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FEATURE ARTICLE

LATE PREHISTORIC HIGH PLAINS FORAGERS: STARVING NOMADS, AFFLUENT FORAGERS?

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ABSTRACT—Past human groups of the High Plains have been variously characterized as starving nomads and affluent foragers. In fact, these terms do not capture the multi-faceted nature of the human foraging experience on the High Plains. Relying on human ecology and archaeological interpretations, this paper examines the coping strategies used by Late Prehistoric foragers in the high variance environment of the High Plains, which was relatively less variable during the early part of the Late Prehistoric time period and more variable in the later part.

Introduction

The western Plains—the “American Desert”—were once thought uninhabitable by foot nomads, who, without the horse of the historically documented western Plains equestrian groups, would have been disadvantaged in their pursuit of the life-sustaining bison (Wedel 1961, 1983). The High Plains archeological record, however, has indicated otherwise; and, once human occupation was accepted, the occupants were described as “chronically starving, gathering nomads” (Mulloy 1954:59). Recently, however, Eighmy (1994) suggested this area was occupied from 500 to 1050 A.D. by groups operating out of well established encampments in the foothills of the Front Range. A dearth of remains in the following 450 years suggested that the Central High Plains was used as a hunting territory by groups for whom this area was peripheral. In contrast, however, Roper (1990) found evidence in locally produced ceramics for likely mobile groups in residence here even during the later time period. In addition, Kornfeld (1994) has offered a radical interpretation of past hunter-gatherers in the area just west of the Black Hills; he argues they were not dependent on bison but “affluent foragers,” meaning foragers with leisure time on par with that seen in contemporary Western society.

The shifting description of the human past of the High Plains from nonexistent to ranging from starving nomads to residential foragers to affluent bison-free foragers is a remarkable trajectory; this evolution reflects our growing understanding of human foraging in a challenging environment based on a more complete understanding of archaeological deposits here. In what follows, I take a closer look at human foragers on the High Plains, focusing on the Late Prehistoric time period from 1 to 1100 A.D. The High Plains, with its interior continental location just east of a major mountain range, offers a larder with high temporal and spatial variances in flora and fauna. Even in the best of times, and especially in the worst of times, these variances are magnified. Human behavioral ecology allows us to anticipate aspects of human foraging under such circumstances.

High Plains paleoenvironmental records indicate that conditions during the early Late Prehistoric (1-900 A.D.) were wetter or cooler than those during the succeeding Little Climatic Optimum (900-1300 A.D.). Thus, my strategy is to contrast evidence on High Plains foraging during these two periods. After reviewing High Plains paleoenvironment and prehistory, I examine human foraging behavior in high variance environments, highlighting the evidence we have from the High Plains. Next, I focus on pit hearth processing as a component of foraging documented for the Late Prehistoric sequence of the White River Badlands of Nebraska and South Dakota, underscoring the role this tactic played in foraging. Finally, I close with my interpretation of the implications of these findings for our understanding of High Plains foragers.

High Plains Paleoclimate and Prehistory

The High Plains, for the purpose of this paper, is defined as constrained to the upper reaches of the Upper Republican River and North and South Platte Rivers as well as the western reaches of the Niobrara and White Rivers (Fig. 1). Populations inhabiting and using the High Plains were also likely familiar with the Black Hills of South Dakota, the Sand Hills of western and central Nebraska, portions of the Front Range, and the intermountain basins of Wyoming.

The prehistoric High Plains regional climate was one with high spatial and temporal variance. Modern and historic climatic records, along with dendroclimatic data, indicate temporal variation in precipitation at both annual and decadal scales (Mock 1991). Mock (1991) also found spatial variation, with little correlation to precipitation values, between historic

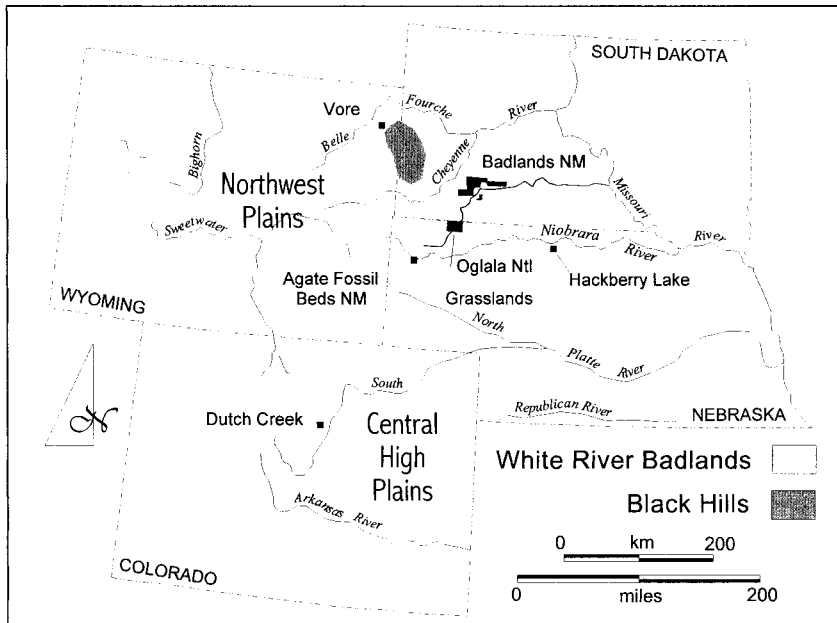


Figure 1. High Plains province.

recording stations 100 to 150 km apart. From this he concluded that drought, when it occurred, was local rather than regional in scale. That these variances are long-standing is affirmed by the drought and fire tolerant plant and animal communities found here (Bock et al. 1991; Fredlund and Tiezen 1994).

