CULTURE, ENVIRONMENT, AND BISON POPULATIONS ON THE LATE PREHISTORIC AND EARLY HISTORIC CENTRAL PLAINS

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ABSTRACT

A close and persistent association between bison and Central Plains Native Americans is a firmly entrenched image in archaeological and historical thought. However, this model is overly generalized. To test the model, unmodified bison bone density (identified specimens/excavated m^3) and sample diversity were measured for a series of semisedentary villages occupied between AD 1 and 1850. The results suggest: (1) Woodland tradition (AD 1-1000) bison use increased from east to west; (2) Central Plains tradition populations (AD 1000-1400) grew crops and practiced a diverse hunting-gathering economy supplemented only occasionally with bison hunting; and (3) after AD 1600, protohistoric and historic villagers engaged in intensive bison hunting with an apparent reduction in maize agriculture and broad spectrum hunting-gathering. Village and group size, the archaeological record, climate change, and intertribal relationships are explored to explain these data. The study concludes that climate change and related resource depletion were the most significant factors in bison procurement variability.

Keywords: bison; Central Plains; climate; subsistence

INTRODUCTION

Scholarly and popular literature inextricably link bison hunting and Central Plains Native Americans. Despite this, archaeological data suggest sharp fluctuations in the intensity of bison hunting, varying between intensive communal hunting at one extreme and broad-based hunting and gathering involving little or no bison at the other. The choice of bison versus other food sources was directly associated with the overall social and demographic configuration of Plains societies.

To understand Central Plains human adaptation, we need to establish the limits of this variability in time and space. Thus, as a partial means to this end, this paper measures the density (number of identified specimens [NISP]/m^3) of unmodified bison bone in archaeological deposits dating from AD 1-1850. Assemblage diversity was also tabulated for select samples. The geographic boundaries of the study include western Iowa, north-central Kansas, and the eastern two-thirds of Nebraska. Middle Missouri, northeastern Plains, and Southern Plains data are briefly considered. Bison bone density and sample diversity variation are considered in relation to environmental change and the character of human societies living through these changes (Fig. 1).

CULTURAL AND ENVIRONMENTAL SETTING

Bryson et al. (1970), Wendland and Bryson (1974), Wendland (1978), and Bryson and Padoch (1980) proposed and refined Holocene paleoclimatic episodes. Generally corroborative evidence has been generated through examination of vertebrate (Johnson 1972; Satorius-Fox 1982; Semken

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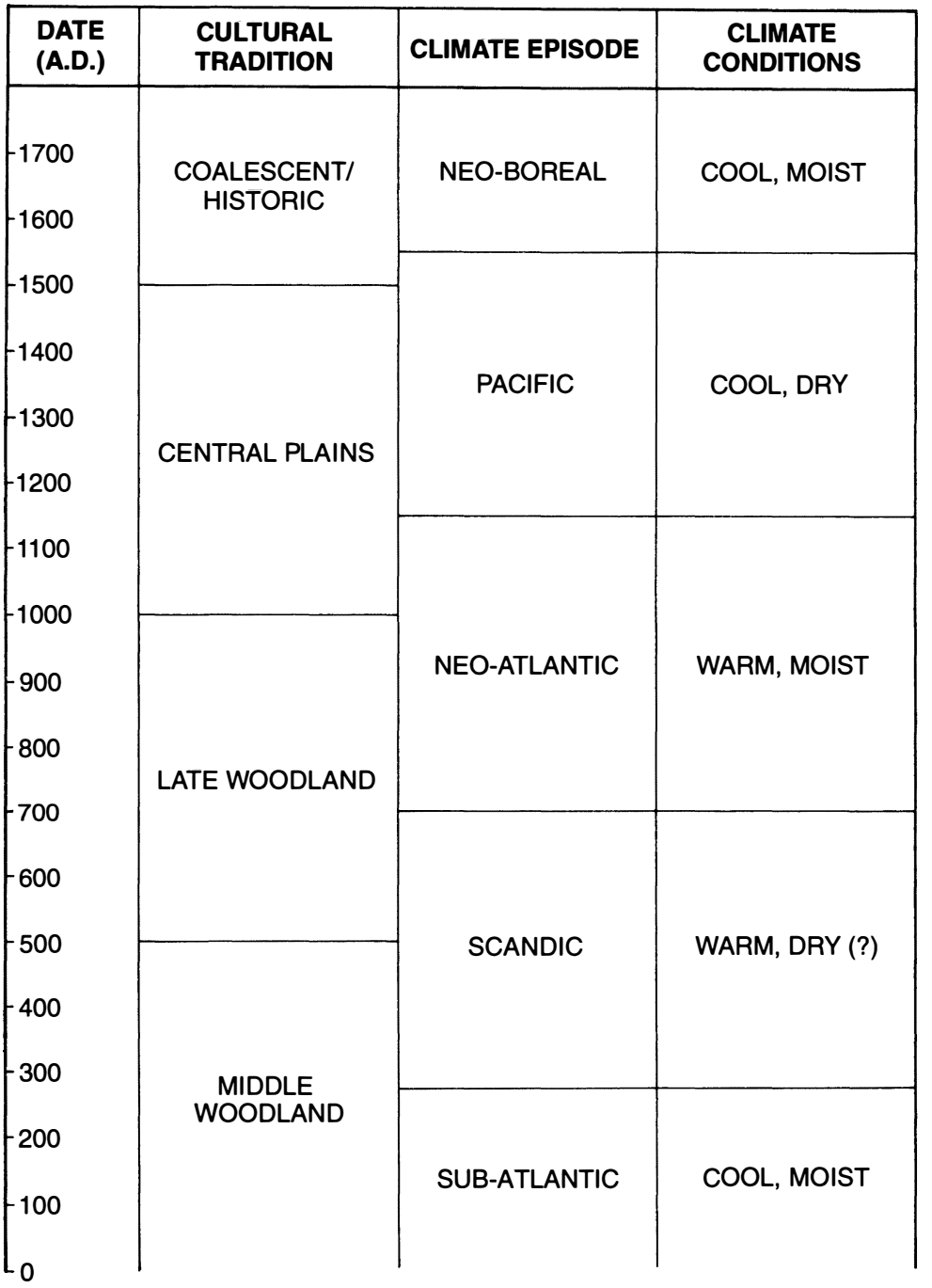

Figure 1. Central Plains cultures and climates, AD 1-1850.

and Falk 1987), geomorphic (May 1986, 1992; Bettis 1990; Toom 1992), floral (Van Zant 1979; Ahlbrandt et al. 1983; Benn 1990), and European/Greenland glacial (Porter 1986) data. The Wendland-Bryson model is nearly 25 years old and attempts to describe climates for large geographic areas. For these reasons it has encountered a certain degree of criticism in recent years as an explanatory tool for culture change on the Great Plains (Blakeslee 1993; Lensink 1993). The model, while certainly in need of refinement, has not been adequately refuted or replaced, and will be used as a frame of reference in this paper.

