Bison Economies on the Late Prehistoric North American High Plains

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This paper explores variability in Late Prehistoric bison faunal assemblages from sites in western Kansas, NE Colorado, and central Nebraska (A.D. 1000–1350). Relationships among occupants of these sites have been a topic of debate for decades, and archaeologists have typically relied on ceramic typologies as a means of separating people, places, and phases. The resulting segregation of sites from different river drainages, however, makes it difficult to assess Late Prehistoric economic variability among related groups who exploited a range of natural environments. As we move away from classificatory and descriptive discussions of artifact assemblages and into considerations of past lived experiences, we may re-examine economic variability in the context of food choice, animal habitat, and shifting migrations of Plains farmers. This study is part of a larger project to establish baseline patterns of bison consumption and use through time among Late Prehistoric and Historical occupants of the North American High Plains. Zooarchaeological methods employed by archaeologists focused on farming communities often differ from methods employed by archaeologists trained on hunter-gatherer bonebeds. In order to facilitate comparisons and to speak to a wider audience about the interactions between hunter-gatherers and farmers and the intersections between hunting and gathering and farming, I argue for broader methodological research protocols that transcend the Plains and are applicable for studying animal use among a variety of middle-range societies.

Introduction

The historical residents of the North American Plains are well-known as big-game hunters who specialized in year-round bison hunting in the west and participated in seasonal bison hunts from horticultural villages in the east (Wedel and Frison 2001). Plains villagers from North Dakota to Oklahoma practiced a dual-economy subsistence strategy focused on bison meat and corn (Lehmer 2001). The extent to which this pattern extends into prehistoric times is not well understood. Archaeologists first working on the Plains in the 1930s uncritically accepted subsistence models based on 18th- and 19th-century Plains Indian economies of seasonal bison hunting excursions to supplement consumption of cultivated crops (Bell and Cape 1936; Strong 1935; Wedel 1934). Recently, archaeological evidence from the Central Plains has revealed a strong dependence on a wide variety of local wild plants and animals, and archaeologists have de-emphasized contributions of large game (Blakeslee 1999; Bozell 1995; Koch 2004). The present study contributes to this debate by investigating the archaeofauna from several sites on the western High Plains periphery that demonstrate strong evidence of bison hunting by Late Prehistoric residents and of transport of bison products to eastern farmsteads.

Although High Plains peoples probably practiced more generalized subsistence strategies than imagined in the 1930s, faunal inventories from several of these sites exhibit high percentages of bison bone. The presence of bison does not necessarily imply specialized bison hunting economies such as those recorded during the Early Historic period (Lehmer 2001; Reher and Frison 1980; Roper 1992; Wedel 1936), but neither should the dietary contribution of bison be minimized. To facilitate broad spatial comparisons, zooarchaeologists working with fauna from farmstead hamlets need data that can be used to address taxa diversity (Number of Identified Specimens [NISP], Minimum Number of Individuals [MNI]), butchery and transport of large-bodied mammals (Minimum Number of Elements [MNE], Minimal Animal Units [MAU]), and processing intensity (fragmentation rates and surface modification). Here, I argue against a strict division of cultural complexes according to subsistence strategies and advocate a broad comparative approach for investigating economic

diversity. High Plains occupants have been neglected in the wider taxonomies of the Central Plains tradition farmers to the east. The importance of bison for food and in exchange between western hunter-gatherers and eastern farmers can best be understood by addressing economic variability with data from the High Plains.

The methods described below expand traditional discussions of dietary choices to include animal procurement and transportation decisions, cooking methods, and butchering and processing techniques. This research offers additional means of addressing prehistoric contact among groups and regions that move beyond culture areas and stylistic attributes, exchange of luxury goods, and relationships between core and peripheral areas.

Late Prehistoric Subsistence and Economic Variability on the North American Plains

The High Plains, a section of the Great Plains physiographic province, is located on a transitional ecotone between tall grass prairies in the east and short grass plains in the west (Fenneman 1931). It is bordered on the west by the foothills of the Rocky Mountains and on the east by what archaeologists refer to culturally and geographically as the Central Plains. The archaeologically-defined Central Plains tradition dates to approximately A.D. 1000–1350 and is part of a larger regional horticultural pattern—the Plains Village pattern—that dominated the Northern and Central Plains between A.D. 900 and 1886 (Lehmer 1954; Wood 1998: 653). These Plains inhabitants lived in earth-lodge houses in semi-settled agricultural communities during an interval that spanned prehistoric and historical time periods. Five phases are grouped into the Central Plains tradition, extending spatially from the Iowa/Nebraska border to western Nebraska and Kansas (Roper 2006; Steinacher and Carlson 1998). The Upper Republican phase is the farthest west of these individually defined groups.

Both nomadic hunter-gatherer groups living on the western periphery of the High Plains and small-scale garden farmers occupying the Central Plains proper share certain diagnostic materials such as cord-marked, globular-shaped pottery vessels and triangular side-notched projectile points. Whether both groups should be classified as belonging to the Upper Republican phase or the Central Plains tradition is a matter of some debate (Blakeslee 2002; Roper 1995, in press; Scheiber 2006; Scheiber and Reher in press).

For the purposes of this paper, I make the distinction between house and non-house sites, between farmers and hunter-gatherers, and between the High Plains (west) and Central Plains (east). Residents of the house sites lived in small hamlets or farmsteads, suggesting less formal social organization than would be expected in larger villages such as those documented during the Early Historic period. I am using the terms hamlet and farmstead interchangeably, although some may argue that even the use of the term hamlet implies a level of social organization not present at these sites (Donna Roper, personal communication 2007).

Detailed studies of faunal remains are fairly standard components of archaeological analyses of Late Prehistoric (also called Middle Ceramic period) sites on the Central and High Plains (Bozell 1991; Koch 1995; Logan 1998; Scheiber 2005, 2006). These analyses demonstrate diverse resource exploitation (Blakeslee 1999; Bozell 1991, 1995; Brown 1982; Falk 1969; Johnson 1972; Watson 1996; Donna Roper, personal communication 1996) in what may be considered a generalized hunter-gatherer-farmer subsistence economy.

Summaries by Bozell (1991, 1995) and Roper (1990, 1995, 2002a) over the last 15 years provide good overall syntheses of Central Plains tradition subsistence practices. In large part reacting to researchers like William D. Strong (1935) and Waldo Wedel (1934, 1959) who emphasized the importance of bison for Late Prehistoric villagers and who proposed summer bison-hunting ventures modeled after contact period Plains Indians, Bozell and Roper concluded that bison were not a particularly important part of Central Plains villager subsistence, whether because of choice or availability. Bison bone in faunal assemblages probably did not represent communal hunting efforts and, more importantly, differed from subsistence models based on the bison-corn dual-economy of groups such as the Pawnee who later inhabited the area after A.D. 1600 (Roper 1992; Wedel 1936).

I contribute to this discussion by adding data from sites recently excavated in the western part of the study area: the Donovan site (5LO204) in NE Colorado and the Albert Bell site (14SD305) in western Kansas (FIG. 1). It may be true that models of extensive bison procurement based on Early Historic summer bison hunting (Lehmer 2001) are not perfect analogies for Late Prehistoric hunting and food procurement, but large quantities of bison bone at several archaeological sites attest to bison's economic importance. Although inventories of animal taxa from archaeological sites are indeed extensive, the contribution of bison for meat and tools has been minimized by the use of certain quantification measurements.