While the late Holocene paleoclimate was relatively uniform, there are several lines of evidence suggesting cooler, moister conditions prevailed from 100-900 A.D., followed by dramatically drier conditions from 900-1100 A.D. First, alluvial geomorphology (Fig. 2a) suggests a stable landscape with soil formation during the time period from about 2000 to 1000 B.P. and sediment aggradation and incision in the succeeding several hundred years (May 1992; Martin 1992a, b; Mandel 1992). Second, alluvial fan deposits in the southern Black Hills, as well as terrace deposits along the White River, suggest stable vegetated surfaces until about 900 B.P., with erosion instability following (Fig. 2b). Third, stable carbon isotope values from southern Black Hills soil samples indicate a shift in grassland composition about 1100 B.P., from one with relatively more C_3 (cool growing

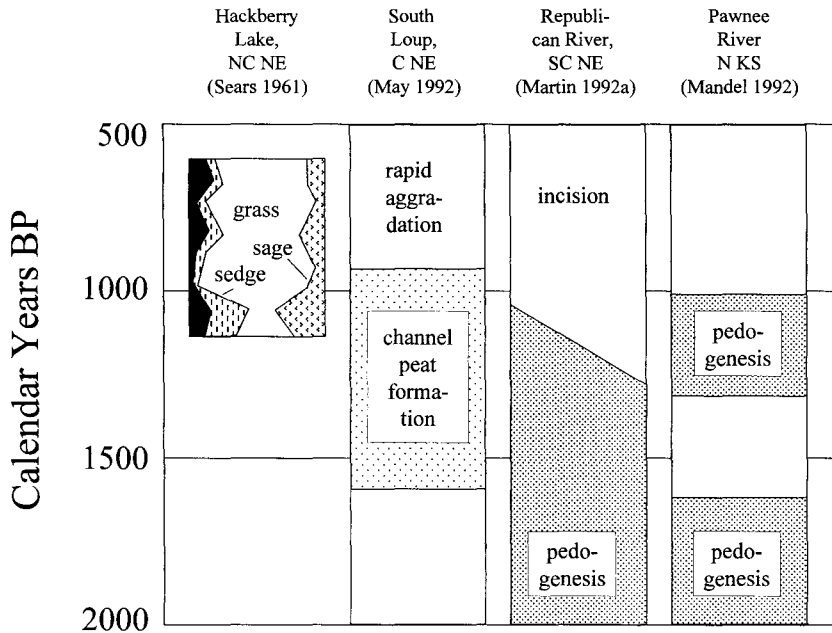


Figure 2a. High Plains Paleoclimatic Reconstructions: Central Plains

season) grasses to one with more C_4 and less C_3 grasses (Fredlund 1996). Pollen data are consistent with this picture, with pine pollen dominating the Hackberry Lake assemblage just prior to 1100 B.P. but grass pollen dominating afterward (Sears 1961). Finally, several glacier advances occurred, between 2200-1600 B.P. and also around 1100-1000 B.P. (Davis 1988).

Taken together, these paleoclimatic data suggest three important trends. First, generally more mesic and possibly cooler conditions prevailed on the High Plains during the first millennium A.D.; and, these conditions were followed by more xeric conditions late in the first millennium A.D. Second, the mesic conditions were not homogenous and continuous; instead, they were varied and also interrupted by several periods of relatively xeric conditions. Third, while similar trends in paleoclimate were seen on the High Plains and on adjoining areas, moisture or temperature regimes were not tightly coupled between regions. For example, on the Central High Plains, relatively mesic conditions appear to have begun later (1800 B.P.)

