
calcanea (CL)	14	32.6	29	67.4	--	--	Burnett 1999b
4th carpal (CPF)	4	40.0	--	--	6	60.0	Hurtado et al. 1999
radial carpal (CPR)	6	50.0	--	--	6	50.0	Hurtado et al. 1999
ulnar carpal (CPU)	6	42.9	--	--	8	57.1	Hurtado et al. 1999
fused 2nd & 3rd carpal (CPS)	5	31.3	--	--	11	68.8	Hurtado et al. 1999
fused central and 4th tarsal (TRC)	17	58.6	--	--	12	41.4	Hurtado et al. 1999
talus (AS)	9	36.0	--	--	16	64.0	Hurtado et al. 1999
lateral malleolus (LTM)	7	43.8	--	--	9	56.3	Hurtado et al. 1999

Preliminary investigation of butchery evidence on the vertebrae supporting the hump also supports the interpretation that this part of the Kaplan-Hoover carcasses received preferential attention. Some 35-40% of the most anterior hump vertebrae (7th cervical and 1st thoracic) exhibit cutmarks, usually along the dorsal spine near the neural arch. In addition, some of the dorsal spines of these anterior thoracics were snapped off above the cutmarks and presumably removed from the bonebed as part of the hump. The frequency of cutmarks decreases regularly as one moves rearward along the vertebral column with 25-35% of the 2nd-5th thoracics exhibiting cuts, 10-25% of the 6th-10th thoracics, and less than 10% of the caudalmost thoracics (11th-14th) having cutmarks.

The ribs also have relatively high %MNE cutmarked values, with 18% of the examined specimens having cutmarks. This supports the interpretation based on MAU% values (Figure 9) that ribs were preferentially processed and transported. Although mandibles do not seem to have been preferentially removed (Figure 9), nearly 10% of the specimens recovered have cutmarks near the symphyses, indicating tongue removal. Thus, the initial data indicate highly selective human use of the Kaplan-Hoover bison, with preference given to the humps, rib slabs, and tongues and with little emphasis on extraction of bone marrow (with the possible exception of the femur). Kaplan-Hoover differs from the more common pattern in which "articulated units or complete long bones

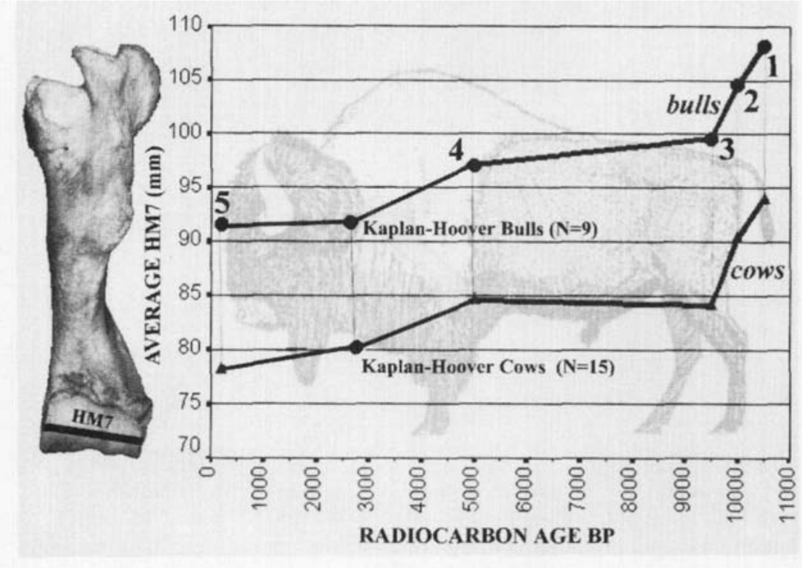

Figure 10. Holocene decrease in average size of humeral distal articular surface (HM7: Todd 1987b). Comparative data from Hofman and Todd (n.d.) are arranged into broad chronological groups: Group 1 (Folsom sites: Lipscomb, Lindenmeier, Folsom, 12 Mile Creek, Agate Basin Main Folsom level), Group 2 (Agate Basin/Hell Gap sites: Jones-Miller, Casper, Frazier), Group 3 (Cody Complex sites: Finley, Horner II, Frasca, Lamb Spring, Hudson-Meng), Group 4 (Early-Middle Archaic sites: Hawken, Scoggin), and Group 5 (Late Prehistoric and modern bison: River Bend, Vore, Glenrock, Bugas-Holding, Roberts, and comparative *Bison bison bison*).

are rare in Archaic camp or kill sites, indicating the intense breakdown and use of animal carcasses" (Frison 1998:152). Human use of the Kaplan-Hoover bison apparently left a large amount of useable meat in the arroyo to be consumed by other carnivores.