Woodland culture, evident on the Central Plains by about 100 BC, is characterized by increased sedentism, pottery manufacture, and horticultural experimentation. Both Middle (100 BC-AD 500) and Late (AD 500-1000) Woodland phases are recognized but population levels were never particularly high. Middle Woodland emerged on the Central Plains during the cool and wet Sub-Atlantic climatic period and persisted well into the warmer, and perhaps drier, Scandic episode. The Late Woodland period occurred during the Scandic and early portion of the Neo-Atlantic. The warming trend that began during the Scandic culminated during the wetter and more mesic Neo-Atlantic.

The Plains Village pattern is first recognized in the region with the appearance of the Central Plains tradition. The tradition encompassed the eastern two-thirds of Nebraska and northern Kansas and extreme western Iowa. Intensive horticulture and construction of wattle and daub houses arranged into small semipermanent villages define the tradition. The Upper Republican, Nebraska, and Smoky Hill phases appeared simultaneously about AD 1000. The St. Helena and Itskari phases developed by AD 1100, and all phases persisted until about AD 1400 (Wood 1969; Lehmer 1971:111; Blakeslee 1978; Wedel 1986:98-133). Although the present study only involves Central Plains samples, it also incorporates two assemblages from the Mill Creek phase of the Middle Missouri tradition centered in northwestern Iowa adjacent to some Central Plains tradition phase distributions (Tiffany 1982).

The Central Plains and Middle Missouri traditions took place during the terminal Neo-Atlantic and the duration of the Pacific episodes. Intermittent, perhaps protracted, episodes of cool temperatures and aridity characterize the Pacific. The Neo-Atlantic–Pacific contact remains a point of contention with dates ranging from AD 1000 to AD 1250 (Bryson et al. 1970; Porter 1986; May 1992; Toom 1992). The effect on culture, and even the existence of Pacific droughts, has come under close scrutiny recently. Blakeslee (1993) and Lensink (1993) argued movements and subsistence variation among Central Plains tradition and Mill Creek people were more a product of culture than environmental change.

Following the onset of the Neo-Boreal episode of cool temperatures and increased precipitation ("Little Ice Age") at about AD 1550, the protohistoric Pawnee appeared in central Nebraska about AD 1600 and remained in place until 1875 (Grange 1968; Wedel 1979; O'Shea 1989). Core village territory was centered near the mouth of the Loup River and lower Platte River valley with outliers in the central Republican and Blue River drainages.

SAMPLE SELECTION AND PROCEDURES

Comparing frequencies of identified specimens, minimum number of individuals, pounds of meat represented, calories, and associated percentages in relation to other taxa does not effectively measure bison use. Frequency comparisons fail to account for variation in village size, human group size, occupation duration, and extent of archaeological excavations. These factors fluctuate dramatically within and among the cultural traditions under consideration. Observing, for example, that a Pawnee community produced more bison, more bison bones, or more protein than did a Central Plains tradition village reveals little given that Pawnee sites were larger and occupied longer. Similarly, observing that a Pawnee site yielded 50% bison and a Central Plains tradition site 10%, speaks only to the relation between bison and other taxa. Relative percentages only indirectly address the correlation between frequency of bison hunting by Central Plains tradition versus Pawnee hunting parties.

Tabulation of bone density in archaeological deposits provides a more accurate account of bison

use. The number of elements per m^3 is a meaningful index since it accommodates variation in excavation extent, village size, and occupation duration. Density reflects the intensity and rate of bison bone deposition in a community. This type of value provides adequate data for observing change reflected in the archaeological record. To further validate this approach, only permanent or semipermanent habitation sites were selected to sample. Kill sites, processing sites, hunting camps, hunting stations, or other nonsedentary sites are not included in the analysis.

Several sample selection criteria were applied for this study. To qualify, samples had to be: (1) from the Central Plains subarea, (2) from semipermanent habitations in village core areas dating to periods under consideration, (3) from single component subsurface contexts, and (4) collected using modern recovery techniques or, for older collections, with all unmodified bison bone saved, as evidenced by field director notes. Samples were drawn from published collections in Nebraska and several unpublished samples available to, or identified by, the author. Nebraska sites meeting the above criteria include: Schultz, Wallace, Walker Gilmore, Palmer Johnson, Olsen, Schmidt, Patterson, Annie's site, Mowry Bluff, Hulme, McIntosh, Gray, Larson, Wright, Linwood, 25FT32, and 25FT80. The study incorporated several Iowa and Kansas assemblages including: Rainbow, Chanya-ta, Brewster, Johnson Farm, State School, and Witt. The sample includes components from the following traditions: Middle Woodland (n=3), Late Woodland (n=2), Middle Missouri (n=2), Central Plains (n=13), and Coalescent (n=4). The higher number of Central Plains tradition samples when contrasted with Woodland and Coalescent samples is noteworthy and may have some effect upon analysis results and conclusions drawn from them. Refinement of this research when additional samples become available is recommended. See Table 1 for pertinent references. Site locations are illustrated in Figure 2.

Certain proveniences within each sample were eliminated. These include: (1) those for which there was some reason to suspect all bison bone originally present in the field was not returned for curation, or (2) those for which a volume could not be calculated, such as surface, disturbed overburden, intercomponent mixed units, or features with inadequate dimensional information. Proveniences ultimately selected were contained features, house floors, and several midden tests.

Density calculations include only unmodified remains. Values were tabulated by specific provenience and a site mean calculated. Values are expressed as Number of Identified Specimens (NISP) per m^3 of excavated matrix. House floor fill depths were occasionally unclear or not available from notes, but for those that were, 20 cm was an average depth. This average was used for other floors without precise depth documentation. Volume calculation formulae are provided in Table 2.

Sample diversity was also tabulated for some assemblages in order to more thoroughly evaluate variation in bison use within the framework of overall faunal procurement. Various considerations of diversity measures appropriate for vertebrate assemblages and other material classes suggest "evenness" is one of the most accurate reflections of diversity (Kintigh 1989:29; Bobrowsky and Ball 1989:7). Evenness is a quantitative measure of the relative abundance of taxa within a sample. In this paper, it is calculated using a scaled value of the Shannon Index expressed as H'/H'_{max} (Pielou 1977; Kintigh 1989:29, 1993:56). The lowest possible scaled diversity value is 0.00, which occurs if all elements were from a single species. The highest scaled diversity value is 1.00, which would occur if all species were equally represented. The relationship between sample size and diversity was also taken into consideration.