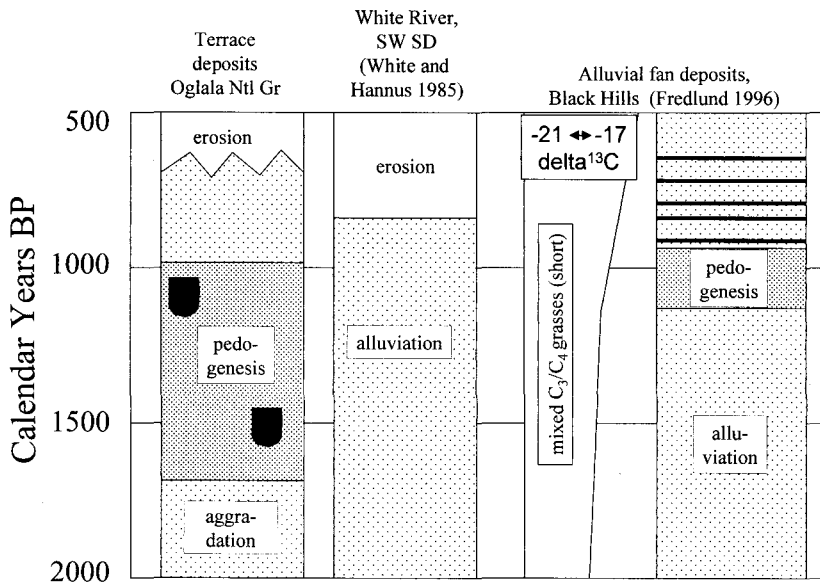


Figure 2b. High Plains Paleoclimatic Reconstructions: Eastern High Plains.

and ceased earlier (1400 B.P.) than similar conditions on the Central Plains further east (2000-1600, 1100 B.P.).

In sum, long periods of relatively moist, a less variable conditions prevailed on the High Plains 2000-1100 B.P., with relatively more xeric and likely variable conditions following with the onset of the Little Climatic Optimum about 1100 BP. Of course, both human and nonhuman foragers, respond to specific conditions rather than to gross environmental trends. For now, the best prediction is that foragers likely relied on different suites of foraging tactics in the early (2000-1100 B.P.) portion, compared with the later (1100-900 BP) portion, of the Late Prehistoric sequence.

Having established a framework within which to examine High Plains foraging, I turn now to briefly review human past on the High Plains as known archaeologically. Unfortunately, we cannot say with precision exactly who the occupants were nor how they were related to contemporary Native American groups (see Wolf 1994). Nevertheless, how these occu-

TABLE 1
High Plains Cultural Sequence (after Hofman 1996)

Taxa	Time Period	Subsistence	Mobility	Technology
Late Prehistoric Period	2500-1100 B.P.			
Plains Village sub-division	A.D. 900-1400	domesticate-oriented economies appear on eastern High Plains		globular-shaped ceramics; bison-scapula hoes in eastern High Plains contexts
Plains Woodland sub-division	500 B.C.-A.D. 900	domesticated plants appear	structures in the foothills of the Front Range on SW High Plains	bow-and-arrow weaponry systems, large, conical-shaped ceramics
Archaic Period	7000-2500 B.P.	diverse, as indicated by the inclusion of many plants and animals	shallow pit structures from the NW Plains suggest some degree of sedentism; tipi rings argue for regional mobility	corner-notched projectile points (atlatl and dart weaponry); roasting pits; ground stone (indicating reliance on foods requiring more processing or processing for storage)
Paleoindian Period	>7000 B.P.	megafauna (e.g., mammoth) and dense herbivore (bison) orientation	400-200 km as indicated by distances between lithic raw material sources and find location	distinctive and large lanceolate projectile points, usually interpreted as spear-points, and associated forms

pants coped with, and perhaps even thrived on, the resource variations on High Plains is approachable archaeologically. Since the focus of this paper is on foraging in the Late Prehistoric period (Table 1), it is useful to briefly review the current understanding of this and the immediately preceding time periods (Bozell and Winfrey 1994; Eighmy 1994; Adair 1996).

The Late Prehistoric time period is sometimes subdivided into the Plains Woodland period and the Plains Village period. The Plains Woodland period is recognized on the basis of large, conically-shaped, cord-roughened ceramics, which appeared at this time. Also found are corner-notched projectile points (atlatl-and-dart or bow-and-arrow weaponry), relatively more elaborate burial practices (see below), and domesticated plant species, both introduced (e.g., maize) and indigenous (e.g., goosefoot, pigweed). The degree to which agriculture was practiced by Plains Woodland period populations in the High Plains was likely limited, given the rare reports of maize and other domesticated plants like goosefoot and pigweed from the High Plains (Irwin and Irwin 1959; Zier and Kalasz 1991:133-36) in contrast to the Central Plains (see Adair 1994, 1996) and the American Southwest.

The Plains Village period followed. On the eastern High Plains of the Upper Republican River valley, the Plains Village period is recognized on the basis of small earthlodges, small- to medium-sized globular ceramics, and small triangular notched or unnotched arrow projectile points. Exotic items from mortuary contexts of this period, including copper, malachite, turquoise, and shell from the Gulf and Atlantic Coasts as well as from eastern North America, are usually interpreted as trade goods (Logan 1996). Also reported are bison scapula hoes, which are associated with agricultural economies, especially on the eastern Central Plains. Further to the west, evidence for earthlodges and agricultural tools is lacking, although locally produced ceramics have been recovered (Roper 1990; Wood 1990).

Based on the paleoclimatic reconstructions, we expect that the foraging strategies used by Plains Woodland occupants in the High Plains were either different, or were implemented with different frequencies, than those used by succeeding Plains Village foragers. My goal is to understand the nature of this foraging, especially during the late Plains Woodland time period.