Carnivore Modification

The degree of carnivore modification of the Kaplan-Hoover bison bones is by far the most intense of any documented Plains bison kill site. Damage to the humeri is summarized in Figure 11. Because the values given in Figure 11 are based on the sample of bones from the uppermost portions of the bonebed, absolute frequencies will change as more field and laboratory work documents materials nearer the bottom of the old channel. Of the 45 humeri examined for degree of carnivore damage, only a single specimen is unmodified. The vast majority (80%) has had the entire proximal articular end removed. Cortical surface condition is good enough at Kaplan-Hoover to unambiguously assign these patterns of modification to carnivore tooth furrowing and pitting. Overall, 98.8% of the humeri from the site have some carnivore damage (Figure 11). This greatly exceeds the 37% carnivore modified humeri from the Casper site (Todd et al. 1997), the 28% from Jones-Miller (Todd 1987a), and the 17% from the Bugas-Holding site (Todd et al. 1997).

Other skeletal element groups have yet to be fully tabulated, but it appears that the rest of the assemblage also exhibits this extreme degree of carnivore damage. While we expect the amount of carnivore modification to decrease as we move deeper into the deposit, and the final percentages of carnivore modified bones to be less than the nearly universal damage shown by the humeri, the Kaplan-Hoover assemblage will provide a productive case study on the nature of human-carnivore interactions on the Plains. As debate about the role that carnivores should play in the management of contemporary "wild areas" increases, it becomes clearer that Plains archaeological sites provide data sets relevant for assessing the degree to which the remains of human predation have contributed to the natural diet of many carnivores.

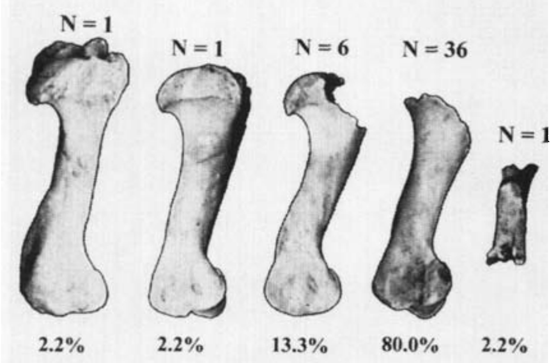

Figure 11. Stages of carnivore modification to Kaplan-Hoover humeri. The sequence from left to right progresses from a completely unmodified humerus to a shaft cylinder with both articular ends removed. The most common form of modification includes 36 specimens (80%) that have the entire proximal end removed to the deltoid tuberosity.

Many visitors to Kaplan-Hoover recognize this as a relevant contribution of archaeological research to their day-to-day interests and concerns.

Spatial Patterning

Spatial patterns within the paleoarroyo result from several processes. First, the way bison entered the channel and were slaughtered may have produced spatial differences in numbers of animals, herd composition, accessibility, and numbers of artifacts. Second, as the carcasses were being processed, some animals may have been intensively butchered and others minimally. Some segments of carcasses may have been systematically removed from the arroyo. Some bones may have been disarticulated and others left in anatomical position. Bones may have been stacked in some areas and scattered in others. Some may have been scattered along the sides of and banks of the arroyo and some left in the arroyo bottom. Once humans were finished at the kill, carnivorous mammals and birds pulled, dragged, and carried some bones away, creating new sets of spatial patterns derived from the distributions left by people. At about the same time the larger carnivores were using the site, invertebrate consumers began removing soft tissue, exposing once-articulated joints to possible scattering. Artifacts such as projectile points lodged in the flesh could move downward through the de-