Late Prehistoric Faunal Assemblages on the Central and High Plains

The data for the following analysis come from five sites in Colorado, Kansas, and Nebraska (FIG. 1). All of these

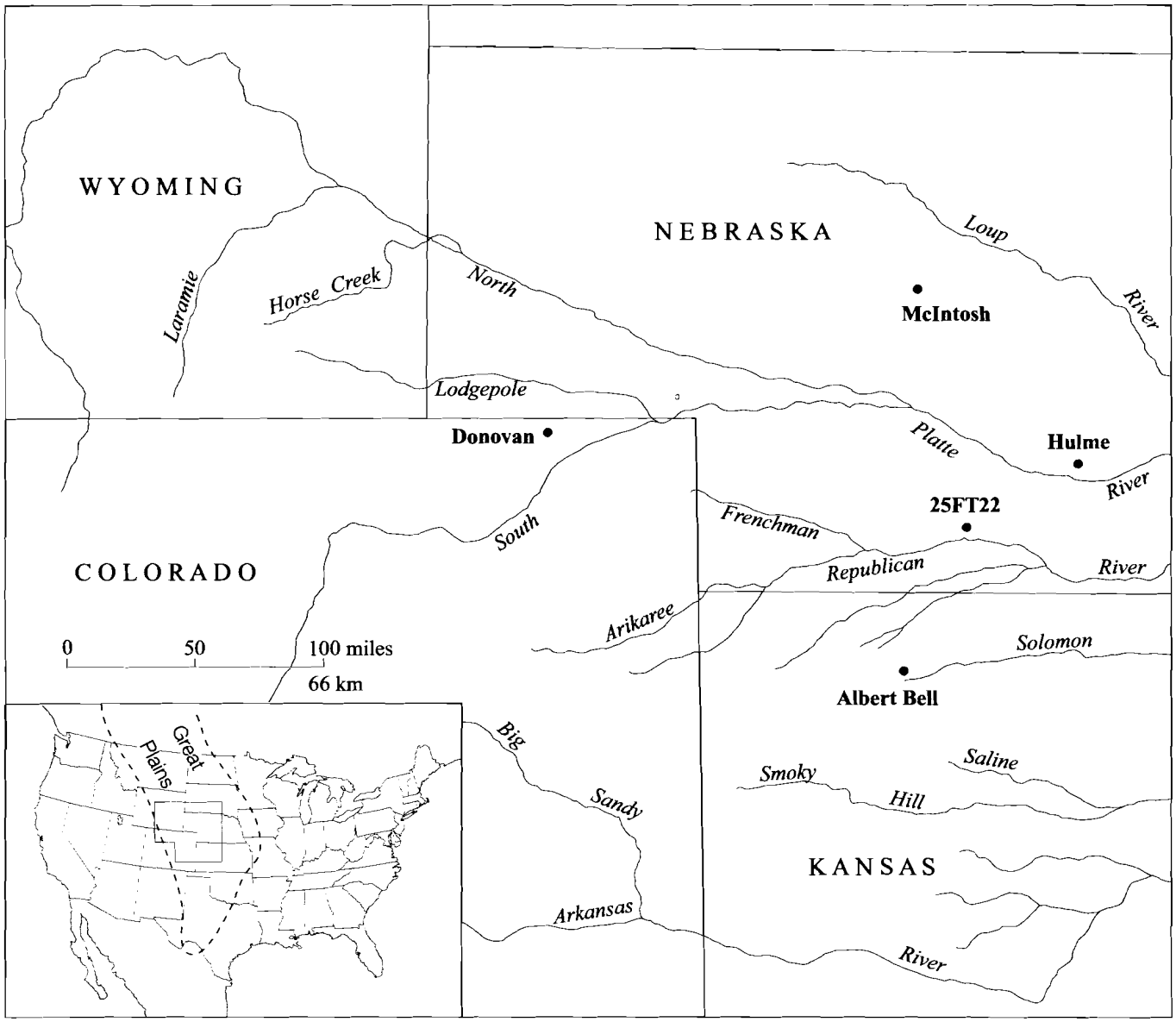

Figure 1. Map of study area on the western North American Plains, with relevant site locations and river drainages. Inset shows location of Plains and situates study area in North America.

sites were occupied by people we associate with material inventories of the Upper Republican phase of the Central Plains tradition, although not all groups may fit the classical definition of this phase (Roper in press). The primary focus of this paper is on recently collected data from the two sites on the western High Plains (the Donovan [FIG. 2] and Albert Bell sites). Available information from several other faunal assemblages is included for comparison.

The archaeofauna in the current study were recovered from several contexts, including hunting campsites, residential farmsteads, and interior house floors. Some of the faunal remains were concentrated in a restricted spatial area, such as those from the Donovan site, whereas others were excavated from numerous loci that crosscut several activity areas, as was the case at Albert Bell. Although the excavated area (number of square meters) and specific context may differ among samples, comparisons across contexts and site types are important because they allow the researcher to maximize basic primary quantification datasets while examining transportation decisions and butchering practices, which are not necessarily dependent on sample location (or, at least, the extent to which sample locations

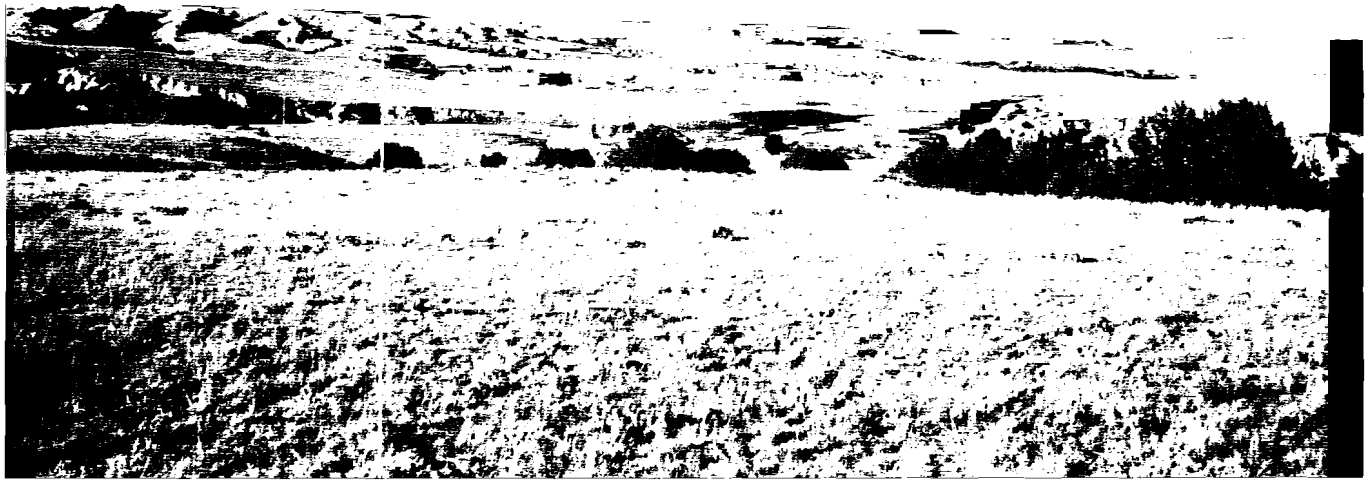

Figure 2. High Plains landscape, Lewis Canyon near the Donovan site, South Platte River drainage of NE Colorado. Photograph taken June, 1998, by Laura L. Scheiber.

may bias results is unknown). As always, a larger sample is preferable. In this study I use all available faunal data from the selected sites regardless of context, sample size, or recovery method. More specific intrasite comparisons of the distribution of fauna from these sites remain a goal of future research, as do more detailed comparisons by site context. For instance, the use of modern recovery techniques to investigate middens between houses at some of the farmsteads would provide particular insight.