Human Foraging in a High Variance Environment

Studies of foragers in high variance environments, those typified by frequent and perhaps unpredictable temporal and spatial changes in resource

abundance, have focused on five strategies (Halstead and O'Shea 1989; Redding 1988; Kaplan and Hill 1992:188). These are:

- 1) mobility with frequent patch abandonment,
- 2) diet selection,
- 3) storage,
- 4) information sharing, and
- 5) resource sharing.

I review the five strategies and the evidence for their employment by High Plains populations. In addition, I consider two other options, low-cost agriculture and intensive agriculture, as possible measures adopted by High Plains populations to deal with resource variation.

Mobility with Frequent Patch Abandonment

Resource patches that are spatially small or which host few prey may be rapidly harvested, and so, patch abandonment should be frequent (Stephens and Krebs 1986). A world-wide analysis of pedestrian human foragers with low dependence on fish (Kelly 1983, 1995:111-60) indicated that, in situations similar to the High Plains, we typically find high levels of residential mobility—15-40 moves/year—with an average distance between moves of 20 km; and, such moves are correlated with patch abandonment and the exhaustion of water supplies. Kornfeld (1994:90-123) compiled information to calculate total return rate (energy captured minus handling cost) for various High Plains resources, ranging from cattail pollen to beaver and bison. However, for the High Plains, we currently lack detailed, independent information on patch size and species abundance of the kind that has been compiled for the Interior Northwestern Plateau of North America (Thoms 1989). Nevertheless, most researchers appear to view the High Plains as providing many redundant patches with low average resource abundance, but unpredictably-occurring resource blooms (e.g., Wedel 1986; Gunnerson 1987). In any case, the archaeological record clearly indicates that 1000-2000 years ago human foragers here were very mobile, with little indication of substantial domestic structures except in the foothills of the Rocky Mountains (Eighmy 1994:228-29).

Diet Selection

Second, under stressed conditions diet may be broadened to include lower quality resources that are relatively stable year-to-year (Kaplan and Hill 1992:188). A mixed strategy, situationally emphasizing both reliable,

low-return foods and sporadically available high-return foods, also might be employed. There are few data available on the quality, relative quantity, or periodicity of various High Plains food resources. However, during the Little Ice Age bison jumping events, at the Vore site, just west of the Black Hills, appear to follow stretches of relatively moister conditions with enhanced forage resources (Reher 1977). Kornfeld (1994) suggested that roots would have been a relatively stable resource, less sensitive to drought, in this area.

Storage

Storage is another option available to foragers in high variance environments (Kaplan and Hill 1992:188). Some storage would have been required for human groups to remain on the High Plains during the non-productive season. However, storage has a number of liabilities. These include: handling costs to prepare food for storage, loss in food value, loss to pests, and lost opportunities since foragers are now tethered to their stores (Kaplan and Hill 1992; Binford 1980). On the Great Plains, the production of pemmican, a nutrient dense food composed of meat that is dried, pounded, mixed with fat and berries and stored in liquid bone grease, is described as a labor intensive process (Wheat 1972; Reeves 1990:169). Similarly, processing camas lily for storage requires several days of pit-roasting, to make these bulbs accessible to the human digestive track (see below), and then another day of dehydration, to make the product durable (Thoms 1989).

Information Sharing

Information collection and sharing among foragers is another possible strategy for reducing the effects of variance in resource abundance. Information about patch locations and their potential productivity is insurance against total resource failure (Kelly 1995:97-98). Unfortunately, other than the presence of exotic materials which signals the flow of material between groups, we have no unambiguous criteria for recognizing information sharing archaeologically.

Resource Sharing

The fifth alternative that has been explored in depth is resource sharing, the reciprocal exchange of products between cooperators (Winterhalder 1986a, 1986b). In a high variance situation, sharing is an optimal strategy. Sharing accrues benefits, even if the number of co-operators is small (< 10), as long as individual harvests are not correlated. Reciprocating relationships among groups may develop under specific circumstances (Spielmann 1986; Kelly 1995:197-201). For example, reciprocity between groups is expected

within an ecosystem when group yields are temporally variable and uncorrelated (Kelly 1995). Moreover, access to patches that are dispersed, readily exhausted and unpredictably recharged, such as seen on the High Plains, will be regulated by the owners of those patches using a variety of social mechanisms that are less costly than on-the-ground patrolling. For example, a soliciting group may seek (and usually obtain) permission from the owning group to locate and harvest from specific patches (Cashdan 1983). This situation contrasts with one in which patches have abundant and predictable yields; in this case, a territorial boundary encompassing these patches is likely to be explicitly patrolled and defended by the owners (Dyson-Hudson and Smith 1978).