For consistency, the diversity statistic was only calculated for samples recovered using fine screens and for which the entire identified sample was available for consideration. This eliminated ten samples which were used in the bison bone density analysis. Before diversity calculation, identified remains (NISP) were collapsed into five classes: bison, deer/antelope, small mammal, bird, and fish/amphibian/reptile. Taxa believed to be noncultural were eliminated prior to diversity tabulation. Diversity calculations were completed on an IBM compatible portable computer using the Turbo Pascal program DIVM modified by Kintigh (1993:56-58) for use with archaeological samples.

Table 1. Diversity index and bison bone density values for select Central Plains late precontact and postcontact assemblages.

Site	Phase	Dates of Occupation[a]	Excavated Volume (m^3)	Bison NISP	Bison NISP/m^3	Diversity Index[b]	Reference
Middle Woodland Tradition							
Schultz (25VY1)	Valley	AD 0-500[a]	51.1	626	12.2	-.-	Hill and Kivett 1941
Wallace (25GO2)	Valley	AD 400-650	11.3	117	10.3	0.56	Author's notes
Rainbow A (13PM91)	Valley	AD 100-700	92.6	133	01.4	0.78	Falk and Semken 1990
Late Woodland Tradition							
Rainbow B-D (13PM91)	Boyer	AD 300-900	133.5	57	00.4	0.59	Falk and Semken 1990
Walker Gilmore (25CC28)	Sterns Creek	AD 975-1300	156.0	12	00.1	-.-	Falk and Angus 1983
Middle Missouri Tradition							
Chan-ya-ta (13BV1)	Mill Creek	AD 1000-1325	48.5	1227	25.2	-.-	Tiffany 1982
Brewster (13CK15)	Mill Creek	AD 925-1150	51.3	1745	34.0	0.83	Dallman 1983
Central Plains Tradition							
Palmer Johnson (25BU37)	Itskari	AD 1275-1400	16.7	3	00.2	0.55	Koch 1991
Olsen (25CU23)	Itskari	AD 1200-1300[a]	38.5	91	02.3	-.-	Author's notes
Schmidt (25HW301)	Itskari	AD 1150-1275	95.0	514	05.4	0.92	Morey 1982
Johnson Farm (13ML128, 129, 130)	Nebraska	AD 1200-1375	117.8	27	00.2	-.-	Johnson 1972; Hotopp 1978
State School (13ML132, 135)	Nebraska	AD 1000-1200	21.6	8	00.4	-.-	Johnson 1972; Hotopp 1978
Patterson (25SY31)	Nebraska	AD 950-1050	32.2	2	00.1	0.71	Bozell and Ludwickson 1994
Witt (14GE600)	Smoky Hill	AD 1150-1400	40.0	6	00.2	0.81	Brown 1981
Annie's (25DX30)	St. Helena	AD 1325-1450	25.2	71	02.8	0.83	Manz and Blakeslee 1988
25FT32	Upper Republican	AD 1300-1425	30.7	16	00.5	-.-	Mundell 1980; Deming 1980
Mowry Bluff (25FT35)	Upper Republican	AD 1150-1200	15.9	39	02.4	0.85	Falk 1969
25FT80	Upper Republican	AD 1300-1500	07.8	72	09.2	-.-	Mundell 1980; Deming 1980
Hulme (25HL28)	Upper Republican	AD 1150-1250	17.4	17	01.0	0.83	Bozell 1991
McIntosh (25BW15)	Unassigned	AD 1300-1400	16.5	403	24.4	0.46	Koch 1995

(continued)

Table 1. Diversity index and bison bone density values for select Central Plains late precontact and postcontact assemblages (continued).

Site	Phase	Dates of Occupation[a]	Excavated Volume (m^3)	Bison NISP	Bison NISP/m^3	Diversity Index[b]	Reference
Coalescent Tradition							
Gray (25CX1)	Lower Loup	AD 1600-1750[a]	103.5	1553	15.0	-.-	O'Shea 1989; Bozell et al. 1982
Larson (25PT1)	Lower Loup	AD 1600-1750[a]	13.2	464	31.3	0.60	O'Shea 1989; Author's notes
Wright (25NC3)	Lower Loup	AD 1600-1750[a]	16.8	609	36.2	-.-	O'Shea 1989; Lamb n.d.; Author's notes
Linwood (25BU1)	Historic Pawnee	AD 1750-1850[a]	50.2	111	2.2	-.-	O'Shea 1989; Carlson 1973; Steinacher and Carlson 1984; Author's notes

[a] Dates based on ceramics or historic documentation. All others are calibrated radiocarbon dates (Stuiver and Reimer 1993) rounded to 25 year increments.

[b] Diversity indices or evenness calculated only for fine-screen recovered samples. Evenness = H'/H'_{max} (Pielou 1977; Kintigh 1989:29, 1993:56).

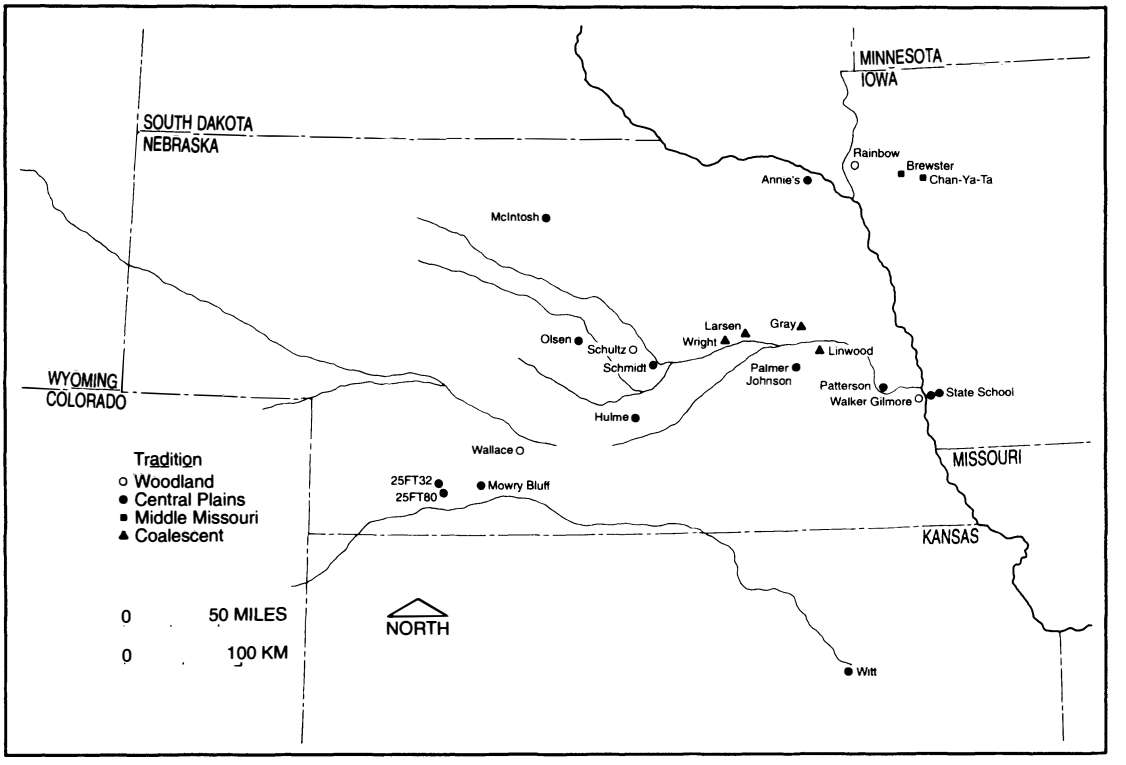

Figure 2. Locations of components used in this study.