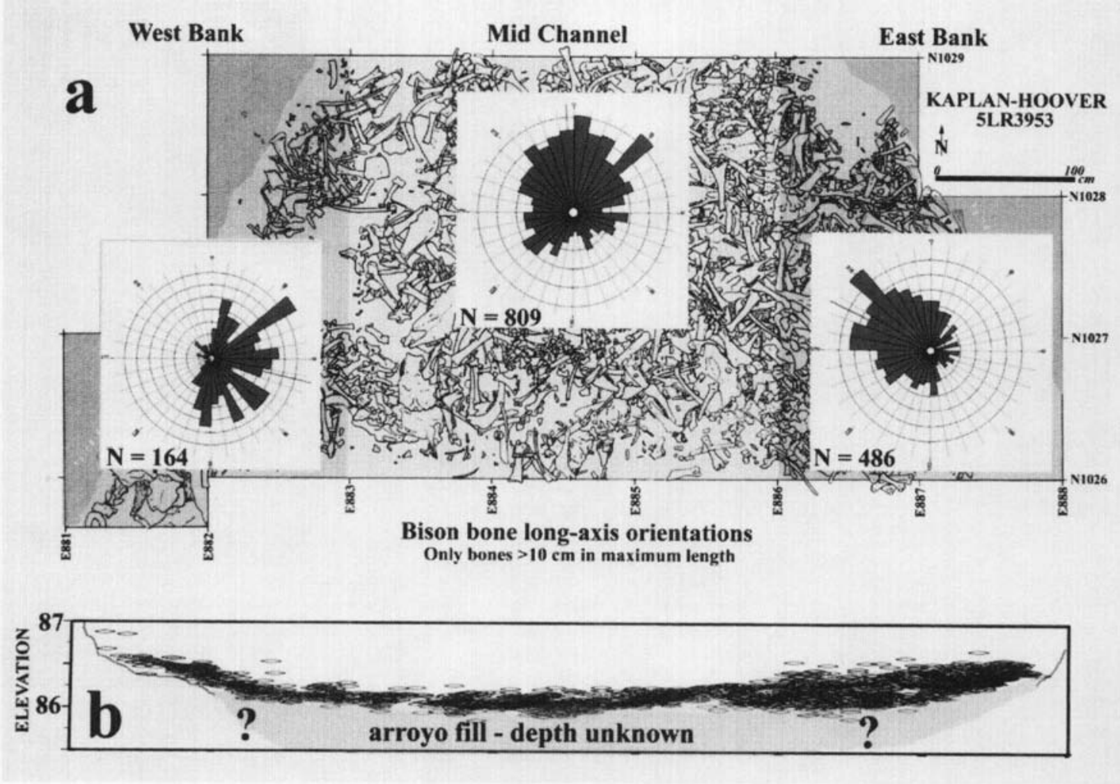

Figure 12. Orientations of long axes of bones >10 cm in maximum length in eastern, middle, and western portions of the Kaplan-Hoover paleoarroyo (a) and backplot of bone elevations between N1026 and N1027 (b).

posit as the tissue putrefied.

Finally, as the bonebed was being buried, water flowing down the channel and from the sides of the arroyo may have swept some materials downslope, carrying some of the lighter materials away, repositioning some of the heavier bones, aggregating some pieces and dispersing others. As sediment accumulated around the bones, their positions stabilized and the general spatial patterns documented through excavations became relatively fixed, with the exceptions of differences that can arise from post-depositional diagenesis or re-exposure. Excavations of the upper surface of the Kaplan-Hoover bonebed exposed a number of bones in unstable orientations (note the near-vertical tibia at the lower right of Figure 4c), suggesting that this last set of down channel movement may have played a significant role in creating the spatial patterns documented during excavations.

A complex, interacting set of taphonomic processes (transformations from bison herd to kill site to burial and eventually to excavation and laboratory analysis) may have contributed to the creation of the spatial configuration of bones. To distinguish these forces, we have begun with an examination of the process that would have occurred last in the sequence, downslope movement and transport within the arroyo, to evaluate how much it may have smudged or altered patterns produced by sequential actions of decay, carnivores, butchering, and slaughter. Several recent methodological studies examine bison bone transport potentials (Burnett 1999a; Larson 1999; Wallick 1999). Patterned long axis orientation is one of the clearest indicators of repositioning of bones, and also probable down-channel movement with some removal of smaller and lighter bones. The rose diagrams shown in Figure 12a represent three areas of the site that should have been subjected to different

Table 5. Summary of northern and central Plains 2000-3000-year-old Late Archaic bison kills (adapted from Niven 1997:Table 4.1).