Groups in different ecosystems may develop fragile, mutualistic relationships that facilitate the exchange of complementary subsistence resources. High resource productivity is most conducive to the development of such relationships (Spielmann 1986:303). We know that intergroup exchange of this sort occurred, from the chronicles of early European explorers (Hammond and Rey 1953, 1966; Riley 1978). For example, some Apache populations on the southern High Plains exchanged bison commodities, principally meat and robes, for maize and cotton grown by Puebloan populations in the eastern foothills of the mountainous spine of New Mexico (Gunnerson 1972). Spielmann (1983), using evidence on the complementary distribution of exotic materials on the southern Plains and adjoining mountains of New Mexico, argued that a mutualistic relationship between these groups was likely in place around A.D. 1450.

Exotic material goods found in some Plains Woodland burials (see below) indicate that High Plains groups were involved in exchange with their neighbors, especially to the east and west, since the mid-portion of the first millennium A.D. (Vehik and Baugh 1994:258; Wood 1980). It is unclear if these exotic materials were brought by itinerant traders, as Spielmann (1983:269) suggests for the southern High Plains, or were transported via an extended trading partner network. The main point is that, even during the Late Prehistoric period, High Plains populations were in contact with other groups to the point that mutualistic relationships sometimes developed. High Plains groups may have abandoned local patches at times and used their trading network for access to other patches on or off the High Plains.

A Lottery Strategy?

An option, understandably not considered by Kaplan and Hill (1992) given their focus on pure foraging, is that of low-cost investment in labor. Under the right conditions and if a person is lucky, the result of a small

amount of labor can be a windfall. If conditions are not right, such as when drought prevails or the grasshoppers descend, relatively little effort is lost. Pastoralism is one such strategy often seen in Old World high variance environments. Herd and flock sizes expand greatly when forage conditions are optimal, but fall through die-off and emigration when forage conditions are poor (Pearson and Ison 1987).

Low-cost strategies may also entail use of weedy plants. Cheyennes in the vicinity of the Black Hills planted maize in small gardens and then left the area to harvest wild foods (Moore 1987:145, 147). The high productivity of maize, along with subspecies that responded well to known local moisture conditions, may have made this low-cost gardening strategy possible. However, it is currently unclear if the indigenous High Plains crops, i.e., sunflower and goosefoot, were productive enough to have been planted as part of such a low-cost agricultural strategy.

Intensification—An Option Not Taken?

Intensification refers to the addition of capital, labor, or skills to increase the energy produced by a parcel of land (Boserup 1965; Morrison 1994). Intensification is an option that may or may not have been available to High Plains populations. A prime example of intensification is agriculture, the creation and maintenance of artificially, productive microenvironments for cultivated grasses and forbs. Typically, we associate agricultural practices with domesticated seed crops; however, as Thoms (1989) argued for the Northwest Coast of North America, it is clear that camas grounds were actively tilled and defended by native populations. This, he suggests, is a form of intensification.

Given the extreme variation in High Plains moisture and temperature, I hypothesize that an intensive agricultural strategy would be a viable option only under a restrictive set of conditions. One important condition is the saturation of the High Plains with foraging groups. A second condition is a cultural repertoire that includes cultivatable species responsive to investments of labor, capital investment, or skill. Rosenberg (1998) has argued at a theoretical level that an increase in group density leading to resource saturation may precipitate dramatic economic reorganization, as groups elect to defend the portion of their former range where intensification will be most successful. In the case of the High Plains, such areas are likely to be the better-watered foothills of the Front Range and along the major rivers, such as the Platte, Republican, and Niobrara Rivers. Until an increase in group density occurs, however, intensification represents a relatively costly option.

Land Tenure

The relative dependence of a group on specific foraging and economic strategies has implications for land tenure. Casimir (1992), building on the work of Dyson-Hudson and Smith (1978), saw a direct relationship between the abundance and predictability of forage resources and the inclusiveness of the property owning unit. He predicted that as forage becomes more abundant and predictable, the size of the kinship group defending a unit of land will decrease, from multiple groups to the clan, the family, and then the individual. Kelly (1995) presents data that suggest this relationship can be extended to foragers. Thus, when resource patches are rich or predictable and where storage or some agriculture is practiced, we expect patch ownership by a family or supra-family group. Conversely when resource patches are readily exhausted and recharge slowly or unpredictably, such as resources that are sensitive to moisture and temperature fluctuations, we expect access to those patches should be open to a wider set of potential exploiters. Access may still be regulated. In this later case, information and resource sharing may be particularly important. While we cannot "see" ownership archaeologically, we can use multiple lines of evidence to address these issues. For example, we can obtain an idea of how widely foragers range by looking at the distance between a source of chipped stone raw material and a site where the chipped stone tools and manufacture debris are recovered. In his analysis of chipped stone projectile points from surface contexts at Agate Fossil Beds National Monument, MacDonell (1996) reported that increasingly local materials were used for the manufacture of projectile points within the sequence of Archaic, Plains Woodland, and Plains Village periods (Table 1).