The Donovan Site

The Donovan site (5LO204) is a multiple occupation bison processing site and hunting camp located in the South Platte River drainage of NE Colorado (FIG. 1) (Scheiber 2001, 2005; Scheiber and Reher in press). It has been excavated by the High Plains Archaeology project through the University of Wyoming since 1992. At least 11 Upper Republican levels are associated with the site, dated to between A.D. 1000 and 1300 (Scheiber and Reher in press). The levels represent different occupational events separated by sterile deposits. This site contains one of the best-preserved Late Holocene geoarchaeological signatures on the High Plains.

The fauna are characterized by highly fragmented bison bones with high frequencies of cutmarks and hammerstone impact marks (Scheiber 2001). Nearly all artifacts were point-plotted, and smaller items were screened through nested 1/4″ and 1/16″ water screens, enabling the recovery of tens of thousands of pieces of crushed bison bone and microfauna. Most of the materials in each level were deposited around several hearth features and ash piles, occasionally interspersed with limestone anvil stones. For this study, I examined the first and last occupational levels at the site. The first level (Cultural Level 9) dates to shortly after CAL A.D. 1000 (with radiocarbon dates of 970 ± 90 B.P. [Beta-76916] and 1020 ± 40 B.P. [SR-5464, CAMS-63095]). The last occupational level (Cultural Level 1) dates to between CAL A.D. 1240 and 1380 (with a radiocarbon date of 720 ± 40 B.P. [SR-5463, CAMS-63097] and an archaeomagnetic date of A.D. 1165–1400 [Col-

orado State Archaeomagnetic Laboratory 5LO204-2]) (Scheiber and Reher in press). These two occupations were chosen because they are so far the best studied and because they represent the beginning and the end of a sequence that spans several centuries at the site. The faunal sample from both levels was recovered from an area 2.5 m by 4 m, or 10 sq m.

The Albert Bell Site

The Albert Bell site (14SD305) is a farmstead located in the Museum Creek valley of western Kansas (FIG. 1). The presence of a lodge or house and an associated midden makes this site fairly typical of the traditionally defined Late Prehistoric Central Plains farmsteads. The site was excavated during two field seasons in 1990 and 2002 as part of the Kansas Archaeology Training Program (Roper 2002b). A single radiocarbon age determination is 710 ± 60 B.P. (Beta-179560) which calibrates to CAL A.D. 1270–1300. A total of 228 sq m were excavated, and artifacts were recovered in 1/4″ screens. Unlike other Upper Republican farmstead faunal assemblages, which often display a high degree of species diversity (Koch 2004; Donna Roper, personal communication 1996), the fauna from Albert Bell are primarily bison. Diagnostic signs of processing and cooking, such as burning, cutmarks, and impacts are largely absent.

McIntosh, Hulme, and 25FT22

For comparison, I examined available faunal data from three sites in central and western Nebraska (FIG. 1): McIntosh (25BW15) in the Nebraska Sand Hills (Koch 2004), Hulme (25HL28) on the edge of the Platte River drainage (Bozell 1991), and House 4 at site 25FT22 in the Medicine Creek area (all data for site 25FT22 were taken from an unpublished report edited by Donna Roper and submitted to the U. S. D. I. Bureau of Reclamation, Kansas-Nebraska Project Office). These sites are all considered residential farmsteads and exhibit classic examples of Late Prehistoric Plains Villager broad-spectrum faunal procurement strategies. For instance, McIntosh and 25FT22 are dominated by fish remains, while deer is the most common taxon represented at Hulme. Bison remains were also recovered from all three of these sites, in varying quantities. The faunal inventories from these sites are the most comprehensive and comparable to the data I have collected from more or less contemporaneous sites farther west.

Exploring Subsistence Economies

Four broad lines of evidence for exploring animal use among Late Prehistoric hunter-gatherer-farmers are considered. To address taxonomic abundance and prey diversity, I examine the NISP per taxa, the MNI per taxa, fragmentation rates, and relative dietary contributions. To explore issues of transport and procurement of bison, I consider body-part representation (MNE and MAU). Evidence for butchering and processing for marrow and bone grease are quantified through comparisons of cutmarks and impact marks, and spatial organization and intrasite patterning.

Taxonomic Abundance

Characterizing Upper Republican people of the Central Plains (and of the Central Plains tradition generally) as subsistence generalists is based on the great taxonomic diversity of faunal remains recovered from archaeological sites (Brown 1982; Falk 1969; Koch 1995, 2004; Koch, Nelson, and Bozell 1999; Manz and Blakeslee 1988; Watson 1996; Donna Roper, personal communication 1996). Blakeslee (1999) notes that the range of animal species found at Central Plains tradition sites is so broad that a list of species *not* found is more analytically useful.

The importance of bison hunting, especially long-distance hunting, once emphasized by archaeologists (Wedel 1986: 123–126; Wood 1971: 80–81), has recently been minimized in favor of considerations of localized hunting strategies (Bozell and Ludwickson 1998a: 132). Bison bone at these sites generally accounts for less than 16% of identified specimens (NISP) (Koch 1995; Mundell 1980), and more often comprises less than 2% of the identified assemblage (Blakeslee 1999; Bozell 1991; Brown 1982). Most of the Central Plains tradition sites do not have adequate samples of bison bones for effective comparative analyses (Christopher Widga, personal communication 1998), but what estimates there are seem to suggest that bison are almost always present in small numbers, ranging from one to four animals and sometimes more.

NUMBER OF IDENTIFIED SPECIMENS (NISP)

As expected, the sites considered here that are located farthest west on the shortgrass plains (Donovan and Albert Bell) are dominated by bison, which comprises at least 80% of the NISP in these faunal assemblages (TABLE 1). The amount of bison bone represented at McIntosh is much lower (only 16%), whereas bison is rare at Hulme (2%) and 25FT22 (1%). Fish remains comprise the largest number of specimens at both McIntosh (72%) and 25FT22 (93%), while deer are the dominant species at Hulme (48%).

While the diversity of animals at Donovan and Albert Bell is not as high as it is at other sites (suggesting a more specialized rather than broad-spectrum diet), the range of species recovered is similar to those recovered from Upper

Republican sites further east. Although the local availability of bison on the Central Plains is not known exactly, top-ranked (i.e., high return) species such as bison were certainly available on the High Plains to the west and this undoubtedly accounts for their higher quantities at sites on the western High Plains. Less bison bone could also result from more preservation and more dried meat, and does not necessarily mean that people were eating less of this food resource.

MINIMUM NUMBER OF INDIVIDUALS (MNI)

Considerations of the MNI minimize the contribution of large game animals from the western sites in particular. The number of individual bison is relatively small in comparison to the other identified taxa, especially in water-screened samples such as those from Donovan that are more likely to include small microfauna (TABLE 1). A total of seven bison have been identified in the Albert Bell assemblage, compared to four (Cultural Level 9) and six (Cultural Level 1) from Donovan and eight from McIntosh. Given differences in site activities (hunting camps versus residential hamlets), length of stay (several years versus a season), and sample sizes (i.e., number of meters excavated and where), this variation in the number of bison does not seem particularly significant. The occupants of each of these sites probably hunted buffalo in small-scale hunting parties. This may not be the case for Hulme and 25FT22, the sites that probably represent longer occupational events with few identified bison bones, although at least two bison are represented at each site. In no case, however, do we see hundreds of bison represented and evidence of large-scale communal hunting, as witnessed at classic Late Prehistoric bison kills in the Northwest Plains such as Big Goose Creek (Frison, Wilson, and Walker 1978), Piney Creek (Frison 1967), Glenrock (Frison 1970), Wardell (Frison 1973), and Vore (Reher and Frison 1980).