Table 2. Volume calculations for houses and pit features.

Square or rectangular house	L x W x H
Circular house	πR^2 x H
Oval house	$\overline{D^2}$ x H
Midden	L x W x H
Basin-shaped pit	$\pi H^2/3(3R - H)$
Undercut pit	$\pi H/3(r_{12} + r_1 \times r_{u2} + r_u)$
Cylindrical pit	πR^2 x H

L = length; W = width; H = height; R = radius; D = diameter; r_1 = radius of base of cone; r_u = radius of top of cone; π = *pi* (3.14).

RESULTS

Table 1 and Figure 3 present results of the bison bone density analysis. Bison NISP/m^3 values are cross-tabulated against chronological estimates for each component. Most dates are calibrated radiocarbon determinations (Program CALIB 3.0.3; Stuiver and Reimer 1993); however, a generalized ceramic date is used for the Middle Woodland Schultz site (Hill and Kivett 1941). Ceramics and historical documentation date the Coalescent components (Grange 1968; O'Shea 1989). Data points in Figure 3 are the mean site dates. The full range of dates is listed in Table 1.

Diversity values are listed in Table 1 and arrayed against mean sample dates in Figure 4. Sample size plotted against diversity value (Fig. 5) failed to suggest a relationship between these variables. That is, it does not appear that increasing or decreasing diversity is only a function of smaller or larger samples. Therefore, it is more likely that the derived diversity values are reflective of something in the archaeological record.

Middle and Late Woodland Traditions

All three Middle Woodland samples belong to the Valley phase and display a distinct east-west trend. Although bison contribute about one-third of the northwest Iowa Rainbow site sample, the density value is low (1.4 elements/m^3). The two central Nebraska samples, Wallace and Schultz, produced higher values of 10.3 and 12.2 elements/m^3. The diversity value for Rainbow is 0.78 and that for Wallace is 0.56

Late Woodland samples come from the Rainbow and Walker Gilmore sites. The Rainbow component belongs to the early Late Woodland Boyer variant and Walker Gilmore to the late Late Woodland Sterns Creek phase. Both samples come from the eastern margin of the Central Plains and yield low bison density values. The Rainbow diversity values for the Valley (0.78) and Boyer (0.59) components indicate that rather broad spectrum riverine hunting strategies in effect during the Middle Woodland in Iowa diminished during the Late Woodland period. Western Late Woodland samples did not meet inclusion criteria; however, casual examination of select collections suggests bison bone is substantially more common here than at eastern components. For example, a single trash pit at the Late Woodland Great Oasis phase Packer site in central Nebraska produced 72.5 bison bones per m^3 (Bozell and Rogers 1989). Packer is not included in this analysis because the available sample is from only one feature.

Central Plains and Middle Missouri Traditions

Brewster and Chan-ya-ta are the only Middle Missouri tradition samples included here. Both are attributed to the Mill Creek phase of northwest Iowa and date rather early, ca. AD 900-1100. In both instances, bison played a major role in the subsistence economy, based on density values of 34.2 and 25.2 elements/m^3.

The Central Plains tradition samples contrast sharply with Middle Missouri tradition values and typically produce faunas reflective of broad spectrum hunting strategies. Of the 13 Central Plains tradition samples, ten yielded very low bison density values. Two values are between 5.0 and 10.0 elements/m^3 and one is quite high at 24.4 elements/m^3. The high density assemblage is from the McIntosh site—a unique component identified as a semisedentary hunting, fishing, and horticultural village on the shore of a Sand Hills lake in the northern tier of the study area. The two slightly elevated samples (5-10 elements/m^3) are attributed to the second half of the Central Plains tradition sequence (AD 1250-1400).

The diversity values for Central Plains tradition components are generally high and suggestive of broad spectrum hunting. Six of the eight samples with diversity values calculated fall between

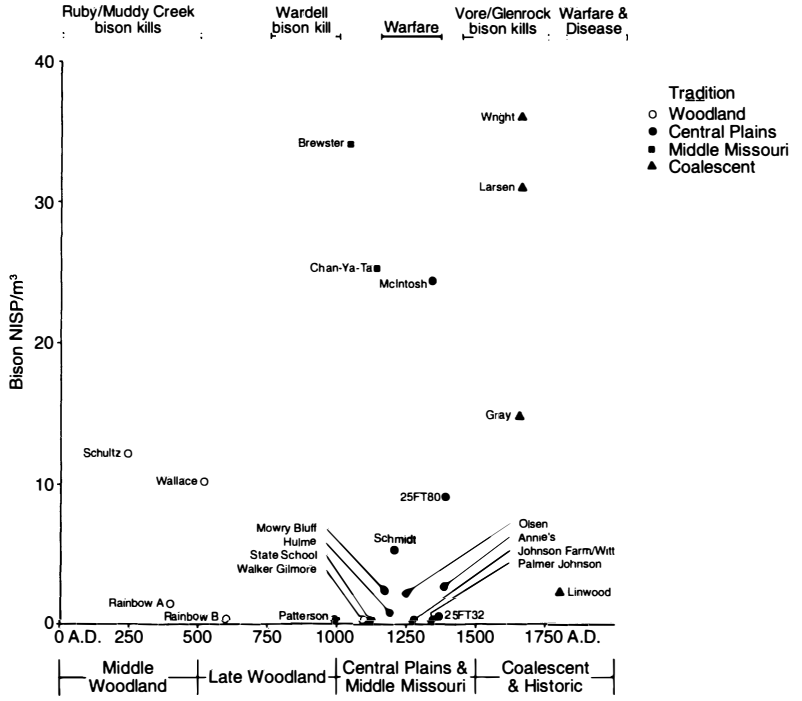

Figure 3. Bison bone density values arrayed against approximate component dates.