Additionally, mortuary practices provide information about land tenure and ownership. The establishment of a burial ground where deceased relatives are interred suggests a commitment to return to that location, which is presumably somewhere within the annual range of the group. Cross-cultural studies indicate that "formal, bounded disposal areas for the dead are maintained by and symbolize the corporateness of social groups (especially lineages) that have rights over the use and/or control of crucial, restricted resources" (Carr 1995:191-92). For the Plains Woodland time period (500 B.C.-A.D. 900), ossuaries, which are cemeteries with multiple interments of presumably related individuals, are commonly reported from the major drainages of the central and southern High Plains (Fig. 3). It is unclear if the spatial pattern of ossuaries is owed to where archaeological

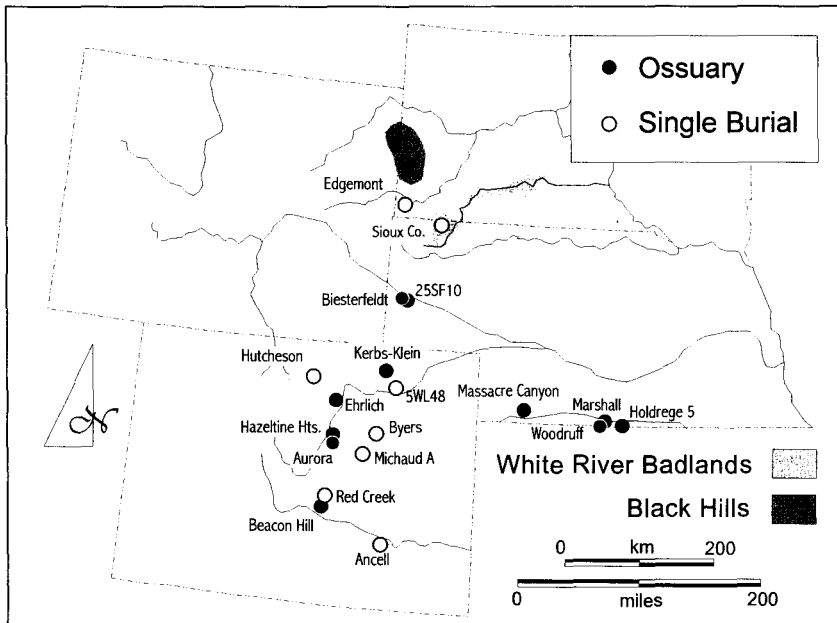


Figure 3. Late Woodland ossuary and single interment locations on the High Plains (modified after Butler et al. 1986). Data from summary in Butler et al. 1986 and Black et al. 1991; Brunswig and Wanner 1993; Hughes 1949:275; Kivett 1953; Oothoudt 1976; Strong 1935.

work has been conducted over the last decades. However, the existence of these ossuaries suggests some level of corporate territoriality was practiced during the Plains Woodland time period.

Foraging and Pit Hearth Technology

In exploring the nature of High Plains foraging, I especially focus on one technological tactic employed by these foragers, that of pit hearth food processing. On the High Plains, pit hearths from this time period are cylindrical in shape, about 1 m deep and 75 cm in diameter, and may have 150 kg of rock near their base, underlain by a bed of charcoal (Fig. 4). Although, these features (Fig. 5) have been observed and written about for almost 100 years (Sheldon 1905; Champe 1946:63-65; Hughes 1949), little is known about them.

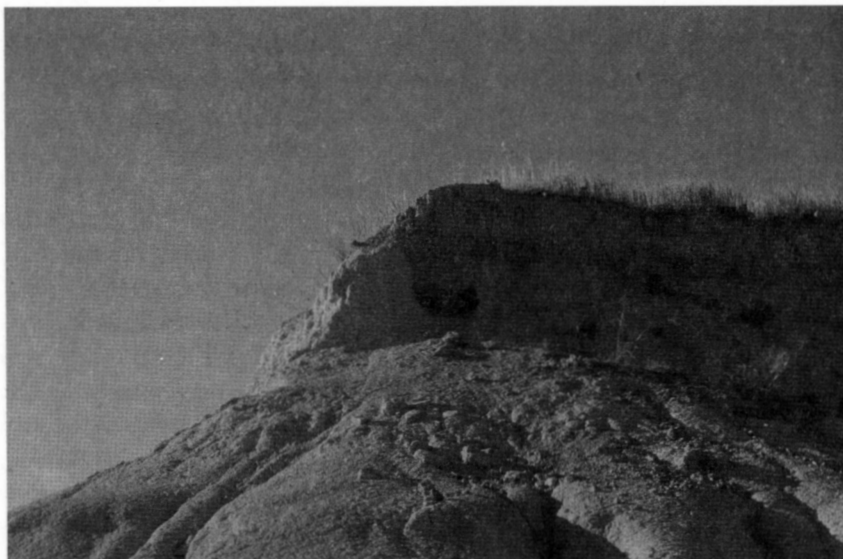


Figure 4. Feature 1, Arner Site, Sioux County, Nebraska

In the White River badlands of northwest Nebraska and southwest South Dakota (Fig. 1), I estimate there to be hundreds, if not thousands, of such features per square kilometer. Such features appeared on the Plains about 5000 B.P. (Frison 1983). In this area, however, most appear to have been built and utilized between 200 and 1000 A.D. (Johnson 1996; Wandsnider 1997; White and Hannus 1985). In the White River Badlands, such features may be found as much as 10 m beneath the modern prairie surface (Fig. 4). Essentially identical features dating to the same time period also occur elsewhere on the High Plains, a meter or more beneath the modern ground surface (Gilmore 1989).