Fish account for the greatest percentage of taxa (MNI) at both McIntosh and 25FT22, whereas the number of identified birds is highest at Hulme. McIntosh is particularly interesting since people clearly had access to bison (MNI = 8), but also filleted over 120 fish. Explanations for this pattern may lie in food choice and availability, division of labor (i.e., children can fish more easily than hunt), seasonality (access to certain foods at certain times of year), and periodic food shortages. Fish would also have been profitable as a stable food resource.

FRAGMENTATION

Fragmentation rates for bison, expressed as the ratio of NISP to MNI, differ greatly from site to site, with rates from Albert Bell and Donovan two to six times higher than McIntosh, which in turn is three or more times higher than Hulme and 25FT22 (FIG. 3). For instance, the fragmentation rate for the first Donovan level is 428 identified fragments per individual animal, whereas at Hulme only 13 fragments were identified per animal.

What this means is that bison were much more intensely processed for marrow and bone grease at the Donovan site compared to all of the other sites (FIG. 4). This may be a result of transport of bison products from this site to eastern farmsteads. On the other side of the study area, people who lived at sites like Hulme were probably not directly accessing the bison, but relying on other means of procurement to obtain this resource.

RELATIVE DIETARY CONTRIBUTIONS

The relative nutritional contribution of these taxa is a further consideration to primary quantification measures of taxonomic abundance. For example, the McIntosh site is somewhat exceptional in that the fauna is highly diverse (48 taxa) yet also includes the remains of eight individual bison (Koch 2004). Although fish contribute 72% of the NISP and 68% of the MNI, they probably only in turn would have contributed 2% of the edible meat, whereas bison, in fact, likely accounted for over 90% of the edible

Table 1. Faunal taxa diversity (NISP and MNI) of selected Late Prehistoric sites on the Central and High Plains. Potential commensal animals such as rodents are not included in this table. Analyses of materials from Donovan and Albert Bell were conducted by the author. Remaining data are drawn from Koch 2004: 115–117 (McIntosh), Bozell 1991: 232–234 (Hulme), and Donna Roper, personal communication 1996, report submitted to the U. S. D. I. Bureau of Reclamation, Kansas-Nebraska Office (25FT22).

	Donovan first occupation		*Donovan last occupation*		*Albert Bell*		*McIntosh*	
Taxon	*NISP (%)*	*MNI (%)*	*NISP (%)*	*MNI (%)*	*NISP (%)*	*MNI (%)*	*NISP (%)*	*MNI (%)*
Bison/Elk	1710 (88.4)	4 (17.4)	1671 (85)	6 (26.1)	816 (79.8)	7 (41.1)	593 (15.8)	8 (4.5)
Deer/Pronghorn	8 (0.4)	1 (4.3)	5 (0.2)	1 (4.4)	84 (8.2)	2 (11.8)	49 (1.3)	4 (2.2)
Carnivores	4 (0.2)	3 (13.1)	21 (1.1)	4 (17.4)	2 (0.2)	2 (11.8)	73 (2)	6 (3.4)
Rabbits	37 (1.9)	3 (13.1)	52 (2.6)	3 (1.3)	57 (5.6)	3 (17.6)	1 (0)	1 (0.6)
Birds	112 (5.8)	7 (30.4)	41 (2.1)	5 (21.7)	11 (1.1)	1 (5.9)	110 (2.9)	27 (15.3)
Reptiles/Amph.	63 (3.2)	4 (17.4)	176 (9)	4 (17.4)	52 (5.1)	2 (11.8)	207 (5.5)	10 (5.6)
Fish	1 (0.1)	1 (4.3)	0 (0)	0 (0)	0 (0)	0 (0)	2722 (72.5)	121 (68.4)
Total	1935	23	1966	23	1022	17	3755	177

meat. In a previous study, Nepstad-Thornberry, Cummings, and Puseman (2002) propose a subsistence model which estimates that as much as 20% of the diet came from large game based on three sites from the Medicine Creek area of western Nebraska (including 25FT22).

Larger quantities of animal live weights or available meat weight or even consumable meat weights do not necessarily indicate relative economic importance, but do provide a rough estimate of the quantity of food available per animal (Lyman 1979, 1994; Reitz et al. 1987; Reitz and Wing 1999). In large animals, the skeletal portion is highly relevant, as well as density attrition and preservation. There is an ordinal level difference, however, between one bison and one fish (or even a hundred fish). Bison have more meat than fish or deer. Neither NISP nor MNI adequately confer the scale of difference. Diversity indices have been used to demonstrate broad patterns of faunal procurement (Bozell 1991), but I am not convinced that richness and evenness adequately describe the differences between taxa, especially for large-bodied mammals. In addition, a greater proportion of the total mass of large mammals tends to be fat. Two animals of the same species may vary significantly in size (i.e., males versus females, immature versus adult), which could, in turn, as much as double the amount of body fat available.

Attempts by Bozell (1995) to measure the amount of bison bone by calculating density per cubic meter of excavation may be a promising step in quantification. The results from Upper Republican villages range from 0.1 to 24.4 NISP per cu m (Bozell 1995: 149–150). Applying similar calculations to the two occupations at the Donovan site, an average of 944 bison bones were recovered per cubic meter (Scheiber 2001) (FIG. 5). The extremely high density at Donovan in comparison to the Central Plains sites could be a result of increased bison exploitation on the High Plains, high fragmentation rates caused by pemmican production and grease manufacture, overemphasis on investigating house sites in the Central Plains which do not leave evidence of primary butchery and processing, seasonal variation, or taphonomic factors such as differences in sedimentation rates and preservation issues.

Hulme		*25FT22*	
NISP (%)	*MNI (%)*	*NISP (%)*	*MNI (%)*
26 (1.8)	2 (2.3)	57 (0.9)	2 (2.4)
702 (47.5)	14 (15.9)	61 (0.9)	3 (3.6)
63 (4.3)	7 (8)	5 (0.1)	2 (2.4)
25 (1.7)	3 (3.4)	59 (0.9)	1 (1.2)
201 (13.6)	39 (44.3)	156 (2.3)	15 (18.1)
421 (28.5)	16 (18.2)	126 (2.3)	8 (9.6)
38 (2.6)	7 (7.9)	6182 (93)	52 (62.7)
1476	88	6646	83

Transport of Large-Bodied Mammals: Body Part Representation

In order to better investigate large mammal transport decisions, distance to kill sites, direct versus indirect procurement, and discard patterns, quantifying body part representation is essential. A common method to do this is by calculating MNE, MAU, and Standardized Minimal Animal Units (% MAU) (Lyman 1994), which are not always calculated by faunal analysts working on the Central Plains in general or by faunal analysts studying farmers more broadly. These are standard measures in the investigation of bonebeds throughout western North America, particularly at well-known Paleoindian sites on the Plains (Byerly et al. 2005; Hill 2005; Jodry and Stanford 1992; Meltzer, Todd, and Holliday 2002). Providing an observed versus expected (fo : fe) statistic is helpful but it is not often clear if authors are basing their results on MNI or MNE.

Body part representation from the sites with the highest number of bison, the first (n = 4) and last (n = 6) occupations from the Donovan site, Albert Bell (n = 7), and McIntosh (n = 8), was further considered. Density-driven attrition and loss by non-human processes are not believed to have caused the patterns discussed below (Scheiber 2001).