Site	Date B.P.	Complex	Season of Death	Type of Kill	Bison MNI	Reference
Powers-Yonkee	3089±207 2680±55	Yonkee	unknown	arroyo	unknown	Bentzen 1962; Frison 1991
Powder River	2910±140	Yonkee	unknown	arroyo	unknown	Frison 1968
Kaplan-Hoover	2740±40 2690±60	unspecified (possible Yonkee)	fall	arroyo	44++	
Kobold	ca. 2700-1500	Yonkee	fall	jump	unknown	Frison 1970
Buffalo Creek	2600±200 2460±140	Yonkee	late winter-spring	arroyo	85	Bentzen 1966; Miller 1976; Niven 1997
Rourke	ca. 2500-1700	unspecified	late spring-early summer	arroyo	23	Zeimens et al. 1977, 1978; Niven and Hill 1998
Koepke	2290±80 2200±110 1760±120	unspecified, corner notched	fall	arroyo (?)	23	Fisher and Roll 1999
Ayers-Frazier	2180±150	unspecified	early winter	arroyo	14	Clark and Wilson 1980
Seline	2160±90	Pelican Lake	summer-fall	coulee	14	Roll et al. 1994
Fulton	2150±150	Pelican Lake	late winter - early summer	arroyo	14	Frison 1991; Niven 1997

directional forces as water moved down the paleoarroyo system. As illustrated in Figure 3, the main excavation area at Kaplan-Hoover is at the confluence of two smaller channels entering from the eastern and western margins of the bonebed. We therefore partitioned the data into three subsets based on these different positioning forces: (1) the central channel, which should be subjected primarily to down-channel (north) transport; (2) the eastern edge, which could have been influenced by both flow down the eastern tributary channel (toward the northwest) and down the eastern bank of the paleoarroyo; and (3) the western edge, which could have been acted upon by flow down both the western tributary and the west bank of the arroyo.

The observed orientation patterns (Figure 12a) and our expectations about directions of water flow down the arroyo channel correspond strongly. This supports the interpretation that, at least in the upper layers of the bonebed, fluvial transport has repositioned many of the bones, possibly obscuring some of the finer-grained spatial patterns produced by events earlier in the site's formational history. It is our impression (as yet not analytically demonstrable) that as we excavate deeper into the arroyo (Figure 12b) the number of articulated units increases, and the pattern of preferred long axis orientation is not as strong. This working model of site formation sees the upper layer of bone as a veneer of redeposited materials (from both up-channel and from the arroyo banks), while the deeper bones may retain their primary death and discard locations and hence maintain a larger number of spatial patterns referable to human processing activities. Hypotheses derived from this model will guide the future excavation and analysis program.

COMPARISONS AND CONCLUSIONS

The Kaplan-Hoover site will contribute a substantial body of information on Late Archaic bison and bison hunters on the Colorado Plains. Although bison have long been considered an important component of prehistoric diet in this area, most evidence on Archaic subsistence has been derived from rock shelters and open occupation sites (Cassells 1997). Five other similarly aged Archaic arroyo traps occur to the north (Table 5) of Kaplan-Hoover and several later arroyo kills are known in the southern Plains (Buehler 1997). Kaplan-Hoover's geographic location, between the northern and southern Plains arroyo traps, adds to its regional significance. Although arroyo trapping was a common Archaic hunting tactic, Kaplan-Hoover represents one of the largest single-event arroyo kills documented. The MNI value of 44 for Kaplan-Hoover listed in Table 5 is the number of animals actually represented in the collections from the site rather than the approximately 200 we estimate to be contained in the arroyo.[5] This MNI is above the average MNI of 30 for the other five sites in Table 5. It is also considerably larger than the average MNI of 14 for the five southern Plains Late Archaic sites summarized by Buehler (1997:Table 3).