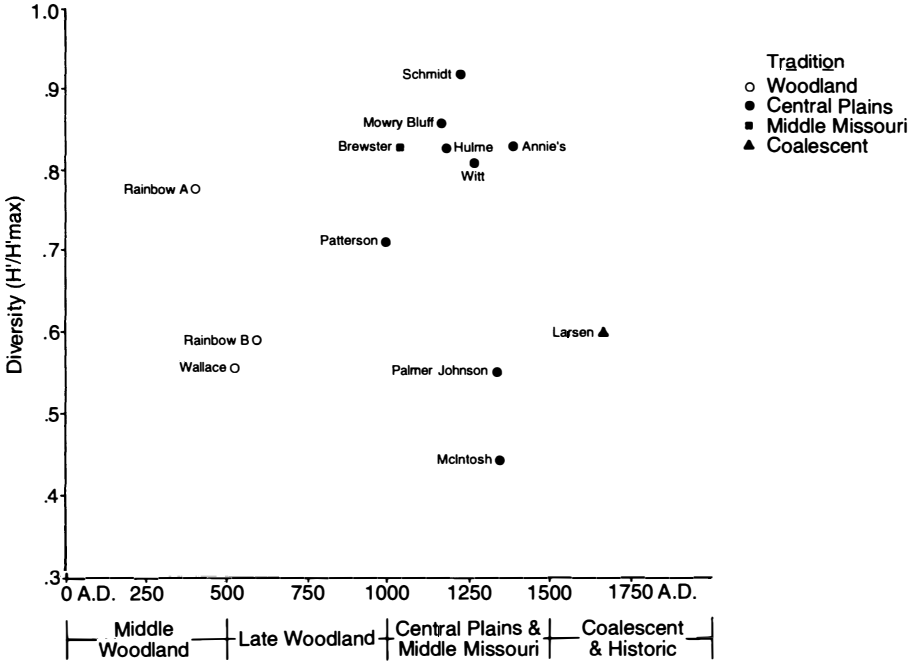

Figure 4. Diversity indices arrayed against approximate component dates.

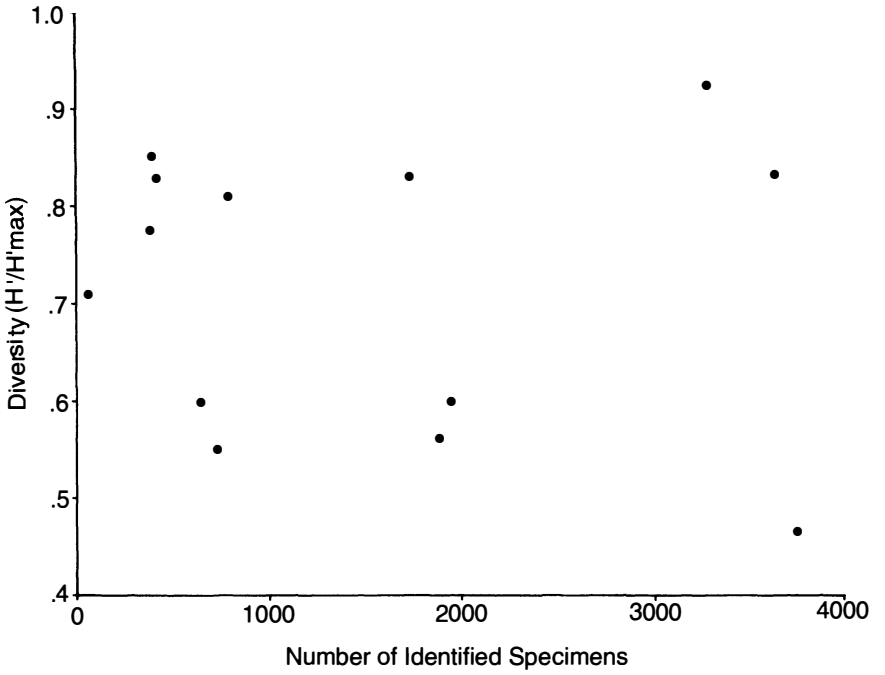

Figure 5. Diversity indices arrayed against sample size.

0.70 and 0.92. Only Palmer Johnson and McIntosh posted low diversity values. In both cases this is due to high numbers of fish remains, not bison.

Coalescent Tradition

Three Coalescent tradition assemblages are affiliated with the protohistoric Pawnee (Lower Loup phase) which flourished from AD 1600-1750. A fourth assemblage, Linwood, represents late Lower Loup and fully historic Pawnee components (AD 1750-1850). The three Lower Loup occupations produced high bison bone density values of 15.0, 31.3, and 36.2 elements/m^3. Lower Loup populations evidently were oriented to bison hunting but domesticated dogs also figured prominently in the diet (Bozell 1988). Other fauna such as deer, pronghorn, birds, fish, and small mammals were taken in relatively low numbers. The only Coalescent sample appropriate for diversity index calculation is the Larsen site. The diversity value is 0.60, which is relatively low in contrast to most Central Plains tradition samples.

In contrast to the protohistoric collections, Linwood produced a density value of only 2.2 elements/m^3. Casual inspection of other late Pawnee sites (e.g., Hill, Clarks, and Horse Creek) suggest Linwood is typical. A recent analysis of fauna from the Omaha "Big Village" (AD 1775-1845) indicates bison bone is not particularly prevalent in that assemblage either (Jackson and Scott 1992).

DISCUSSION

The preceding data display patterning in bison bone density and assemblage diversity in Central Plains archaeological sites dating from AD 1-1850. Woodland sites in the western portion of the region produce moderate densities of bison bone while those in the east display low values. With few exceptions, Central Plains tradition sites produce diverse assemblages with low densities of bison bone contrasting with dense protohistoric samples characterized by low overall diversity. The only historic sample yields a low bison bone density value. Explaining this variability requires consideration of three factors: (1) environmental change and related bison population fluctuations; (2) taphonomy and the nature of the archaeological

record; and (3) human social organization and diet choices.

Climate Change and Bison Population Response

Effective moisture, frost-free days, and temperatures combine to have an impact on the quality of grasses available as bison forage and consequently on the nature of bison populations (McHugh 1972:20; Reher 1978; Bamforth 1988:67-84). Periods of protracted drought or regular episodic drought reduce the quality of grasses and access to drinking water. Cool drought conditions compound the problem by limiting the length of an already poor growing season. Severe climatic deterioration can result in plant biomass reductions of 70-80% (Coupland 1958:288).

Forage quality affects bison herd responses. Bamforth (1988:Table 6-1) proposed bison response to poor forage would be low population density, small herds, and herds which move faster, farther, and more frequently with larger home ranges. Response to high forage production would lead to high population density, large herds, and herds which move slowly, over shorter distances, and within smaller home ranges.