Pit hearths were designed to process a specific range of foods and products. Because of this, their presence or absence is a powerful indicator of how prehistoric populations subsisted in the high variance environment. Pit hearth technology, however, may be a component in one of several different possible coping strategies. To what degree was pit hearth processing an aspect of specialized foraging, tied either to overwintering or to commodity production? To what degree did it reflect an intensive root harvesting strategy by hunter-gatherer populations with limited mobility options? Did it reflect one tactic of a diversified foraging strategy that



Figure 5. Feature 6, Arner Site, Sioux County, Nebraska.

yielded either a broad, shifting diet or a relatively stable diet. Or, was this technology an epiphenomenon tied to other activities, such as information gathering by “galloping gourmets?”

A greater understanding of pit hearth function provides a bases on which to distinguish among these options. Ethnographic accounts indicate that pit hearths functioned as an oven, with heat from combustion and coals stored in the walls and rock element of the hearth. For a modest fuel investment, pit hearths allowed foods to attain temperatures of 95°C, falling to 40°C over a period of several days (Wandsnider and Sodha in press). Such temperatures and cooking times are useful for processing specific foods, such as high fat meats and plant foods composed of complex carbohydrates, like the starches of potatoes, corn, and rice or the fructans of onions, camas, sego lily, and Jerusalem artichoke. Each of these foods is difficult for the human gastrointestinal tract to fully digest. Uncooked fatty foods or complex carbohydrates pass through the human digestive track without the full extraction of fats and potential energy. By subjecting fatty meats and complex carbohydrates to a moist heat, i.e., by pit-roasting them, they become less complex and therefore more digestible.

Starches and fructans of plants occur in a variety of forms, which determine in part the difficulty of digestion. For example, plants with fructans in the form of inulin, such as sego lily and Jerusalem artichoke, cooking is essential. The human body does not possess the enzyme critical for digesting inulin. Without cooking, inulin passes into the small intestine, where it ferments. Only half of the total potential energy contained in foods containing inulin is actually absorbed (Hendry and Wallace 1993). Animal flesh, in contrast, does not require extensive roasting to increase its palatability and digestibility (Wandsnider 1997). Indeed, prolonged exposure to elevated temperatures makes meat tough and less palatable. Cooking is issued to increase durability.

Ethnographically reported cooking times are on the order of several to twelve hours. Hence, a rock element within the oven, which extends the length of time over which high temperatures are maintained was rarely used in roasting small mammals. When it was, ethnographic accounts indicate that the rock element was very small (Wandsnider 1997). In contrast, more than 80% of 72 ethnographic accounts of pit hearth roasting of plant foods report that a rock element was employed; and, 100% of plant foods with fructans were processed this way. Cooking times ranged from several hours in the case of onions, to several days in the case of camas (Wandsnider 1997).

Although the pit hearths on the White River likely functioned as roasting ovens, we currently have no direct evidence for this interpretation. However, charred camas and onion bulbs have been reported from excavated

pit hearths on the Northwest Plateau (Thoms 1989) and unidentified charred roots from Green River Basin (Wyoming) cobble-filled hearths (Francis 1997). Hughes (1949:275), noted the lack of animal remains associated with similar features in South Dakota, and suggested that plant foods were processed here. Johnson (1996), however, report charred rodent bones from one Badlands National Monument pit hearth. White River pit hearths were likely used for processing many kinds of foods; for those with a rock element, I assume for now that bulk quantities of bulbs or roots, e.g., sego lily, camas, onion, or Jerusalem artichoke, were processed because of the strong empirical relationship seen between fructans-bearing plant processing and roasting in the pits with a rock element. In the future, direct evidence for this interpretation would be opal phytoliths, macrobotanical remains, or plant lipids from the pit hearth walls and rocks.

If the pit hearths had a fructans-bearing plant processing function, what would this suggest about High Plains economies? With which of the foraging options would they be most consistent? In the following, I use a comparative approach, contrasting evidence from White River pit hearths to those used historically and documented ethnographically, especially from the Northwest Plateau of North America. In doing so, I rely on several lines of archaeological evidence. As seen in other historical sciences, such as paleontology and geomorphology, any one line of evidence may be consistent with more than one interpretation. By marshaling several lines of evidence, however, we should be able to eliminate some prospects and target others.

Results and Discussion:

Evidence on Foraging Strategy from Pit Hearths

Specialized Commodity Producers?