The parts of the body that were transported to the sites are remarkably consistent (FIG. 6; TABLE 2). The appendicular skeleton in particular is well represented, while elements of the axial skeleton, especially the thoracic vertebrae and ribs, are relatively rare. This suggests that people from all of these sites chose to bring similar packages of meat and marrow from kill-butchery sites to processing areas and farmsteads. Although it has been suggested that Upper Republican people obtained some of their bison meat through trade or travel, the high percentage of heavy limb bones and similarities to the Donovan processing site further west on the High Plains suggest that the animals at Albert Bell at least were obtained locally and possibly that marrow production and bone grease manufacture followed the arrival of people carrying these elements to the site.

Evidence for Butchering and Processing

Recording bone surface modification can allow researchers to further evaluate butchering and processing patterns and to evaluate commensality of small animals found in faunal assemblages. Without specific evidence of cutmarks, impacts, and burning, assessing an animal's dietary contribution is imprecise. It is possible that many of

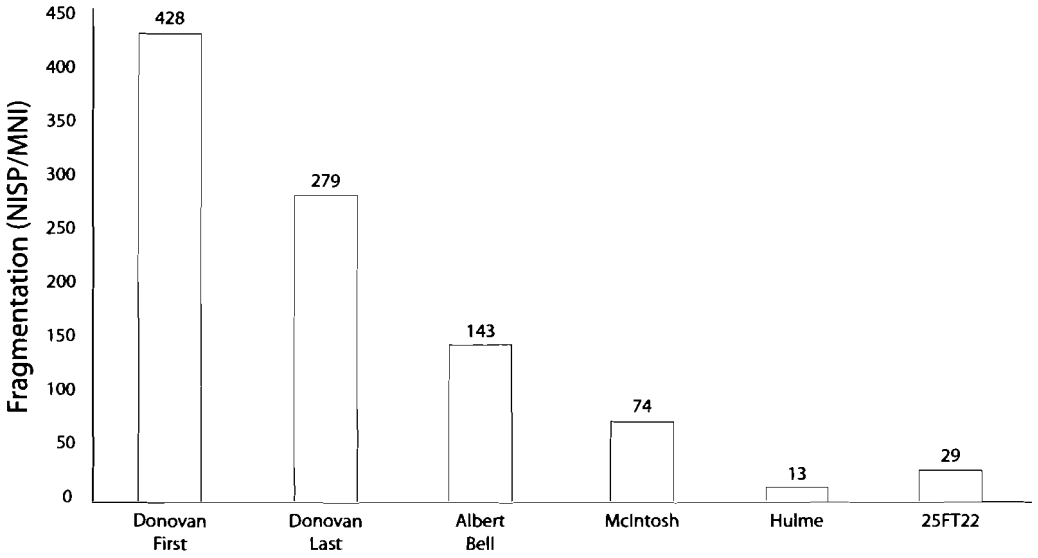

Figure 3. Upper Republican bison fragmentation rates, expressed as the ratio NISP to MNI.

Table 2. Bison body part distribution (standardized minimal animal units, or % MAU) from selected Late Prehistoric sites on the Central and High Plains. % MAU = MNE/MAU. Cranium includes cranium and mandible; upper vertebrae include cervicals and thoracics; lower vertebrae include lumbars and sacrum; forelimbs include humerus, radius, ulna, and metacarpals; hindlimbs include femur, tibia, and metatarsals; feet include carpals, tarsals, and phalanges. Data from McIntosh are drawn from Koch 2004: 119.

	% MAU		
Element	*Donovan first occupation*	*Albert Bell*	*McIntosh*
Cranium	83	30	20
Upper vertebrae	33	8.6	20
Lower vertebrae	80	40	60
Ribs	19	2.2	10
Scapula	50	30	33.3
Forelimbs	100	60	91.6
Innominate	100	100	91.6
Hindlimbs	100	90	100
Feet	13	10	31.7

the identified taxa were not eaten at all but instead represent natural postdepositional intrusions. Until these kinds of analyses are commonly conducted, claims of high taxa diversity cannot be properly evaluated. I examined bone surface modification on bison bone from the upper and lower levels at the Donovan site (Scheiber 2001) and the single occupation at Albert Bell, noting differences in placement and number of cutmarks and impact marks in particular. The following section summarizes these results, while a more thorough analytical discussion is in preparation.

CUTMARKS

Cutmarks can indicate skinning, dismemberment, filleting meat from bones, and marrow extraction (Binford 1981). I recorded each cutting stroke (following White 1992) rather than counting parallel cuts within one cm of each other as a single mark (e.g., Lyman 1987; Turner and Turner 1999). Some ethnographic discussions of butchery practices exist on the Plains (e.g., Wilson 1924 for the Hidatsa; Wissler 1910 for the Blackfeet; see review in Wheat 1972), but for the most part, ethnographic information is incomplete. Ethnographically, both men and women on the Plains were involved in primary butchering, and women were more heavily involved with secondary butchering, processing, and cooking (Hudeck-Cuffe 1998; Jodry 1999; Losey 1971; White 1954).

Cutmarks were recorded on bones from all three assemblages (FIG. 7). The incidence of cutmarks for all identified elements from the Donovan assemblage (14.5%) is double that of and significantly higher than the Albert Bell fauna (5.9%) (Donovan first and Albert Bell: $X^2 = 16.496$, df = 1, $p < 0.001$, n = 1077) (Donovan last and Albert Bell: $X^2 = 9.682$, df = 1, $p = 0.002$, n = 1254). Although variation is noted between the two Donovan occupations, most of the significant differences occur between Donovan levels and Albert Bell, particularly in statistically lower frequencies of cutmarks on the axial skeleton on the Albert Bell fauna ($p < 0.05$). Presence of cutmarks on bone is not necessarily correlated with number of cut strokes (Egeland 2003), and variation may be due to differences in butchering techniques, carcass condition, and packaging decisions.

Figure 4. Donovan bonebed and stratified profile showing fragmented bison assemblage in a 50 cm wide excavation block, facing south. Photograph taken August, 1999, by Laura L. Scheiber.

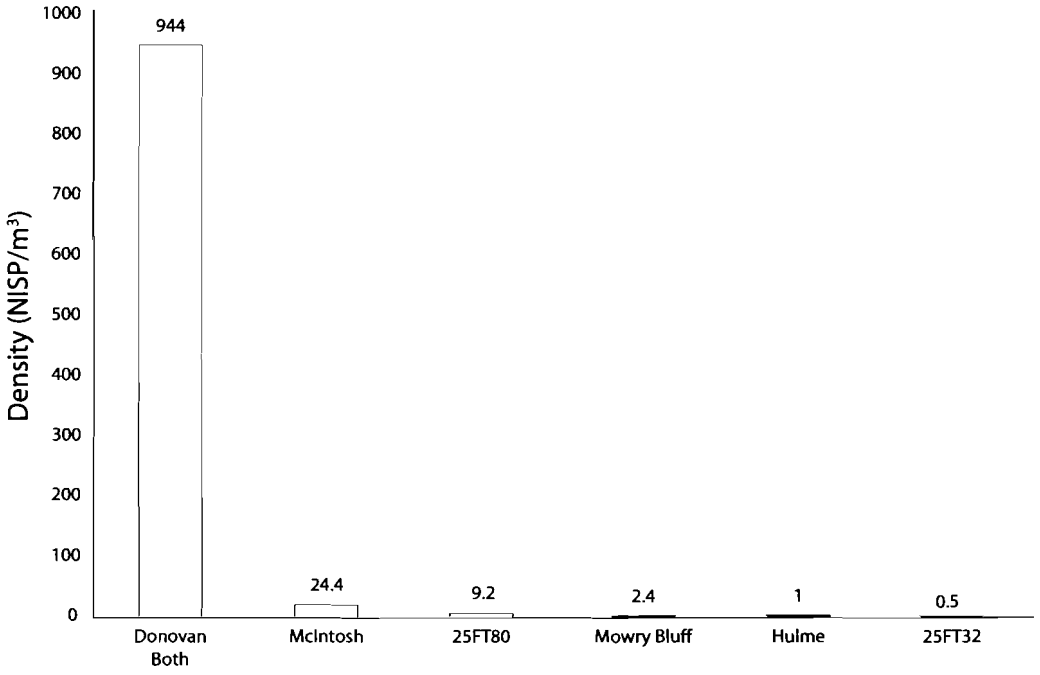

Figure 5. Upper Republican bison bone density, expressed as the ratio of NISP per cu m excavated. Data from Bozell (1995) and Scheiber (2001).