Given these predictions, the following trends are expected. The moist and cool Sub-Atlantic (1000 BC-AD 250) and Neo-Boreal (AD 1550-1880) episodes and perhaps the warm, moist Neo-Atlantic (AD 750-1150) episode should have favored large, slow moving bison herds predictable to hunting parties. The cool, dry Pacific episode (AD 1150-1550) and perhaps the Scandic (AD 250-750) regime should have witnessed poor forage for bison resulting in small, fast-moving, unpredictable herds. The bison density data correlate fairly well with the above predictions, yet regional and temporal dichotomies exist.

Woodland values suggest that throughout the history of the tradition, bison were more frequently hunted in the western and central portions of the region. This is despite the fact that three climatic regimes, including the dry Scandic episode, are represented. Although the late Middle Woodland Wallace site in central Nebraska yielded a moderate bison density value, the assemblage is dominated by pronghorn, perhaps reflecting a response to the dry Scandic climate. Also, the early Central Plains tradition and some Late Woodland values are low. If climate is a strong limiting factor on bison population, the situation suggests the Pacific began in some areas around AD 1000, at least a full century prior to the conventional AD 1100-1200 date. The most recent, transitional Neo-Atlantic–Pacific data in the Central Plains is geomorphic. Deposits as early as AD 1000 indicate a period of high magnitude flooding, erosion, and alluviation (May 1992:128). Such deposits occur when reduced effective moisture creates poor covering vegetation. Then, when infrequent heavy rains do occur, large volumes of sediment are transported.

Pacific era sites which produce high bison density values are the McIntosh site in the Sand Hills and Mill Creek phase sites of northwest Iowa. The Sand Hills is a unique region which historically does not respond to climate change as surrounding regions do and may have been an area Central Plains tradition hunters used to buffer the effects of Pacific episode droughts. Holen (1989:200-203) suggested the Sand Hills may have been a very significant region for Native American bison procurement. Wilhite and Hubbard (1989:20) state:

> The Sand Hills have historically been less vulnerable to the impacts of droughts than other parts of Nebraska.... Vulnerability is also decreased because of the existence of a large groundwater reservoir, which (among other things), stabilizes stream flows, provides water to numerous lakes and subirrigated meadows, and...stabilize[s] forage supplies for the region's livestock industry and wildlife.

The high bison density values for Mill Creek sites may relate to close association with Middle Missouri populations in central South Dakota. Although Middle Missouri subarea micromammal data attest to cool, dry Pacific conditions (Semken and Falk 1987:221), bison populations were not as dramatically reduced as they were on the Central Plains. The explanation for this is unclear and the response of bison and human groups to climate change is not completely understood.

The Neo-Boreal values correlate well with climatic proposals. Late Central Plains tradition sites begin to display elevated bison density values. This dramatically accelerates in Coalescent

samples dating after AD 1600. Evidently, increased moisture resulted in lush grasslands across the region and favored the return of large herds. Not only do sedentary protohistoric villages display high bison density figures, but protohistoric bison hunting camps are relatively common in the area.

The latest sample, Linwood, yielded a bison density value similar to the Central Plains tradition cases, although the occupation also occurred during the Neo-Boreal. The reasons behind this are unclear but may involve equestrian hunting much farther away from villages than before with less bone transported home. In addition, the adoption of metal tools during the historic period may have enabled more efficient and thorough field butchering. A renewed bison population decrease also may have been involved. Such conditions stemmed from intertribal competition (with the arrival of equestrian nomadic tribes such as the Sioux and Cheyenne) for herds to fill subsistence and Euroamerican robe trade needs and perhaps the introduction of domestic cattle diseases (see, for example, Flores 1991). Accounts of vast historic period bison herds are numerous but it is conceivable the herds may have been even larger during the protohistoric period.

The chronology of major Wyoming bison kills correlates well with apparent periods of increased and decreased bison populations proposed in this paper (Frison 1991:34-36). Woodland, Besant, or Avonlea kills occur at sites such as Ruby, Muddy Creek, and Wardell. Kills are rare after AD 1000 and sustained evidence for large scale bison procurement does not reappear until after AD 1500 at Glenrock, Vore, and other sites. The AD 1000-1500 hiatus encompasses the very centuries when low bison density values are indicated for large tracts of the Central Plains.

The Archaeological Record

Complexities of taphonomic processes as well as archaeological data recovery and interpretation might leave the climatic interpretation more apparent than real. Although care was taken to draw consistent samples with respect to recovery and site type, other dynamics may be in play. For example, people of disparate cultures such as the Woodland, Central Plains, and Coalescent traditions may have hunted and consumed bison at a constant rate but in different ways resulting in varying archaeological signatures.

The most obvious source of variation in the archaeological record is local versus extralocal hunting. People who hunted far from their villages, thoroughly processed carcasses, left bone in the field, and returned the meat to the villages with small amounts of adhering bone, may be responsible for sites with "low density" signatures. Conversely, the "high density" samples may reflect near-village bison hunting with transport of more of the carcass home for reduction.

Testing this explanation requires consideration of "off-village" sites. Far more Central Plains tradition "villages" have been recorded in the region than those attributed to the Coalescent or Historic periods, although admittedly the later villages were larger and the Central Plains tradition spans about a century longer. Still, it is remarkable that throughout more than 60 years of archaeological reconnaissance and excavation, with equal chances for discovery, only a handful of even partially satisfactory examples of Central Plains tradition "hunting camps" have been discovered.

At one time, Central Plains tradition sites in extreme western Nebraska, eastern Colorado, and eastern Wyoming were believed to be hunting camps left by central Nebraska and Kansas villagers. Recent reconsideration of these sites, however, led Wood (1990) and Roper (1990) to independently conclude they are the remains of indigenous Central Plains tradition-like people residing on a permanent basis in the Western Plains.

The protohistoric villagers, on the other hand, left clear evidence of bison hunting camps along the central and western Platte basin (Garrett 1965; Holen 1983, 1991; Roper 1994a), the central Niobrara (Wood 1965; Falk et al. 1985), the Nebraska panhandle (Bozell and Ludwickson 1988), and along the margins of the Sand Hills (Roper 1989). These sites typically produce small, specialized artifact collections, no contained features save for hearths, scant evidence of structures, and large amounts of bison bone. These are just the sort of characteristics expected for bison procurement and processing camps.

Even if we assumed that Central Plains tradi-

tion bison hunting camps were of a different character than Coalescent camps, one attribute ought to be shared if they both focused on bison hunting—quantities of bison bone. Yet "off-village" Central Plains tradition sites producing significant amounts of bison bone continue to be rare. Camps in western Nebraska and points west do occasionally yield significant bison remains (see, for example, Cannon 1991; Reher et al. 1994; and Butler 1994). However, they are (1) far west of the range of Coalescent hunting camps and (2) their association with true Central Plains tradition villagers remains to be demonstrated. Also, selected oral traditional evidence suggests ancestral Northern Caddoan "subsistence patterns perhaps did not include a major emphasis on buffalo hunting..." (Echo-Hawk 1990:45). If the Central Plains tradition is in fact ancestral Caddoan, these traditions further support the archaeological data.