In terms of processing intensity, the central High Plains Kaplan-Hoover site is more similar to the somewhat later southern Plains sites from Texas and Oklahoma (Buehler 1997) than it is to the northern Plains sites (Table 5). Frison's summary of northern Plains Late Archaic processing interpreted as "indicating the intense breakdown and use of animal carcasses" (Frison 1998:152) is in sharp contrast to the selective use of carcasses indicated by the upper portions of the Kaplan-Hoover bonebed. For the southern Plains, Buehler suggests a variable, but "general pattern of less than full use of the available resource" (1997:141). While marrow extraction did occur "it was not extensive, and was completely absent at some kills" (Buehler 1997:142). These differences make intuitive sense. One would expect that the quantities of foods needed from kills would be less on the southern Plains than on the northern Plains where winters are usually longer, harsher and colder, making seasonal availability of food resources less predictable. These apparent differences in butchering practices and subsistence strategies provide additional hypotheses about population densities, trading relationships, and food storage that will be investigated as we develop a more complete picture of the Kaplan-Hoover site.

The basic patterns documented in this report are clearly not the final word on the site. Many questions remain. How deep is the arroyo? What is the full range of variation in projectile point morphology? Are there spatial differences in processing intensity? Our current answers to these questions are little more than preliminary hypotheses requiring a great deal of additional investigation. For example, the MAU% values suggest that some of the femora may have been selectively removed from the bonebed. Therefore, we expect that as analysis of butchery patterns continues, cutmarks may be relatively common around the margin of the acetabulum.

In addition to anthropological research, Kaplan-Hoover has the potential to contribute much to our understanding of bison paleoecology. Excavations are producing a large collection of well-preserved bison bones, which are being donated to Colorado State University by the landowner. Methods for deriving a wide range of new data sets from such bonebeds are developing rapidly (e.g., Chambers 1998; Gadbury et al. 2000), and we will have the opportunity to incorporate several of these into our field research designs. For example, selection of bone for DNA analysis (Grutt 1999) or stable isotope studies (Jahren et al. 1998) can be incorporated into the field sampling techniques as part of an overall research design rather than applied only to extant collections.

The site also provides excellent opportunities for developing better communication with the general public about archaeology's goals and potentials. We've found that while many people come to the site with a basic interest in the past, they have little idea about what can be learned from archaeological excavations. One of the most frequent comments we hear from visitors is "I had no idea you could learn so much from a pile of bone!" It is one thing for archaeologists to talk about the importance of context and the fragile, irreplaceable nature of archaeological resources, but quite another to provide the public an opportunity to actually observe that our excavations are aimed at much more than collection of artifacts. Given the population growth and associated modifications to the Plains landscapes, it is particularly important for us to take every opportunity to let people know what can be learned from the archaeological record and to recognize that development plans and research goals need not be mutually exclusive endeavors.

NOTES

1. Russ Graham of the Denver Museum of Natural History first contacted us in September and we were again notified of the site's potential though the efforts of Ron

Myers, Karla Radee, and Bill Hawes in October 1997. Bill Hawes and Karla Radee had also found a heavily reworked Late Archaic projectile point associated with the bones (F28-7-1).

2. The site has been named Kaplan-Hoover in recognition of Les Kaplan and Gary Hoover, who have allowed excavations to be conducted in the midst of the River Ridge Development.

3. Only sediments from within the bonebed have been waterscreened. The sediments above the main bonebed level were dry-screened on site. The counts of debitage reported here from the waterscreened materials represent only the materials that have been sorted in the laboratory. Additional waterscreen samples still need to be documented and the debitage count will increase.

4. Grutt's study is evaluating the degree of homogeneity of multiple DNA samples extracted from several locations on articulated limb segments to asses whether the complex organic mixtures resulting from decay, putrefaction, and postdepositional leaching may have produced some cross-contamination from one carcass to another during bonebed formation. In order to make full use of ancient DNA studies we need to begin assessing some of the factors other than herd composition that could influence the results of samples derived from complex, multi-animal bonebeds.

5. The minimum number of individuals estimates for all sites listed in Table 7 probably differs considerably from the actual numbers killed at these sites. Erosion, partial excavation, and other factors have all removed evidence of some carcasses from each MNI count.

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