IMPACT MARKS

Impacts are hammerstone percussion marks often produced by hammer and stone anvil techniques, indicating smashing of the bones to obtain grease and marrow and possibly for pot sizing (White 1992). White (1992) separately records crushing, where the cortical surface has been crushed into the bone; percussion pits, where the cortical bone is struck and scarred but not inwardly crushed; and adhering flakes, where flakes remain attached to the place the bone was struck. I counted all of these features as impact marks. Anvil marks were not recorded separately.

Fats have very high caloric values and are crucial for transporting other nutrients in the body. They are thus crucial sources of energy for hunter-gatherers (Speth and Spielmann 1983), especially during times when animals are lean and not plentiful (Binford 1978). In addition to subcutaneous, intramuscular, adrenal, and intestinal fat deposits, fat can be obtained directly from animal bones. Bone marrow comes from the cavities of the mandible and long bones of the bison skeleton, and bone grease is obtained by boiling cancellous bone, found at the ends of long bones and in the axial skeleton, and skimming the floating fat (Outram 2001). Numerous ethnographic and ethnoarchaeological works refer to bone marrow (and bone grease) production (Binford 1978; Kent 1993; Leechman 1951, 1954; O'Connell, Hawkes, and Blurton-Jones 1988; Wilson 1924; Zierhut 1967). As noted by Outram (2001), efforts to quantify intensity of bone fat utilization and type of bone fat use have been minimal, while the focus has instead been on meat utilities. On the Plains, bone marrow and grease were often primary ingredients in pemmican, a jerky-like dried meat product (Densmore 1929; Gerard 1910; Lowie 1924). White (1992) has recorded pot polish or abrasion on the ends of bones that resulted from bones scraping against ceramic vessels during bone grease extraction or stewing. I recorded the number of impacts per identified element (% NISP) so that relative frequency data could be used to compare the frequency of butchery-marked bone within smaller and smaller subsamples of body segments (Lyman 1994).

Impact marks were noted more frequently than cutmarks, again with significantly lower frequencies on elements from the Albert Bell site (17.2%) compared to either Donovan level (30.7%, FIG. 8) (Donovan first and Albert Bell: $X^2 = 17.975$, df = 1, $p < 0.001$, n = 1077) (Donovan last and Albert Bell: $X^2 = 16.445$, df = 1, $p = 0.002$, n = 1254). Unlike cutting, which often does not leave evidence on the bones, impact marks should be present if people were breaking the bones to retrieve marrow or pot sizing to boil them for grease. Donovan residents more significantly impacted the bone assemblage, perhaps through a greater focus on pemmican production, storage, and longer-distance transport. The lower frequency of impact marks found on the Albert Bell bones may indicate less

bone grease extraction as opposed to disarticulation during butchering before disposal in the nearby midden of this farmstead.

Spatial Organization

Ideally, intrasite patterning of artifact distributions, including animal bones, would allow us to say more about economic variability at these sites (Lightfoot, Martinez, and Schiff 1998). Often this kind of data is unavailable, especially for fauna from earlier excavations. What we do know is that all of the faunal remains from the eastern sites, including Albert Bell, were recovered from farmsteads, and more specifically residential samples. Larger bison bones may have been left at primary butchering areas (Koch, Nelson, and Bozell 1999), but to date no primary kill sites have been documented for the Upper Republican phase, making sites like Donovan all the more interesting. Although the horizontal extent of excavation at Donovan is relatively small, the faunal remains are concentrated in one or two areas without variation according to element, body segment, or specific tasks. The distribution, and by implication, intentional discard of bone fragments, varies by size with the heavier and larger bones in both levels deposited at the edges of the main processing areas. This pattern conforms to ethnoarchaeologically-produced models of hearth-centered activity (Binford 1983). Given the kinds of activities expected to occur at processing sites, the evidence from Donovan is one of tightly clustered and highly structured activities including animal procurement, processing, and discard. At the Albert Bell site, fauna were recovered from both house and midden settings. Distributional patterns are currently being further analyzed.

Consideration of Bone Tools: What about the Hoes?

One of the problems in assessing the economic importance of large game animals like bison relates to the way archaeofauna are analyzed. Some of the bison remains were probably transported some distance before people brought them to the hamlets. We have good evidence of this in scapula hoes, but too often these modified faunal remains are classified as tools and rarely included in faunal analyses. On the one hand, a comprehensive inventory of all fauna is important for assessing the relative contributions of and access to various animals. On the other hand, the presence of a single bone element from a particular taxon will bias estimates of diet.

Modified bison scapulae hafted to sturdy wooden handles were used extensively as farming implements by Plains Villagers (Weltfish 1965; Wilson 1987), for hoeing maize and other cultigens. The numerous bison scapulae farming implements in Central Plains sites may have originated from local hunting (in which case we lack any evidence of kill sites), from trade with western High Plains groups, or from hunting expeditions on the High Plains by Central Plains residents (Bozell and Ludwickson 1998b: 557). The high frequency of bison scapula hoes in Central Plains sites could be evidence for non-local procurement strategies, since the number of animals represented by scapula tools is much higher than other unmodified bison bone at various village sites (Brown 1982; Fishel 1999; Gilbert 1969; Johnson 1972; Ludwickson 1978; White 1953, 1954: 258; Wood 1967: 184). For example, the number of individual bison from the Hulme site based on unmodified bison bone is one, whereas the number of individuals based on bison scapulae is 20 (Bozell 1991). Similarly, 86% of the bison bone from the Mowry Bluff site in Medicine Creek are tools and scapulae fragments (Falk 1969).

There is no doubt that people had access to bison because of the presence of scapula hoes and other bison bone tools. It is reasonable to assume that people also obtained some meat either through direct procurement or trade, a scenario considered by Wedel (1970) some years ago. I think it is likely a combination of both direct and indirect procurement although broader interactions are likely as well. By minimizing the contribution of bison (what Blakeslee [1999: 76] calls the "invisible portions of the diet"), we probably also consider these people as less mobile and more isolated than they really were. Until bone tools are regularly analyzed with unmodified faunal elements, this gap will continue. These patterns are not apparent until broad comparisons across sites are considered. It then becomes evident that transported scapulae can bias the results. At the Donovan site, fewer scapulae are observed than expected in comparison to the forelimb long bones, which I attribute in part to trade or transport to eastern farmsteads.

Following the Buffalo Herds or Staying Close to Home?

A significant question in Plains archaeology has been where the bison represented by faunal remains in archaeological sites were procured: whether locally, through long-distance hunting parties, or by trade. Because the local availability of bison to residential farmers remains unknown, the travel distance to obtain bison meat, hides, and tools is also unknown. The bison must have been hunted and processed somewhere away from the hamlets, but these kill-butchery sites have not been found. I believe that we should have discovered archaeological evidence of these sites by now if Central Plains residents were hunting bison locally.