Another possible argument is that protohistoric and historic villagers possessed firearms and horses and therefore were able to kill more bison and pack the meat (and bones) great distances home. Conversely, it would be more efficient for pedestrian Central Plains tradition hunters to strip meat in the field and leave the bones behind. Three factors suggest this interpretation is flawed. First, while the late protohistoric and historic villages do produce some horse bones and gun parts, these items are quite rare in the early protohistoric assemblages (ca. AD 1600-1700). The Pawnee had few, if any, horses and guns prior to AD 1700 (Roper 1992), yet villages of this period produce vast amounts of bison bone. Second, the latest village in the study, Linwood, has a low density of bison bone and this is the site which possessed the most horses and firearms. Third, the near absence of Central Plains tradition hunting camps discussed above calls into question a model of prehistoric hunters procuring bison in the west-central Plains.

Domestic dogs feeding on meat and bone piles have an effect upon the composition of vertebrate samples. Ravaging carnivores not only disarticulate and carry away some skeletal portions but also entirely consume some elements. On the Central Plains, dogs occur throughout the Woodland, Central Plains, and Coalescent/Historic periods. Their frequency however increases dramatically during the Coalescent period (Bozell 1988). If gnawing by dogs was a significant factor affecting bison bone density, the later samples should show the greatest effect. However the late samples in fact have relatively more bison bone than the earlier Central Plains tradition samples, which suggests the actions of carnivores did not have a serious affect on assemblage composition.

It is recognized that taphonomic processes and preservation conditions may be different between feature types. However, all feature types were used for all cultural complexes and the conclusions of this paper are broad generalizations which should not be affected by minor differences in preservation conditions. There are no cases where the majority of samples are from a single feature type. Feature types are spread fairly evenly throughout the samples.

We are left with a weak argument that the dichotomy between Central Plains and Coalescent tradition bison density values is merely a function of taphonomy or divergent archaeological records. It is true that these traditions are quite different adaptations. If all were procuring bison on a regular basis, however, the required evidence in the archaeological record is minimal at best.

Decisions about Subsistence Strategies

Cultural factors exclusive of climate regimes may condition bison density values. The samples posting low values such as those attributed to the Central Plains tradition and the eastern Woodland tradition may reflect conscious decisions by hunters to procure a more diverse diet not dominated by buffalo. For example, Osborn (1987:41-45) argued that eastern Central Plains tradition deer procurement deliberately received more attention than bison hunting and maize production—although bison were available. This may be particularly relevant considering that Central Plains and Woodland tradition people existed in smaller and more widespread population aggregates than those of the protohistoric period. Large protohistoric populations may have more urgently needed to organize distant communal bison hunts to meet the subsistence needs of hundreds of individuals. Conversely, the smaller prehistoric groups likely operated as individual families or in aggregates of several families—units small enough that local

hunting of deer, birds, fish, and small mammals provided sufficient protein.

In support of this reasoning, Fawcett (1987) argued that climate change models of bison hunting intensity through time are too simplistic. He suggested the timing and geography of bison kills do not correspond precisely with paleoenvironmental conditions. Fawcett (1987:210) cited mediation of sociopolitical tensions, feeding many people, amassing goods for trade with horticulturists, and securing personal prestige as the central reasons behind communal hunts. His arguments are supported by evidence that some kills were made during drought periods and that animals procured were under significant environmental stress.

Evidence counter to the assumptions by Osborn, Fawcett, and others can be presented. Many small group populations regularly procured bison, including Paleoindians, historic nomads, and Archaic Logan Creek and McKean complex groups to name just a few. None maintained particularly large population aggregates. Simply because small groups like Woodland and Central Plains tradition villagers did not need to procure bison does not mean that they would largely ignore this cost efficient resource if it was available. It is difficult to imagine that if bison were abundant in an area they would not be regularly hunted. The time spent foraging for and capturing migratory birds, deer, and other small animals would not be as efficiently spent if the same effort could be used to kill buffalo, which yielded much greater amounts of meat. Osborn (1987) is certainly correct in his assumption that deer played a major role in eastern Central Plains tradition economies, although I argue the reason was due to low bison availability rather than choice. Furthermore, Fawcett's criticism of climatic factors controlling bison herd density and related human predation is premature. His and other studies confronted paleoclimatic conditions on too fine-grained a scale. Radiocarbon technology and modeling of past climates are rudimentary exercises and predictions of bison response to climate on a micro-episodic scale is overly speculative. We remain at a juncture which requires continued consideration of climatic data on a coarser temporal scale.

Beyond the Central Plains

Since Dillehay's (1974) identification of bison "presence and absence" periods on the Southern Plains, a number of researchers have tried to refute or fine tune the model (see, for example, Lynott 1980 and Huebner 1991). With some minor inter-study variation, the broad picture remains stable and contrasts with Central Plains data. Southern Plains bison populations prior to AD 1200 are listed as low, scattered, or nonexistent. After AD 1200 and continuing through the protohistoric period to the mid nineteenth century, herds are characterized as abundant. The Central Plains contrast with the Southern Plains primarily in that dense bison herds appear in the south about three centuries prior to their apparent emergence farther north.

North of the Central Plains, the Middle Missouri subarea also does not appear to have been affected by bison depopulation between AD 900 and 1600. Cursory examination was made of Middle Missouri subarea samples attributed to the Initial Middle Missouri, Extended Middle Missouri, Initial Coalescent, Postcontact Coalescent (protohistoric), and Disorganized Coalescent (historic) variants (Calabrese 1972; Falk et al. 1980; Steinacher and Toom 1983). The data indicate a slight reduction in bison density values between AD 1200 and 1500, but not as drastic as on the Central Plains. Toom (1992:378-379) amassed a large body of archaeological and geomorphic data verifying a deteriorating climate in the Middle Missouri after AD 1250, but the environmental changes were not sufficiently severe to result in abandonment of that subarea. After about 1500, bison procurement rises in the Middle Missouri and data from protohistoric sites attributed to Oneota in Iowa (Tiffany and Anderson 1993:296) and Wisconsin (Boszhardt 1994) suggest a strong bison hunting orientation.

CONCLUSION

Looking at the transition from late prehistory to protohistory on the Central Plains specifically and Plains-wide more generally, several trends occur in human social groups, subsistence patterns, and climate. Figure 6 presents a theoretical model of subsistence change on the Central Plains

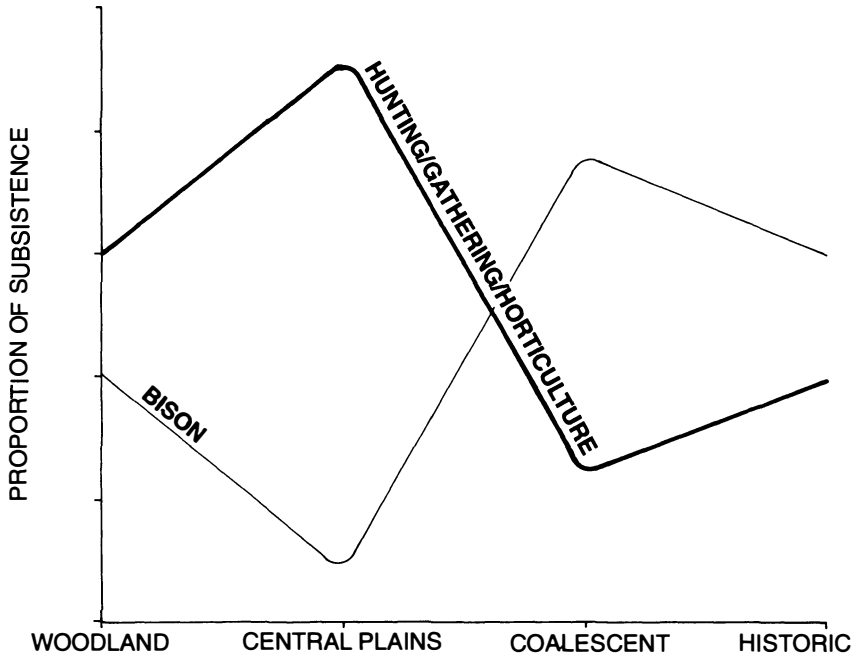

Figure 6. Theoretical variation of major subsistence categories on the Central Plains.

during the period under consideration.

Woodland tradition data do not have sufficient resolution to offer substantive comment. However, it is apparent that both Middle and Late Woodland people utilized bison with increasing frequency from east to west (Bozell and Rogers 1989). Communal bison hunting is not directly evident in the region but did occur at contemporaneous sites in Wyoming. Similarly, large quantities of bison bone at Middle Woodland Sonota Complex sites in South Dakota indicate the species was a critical subsistence item in the Middle Missouri subarea (Neuman 1975:99-104). In many Woodland cases, a rather diverse array of backup resources also was used.

The evolution of the Central Plains tradition is important in understanding late prehistoric bison economies. The tradition was configured along a slow southwest to northeast migration. By AD 1400, most sites of the tradition were concentrated in northeast Nebraska as well as being evident in the Initial Coalescent variant of South Dakota (Roper 1994b). During the latter century of the tradition, warfare ensued as Central Plains tradition people encroached upon territory claimed by the Middle Missouri tradition.

Throughout its history, the Central Plains tradition was characterized by a diverse hunting-gathering and horticultural economic strategy. The diversity of animal procurement is reflected in relatively high evenness index values illustrated in Figure 4. Bison never played a particularly dominant role, although herds were certainly exploited when available—such was the case at the McIntosh site (Koch 1995). Bison procurement during the Central Plains tradition appears to have been an opportunistic component of hunting and perhaps lithic procurement forays rather than intensive communal efforts. Trading with Western Plains groups for buffalo meat and scapulae also may have occurred. However, it seems that incursions into the Middle Missouri heartland were designed to share or even cooperate in procurement of bison herds for food and possibly to gain a greater involvement with Mississippian and Oneota trade. For example, some South Dakota Initial Coalescent components (such as the Whistling Elk site) now understood as simply northern

Central Plains tradition sites, produce significantly more bison bone than most Nebraska Central Plains tradition sites (Steinacher and Toom 1983). Central Plains tradition attempts to share or wrest control over herds were unsuccessful. By AD 1400, as a distinct entity, the Central Plains tradition falls from the archaeological record or was swept up in the development of the Coalescent tradition, perhaps eventually culminating in the historic Pawnee and other groups (Echo-Hawk 1990). The region was largely abandoned save for presence of Oneota populations such as the White Rock aspect along the southeastern margin of the study area.

Occupation of the Central Plains did not reoccur until the arrival of the Pawnee about AD 1600, and Dismal River phase (Apache ?) groups about 1700. The Pawnee developed a sophisticated culture with large population aggregates. Their success likely involved uncontested access to vast Neo-Boreal bison herds. Gunnerson (1972:2) even suggested Neo-Boreal herds were so large that in the western half of the study area, it was "impractical and perhaps even dangerous for people to build substantial houses and plant fields." Pawnee dominance of the region persisted until the early 1800s when increasing pressure from the Sioux, Cheyenne, and other nomads for control of bison resulted in renewed warfare. Low bison density values at late Pawnee villages such as Linwood may reflect nomad-Pawnee competition for herd access. These conflicts, accompanied by disruptions from disease and eventually direct Euroamerican contact, ultimately led to the collapse of the successful adaptation the protohistoric villagers had developed around bison hunting.

In most regions of the Plains, sedentary protohistoric Native American cultures are characterized by large villages, intensive bison procurement, some hunting-gathering, far-reaching trade networks (Blakeslee 1975), and horticulture. Preliminary interpretation of Central Plains stable isotope values (Reinhard et al. 1994:69-70) and caries frequency data (Masters 1987:119, 130-132) suggest maize horticulture played a more important role during the Central Plains tradition than during occupation of the region by historic villagers. In every protohistoric case, bison densities are high archaeologically and climate appears dominated by the moist Neo-Boreal episode. While large compact human populations were new to the Central Plains about AD 1600, they show greater antiquity in the north and south. Not surprisingly, so does intensive bison procurement. For example, Middle Missouri tradition variants (AD 900-1500) produce larger villages than the Central Plains tradition. Similarly, the late prehistoric Southern Plains saw development of larger villages after AD 1200, contemporaneous with dense bison bone refuse. The Pacific episode was not consistently widespread across the Plains and may have been more severe on the Central Plains, delaying the emergence of large villages.

The strongest conclusion that can be drawn from the data is that Central Plains bison population levels fluctuated significantly during the late prehistoric and protohistoric periods. Furthermore, these changes were likely precipitated by climate shifts and the most dramatic fluctuation occurred between the Pacific and Neo-Boreal episodes (see Blakeslee 1993 and Lensink 1993 for counterarguments). Low bison population did not have a severe effect on the ability of people to occupy the region but it did affect social organization. Evidently, abundant bison herds were necessary to sustain large semisedentary population aggregates on the Great Plains. However, large populations did not always develop in response to episodes of dense bison herds. Smaller human groups, such as Early Archaic and some Woodland populations, persisted with plentiful bison, yet the Central Plains tradition comfortably adapted to periods of low bison availability by employing maize horticulture and a diverse hunting-gathering strategy. It is possible, however, that the Central Plains tradition economy eventually became taxed as populations began to swell and resources became depleted, thus setting the stage for warfare with Middle Missouri tradition groups.

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