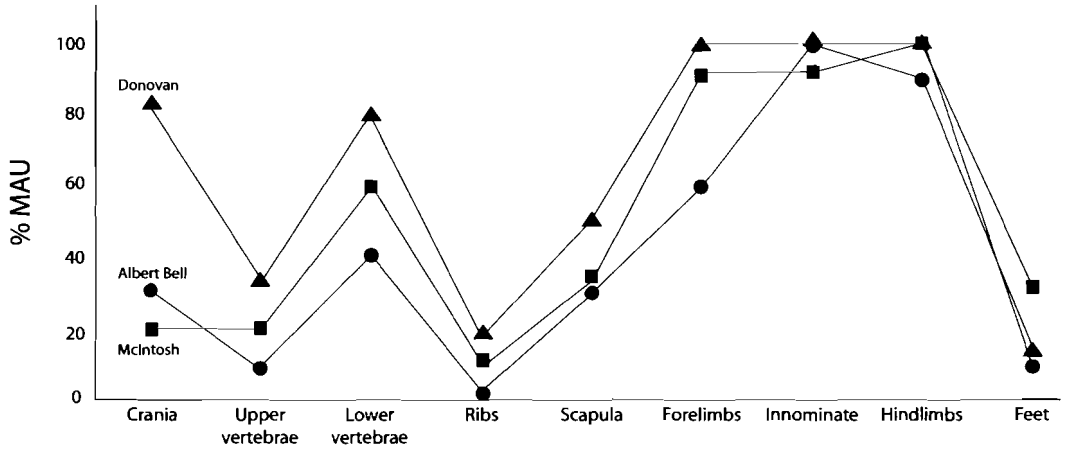

Figure 6. Bison body part distribution by element grouping (standardized minimal animal units, or % MAU) at Upper Republican sites on the High Plains and Central Plains.

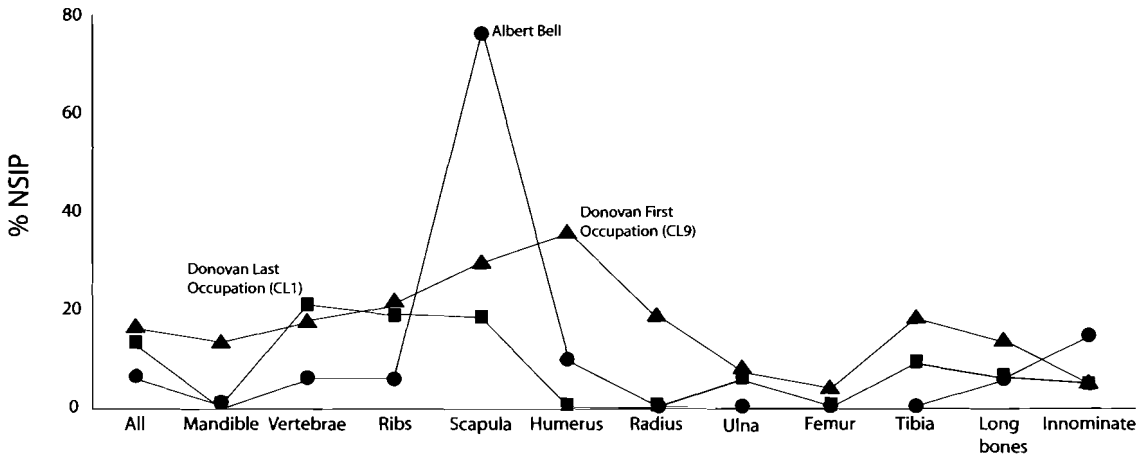

Figure 7. Cutmark rates from High Plains faunal assemblages at Donovan (5LO204) and Albert Bell (14SD305), expressed as number of cutmarks recorded per NISP.

Archaeologists have speculated for more than 70 years about the reasons for hunting bison on the High Plains, questioning why hunting parties would travel out onto the Plains when bison were also presumably available at home (Reher 1973; Wedel 1970). The lack of hunting campsites and even secondary processing sites closer to the Central Plains farmsteads, and solid evidence for these kinds of sites on the High Plains, suggests that there were at least some compelling reasons for traveling farther away to hunt bison. Perhaps the bison herds were larger or more predictable and the meat was of better quality on the High Plains? Perhaps ecological conditions limited the number of bison nearer to the Central Plains horticultural sites? Perhaps hunting bison on the High Plains was a buffering strategy during the early stages of experimentation with horticulture, such that some members of the group would stay in remote camps collecting a somewhat predictable resource. Alternatively, perhaps 150 miles is a reasonable distance to travel to hunt buffalo, especially given that Upper Republican people may have traveled to Pueblo sites in the Southwest (or met with traders halfway) and certainly interacted with more eastern villages.

Body part representation is very similar in the three sites with comparable data (Donovan, Albert Bell, and McIntosh), suggesting the same techniques or similar transport decisions. Currently, we lack comparable data from other sites. Butchering intensity may address this issue if we expect people to be more intensely processing the animal for transport, and in fact sites like Donovan do indicate much higher fragmentation and possible intensive strategies.

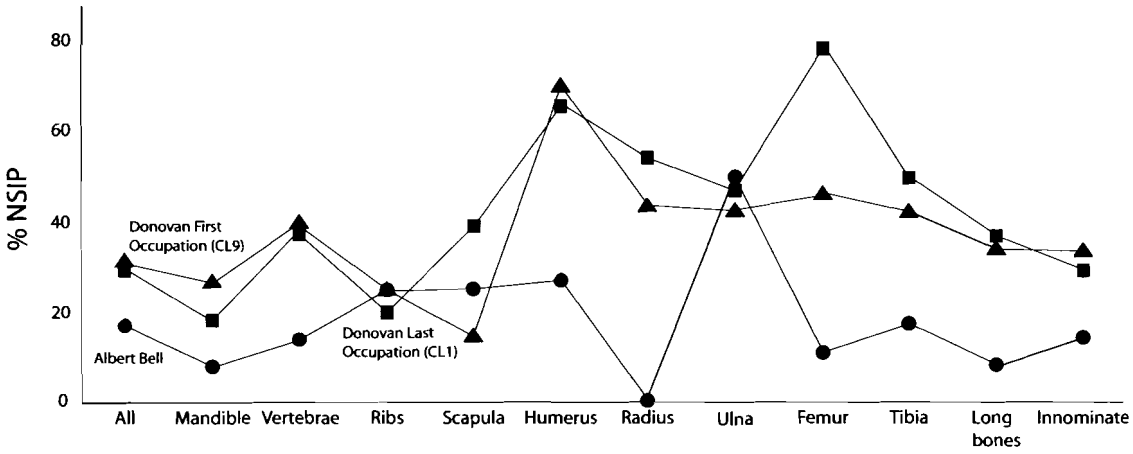

Figure 8. Impact mark rates from High Plains faunal assemblages at Donovan (5LO204) and Albert Bell (14SD305), expressed as number of impact marks recorded per NISP.

I am not suggesting that all bison recovered from Upper Republican archaeological sites were hunted on the High Plains. I believe that connections between east and west, hunter-gatherers and farmers, and campsites and house sites may be stronger than currently realized and that access to bison may be more critical than recent researchers have suggested. Separating indirect versus direct procurement may not be possible. I believe that some direct procurement did occur and that exchange in bison products was an important social mechanism for connecting people, places, and resources when people did choose to stay closer to garden plots. Worked bison scapula hoes were probably not only functional farming implements, but also tied farming communities into wider relationships with big-game animals as witnessed during the Early Historic period and into relationships with people who, while taxonomically distinct in our archaeological terminology, nonetheless may have been relatives and distant cousins.

Conclusions

This study is part of a larger research program in which I am developing spatial and temporal baselines of comparative food practices among incipient farmers/hunter-gatherers. Late Prehistoric communities of the Central and High Plains undoubtedly had more in common than a simple dichotomy based on the presence or absence of agriculture and architecture implies. Recent research demonstrates wide spatial similarities in ceramic composition (clay and temper) over much of the Central Plains. Based on stylistic analysis of pottery, Donna Roper suggests that connections along E–W river drainages and corridors may be more relevant than traditionally defined N–S ceramic taxonomies (Donna Roper, personal communication 2006). Donovan pottery was likely made from local western clays, although neutron activation studies show that the earliest ceramics from the site are more similar to clays used to make pottery on the Central Plains (Cobry and Roper 2002; Roper et al. in press). Despite being characterized as subsistence generalists with bison only contributing partially to prehistoric diets, people from at least three of the sites discussed here relied on buffalo meat and buffalo products.

Donovan is a prime example of an intensive bison processing area, where bison were locally available and where pemmican, dried meat, hides, tools, and ornaments were prepared for later use. The occupants of Albert Bell, one of the most western Central Plains tradition house sites, also likely procured buffalo locally, with fewer signs of pemmican and grease production. Future research will further identify distributional differences between the midden and house areas. The McIntosh bison assemblage may represent trade, although the body part distribution makes direct procurement more likely. The culturally specific ways that people butchered and processed these animals may prove to be a fruitful method for further differentiation.

Sites like Hulme and 25FT22 may or may not be more typical of Upper Republican lifeways. The small amount of bison bone in the faunal assemblage in combination with bison bone tools argue for acquisition through trade. Whether or not people traded meat along with hoes (a haunch and a hoe if you will) and to what degree bison may have contributed to the subsistence economy remains conjecture. We should consider shifting settlement practices carefully in order to understand whether the western sites are critical for evaluating the integrated system. Trade and exchange are too often peripheralized instead of ad-

dressed as important economic variables. I do not think that these communities were isolated or acting independently because of the presence of diagnostic Central Plains tradition artifacts on the western Plains, the presence of western lithic raw materials in eastern sites and vice versa, and because of the possible presence of eastern clay sources found in ceramics in the west.

Although High Plains occupants probably practiced more generalized subsistence strategies than originally imagined in the 1930s, faunal inventories from these sites continue to demonstrate various percentages of bison bone. The presence of bison may not necessarily indicate specialized bison hunting economies such as those witnessed during the Early Historic period, but neither should it be minimized. To facilitate broad spatial comparisons, zooarchaeologists need to commit to conducting analyses that can be used to address taxa diversity (NISP, MNI), butchery and transport of large-bodied mammals (MNE, MAU), and processing intensity (fragmentation rates, surface modification).

I do not wish to suggest that Central Plains tradition people were universally bison hunters, that a typical vertebrate pattern exists, or that this pattern is not highly diverse, but I do suggest that bison were a crucial part of the economy. How this relates to diet and subsistence remains a topic for further study, but bone tools remind us that low frequencies of unmodified fauna do not necessarily indicate lack of meat. Quantification measures that highlight NISP and diversity indices but not MNI and MNE minimize the role of bison. The degree to which the sites chosen for analysis and comparison in this study are representative of the wider area or demonstrate a gradient in the use of bison from west to east remains to be explored. Further studies should also consider seasonality and temporal change. Through the kinds of analyses explored above, I hope to expand the discussion beyond the house and the hoe (and pottery styles) to other productive lines of inquiry.

Acknowledgments

This paper was first presented in a symposium that I co-organized for the 64th Annual Plains Conference in Topeka, Kansas, in 2006, called "Investigating Economic Variability in Horticultural Societies on the North American Plains." I thank my co-organizer Scott Brosowske as well as participants Mary Adair, Eric Hollinger, Brad Logan, Bev Nicholson, Daniel Pugh, Lauren Ritterbush, and Donna Roper, who all participated in a productive and lively discussion following the session.

I would especially like to thank Oskar Burger, Eric Hollinger, Stacie King, Margaret Conkey, Diane Gifford Gonzalez, and Judson Finley for their positive feedback and comments, as well as Donna Roper, Marcel Kornfeld, and an anonymous reviewer. The Kansas Archaeological Association sponsored the excavations at Albert Bell, and the High Plains Archaeology project sponsored the excavations at the Donovan site. I thank the University of Wyoming and the Kansas State Historical Society for permission to analyze the collections, as well as the Donovan family and Alan Nelson for permission to excavate in Lewis Canyon. Charles Reher inspired my work on the High Plains and provided me with much guidance over the years. Student labor has been critical in gathering the data presented here, and I greatly appreciate the help of dozens of students from University of California-Berkeley, University of California-Santa Cruz, University of Wyoming, and Indiana University, especially Amy McCabe, Yasemin Gencer, Ashley Fragomeni, Melissa Hammond, Gina Zavala, and Kili McGowan. Funding was provided by the Stahl Endowment of the Archaeological Research Facility, the Lowie and Olson Funds of the Department of Anthropology, and the Vice Chancellor for Research, all of the University of California-Berkeley, as well as the George C. Frison Institute for Archaeology at the University of Wyoming. Christopher Widga kindly provided unpublished data about Central Plains faunal collections.

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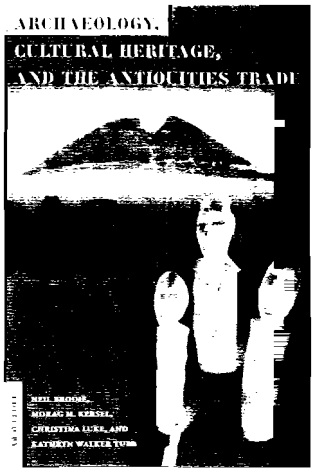

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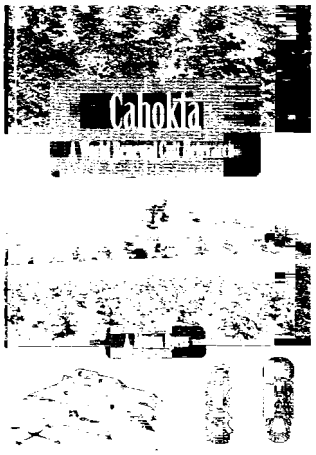

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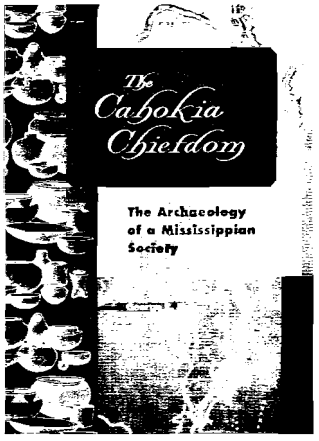

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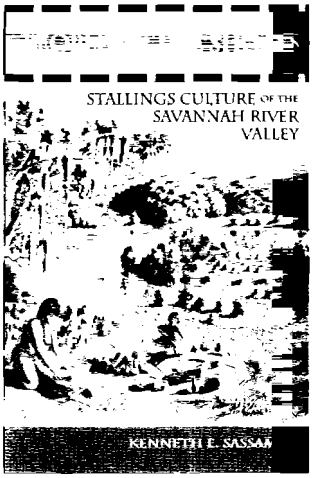

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