Could pit hearths have been used by specialized foragers to amass stores for winter or to trade with other peoples elsewhere? Three lines of evidence argue against this proposition: small pit hearth size, lack of evidence for dog transportation, and lack of processing tools. Compared with pit hearths from the interior Northwest Plateau of North America, where camas processing is well documented ethnohistorically, White River pit hearths are relatively small (Fig. 6). In the interior Northwest Plateau, groups harvested huge quantities of camas (Thoms 1989). Women would spend most of summer and part of the fall at the camas grounds harvesting

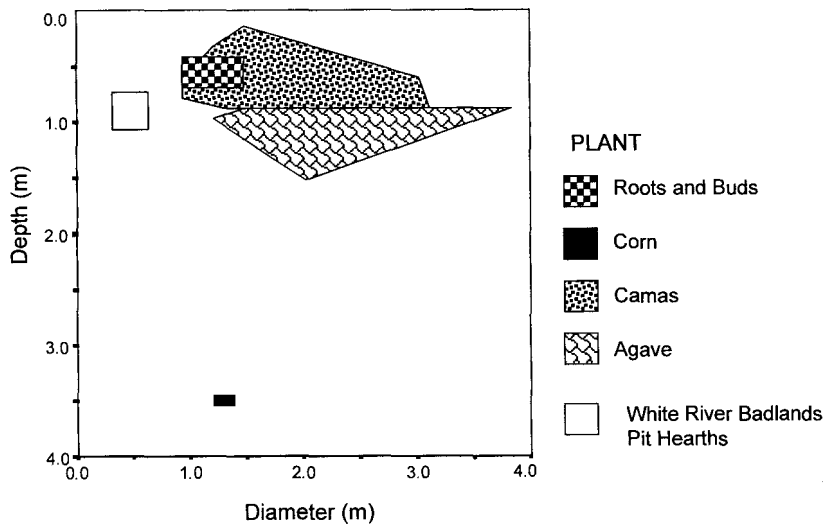


Figure 6. Dimensions for High Plains archaeological pit hearths and ethnographically documented pit hearths used for preparing roots, bulbs, cactus buds, or agave hearts (but not sotol or yucca, which involves the processing of bulky, food-poor leaves).

and processing literally tons of camas. Camas provided perhaps as much as 30% of the annual diet of interior Northwest Plateau groups such as the Coeur d'Alene and Flathead (Thoms 1989). The diameters of the archaeological camas pit hearths reported for the Calispell valley range from 1.2 to 3.5 m, with an average diameter of 2.4 m (Thoms 1989:401-3), twice the average volume of those from the High Plains White River area (Wandsnider 1997).

Several observations from the interior Northwest Plateau and intermountain west are helpful for appreciating how pit size related to the scale of the roasting activity. First, the nutritional qualities of camas degrade rapidly, if not processed soon after harvest. Thus, typically, camas would be roasted after enough had been amassed, usually no later than a couple of weeks after harvest (Thoms 1989:265-70). Second, roasting facilities were constructed near the camas grounds, where fuel, water, hearth rock, and camas co-occurred (Thoms 1989:253-57). Third, women would harvest

individually, but three to four women would pool their harvest for roasting, taking care to mark their lot. Roasting facility size therefore reflects: the number of women cooperating to roast their harvests, the bulb density of the camas grounds, and the dependence of these groups on camas as an overwintering or exchange product.

Thus, the relatively small size of the White River pit hearths, compared with those from the Northwest Plateau, suggests several possibilities. Harvesting parties were likely smaller, perhaps based on nuclear family labor rather than the pooled labor of women from several such families. Small pit size may also mean that patches had low bulb densities that could not bear heavy harvesting. For example, sego lily appears to grow in relatively low densities (photo in Frison 1991:337) compared to camas (150-850 bulbs/m², Thoms 1989:166-70). In any event, it is likely that the relatively small scale of exploitation suggested here was more geared toward household production and immediate consumption than toward significant levels of commodity production for storage or exchange.

It is noteworthy, however, that along the White River it is common to find several additional pit hearths once one pit hearth is found. Currently, it is unclear if this pattern is an artifact of the erosion that exposes features that were built at disparate times, or if it is created by the active clustering of hearths produced during simultaneous roasting events. Careful excavation of several hearths in a single cluster may help to resolve this issue.

In the absence of rivers, it is relatively expensive to move products to consumers. Especially in the case of commodity trade, transportation may be critical. Spanish chroniclers report vast trains of dogs carrying bison products from the Plains and agricultural products from the western Pueblos of the southern High Plains (Gunnerson 1972). The historically documented interior Northwest Plateau groups made extensive use of horses to pack processed camas to winter camps (Thoms 1989). A question that remains to be answered for interior continental locations is the degree to which specialized production, whether associated with commodities exchange or not, can proceed without beasts of burden. While no special analysis has been conducted on the few faunal materials recovered from pit hearths sites, there has been no explicit mention of dog bone nor evidence of dog gnawing. This observation is consistent with the idea that dogs were not being used to haul processed products from the White River area to other locations.

Preparing bulbs and other products for storage and transportation requires additional processing. Northwest Plateau groups used stone and wooden mortar and pestles to grind or knead roasted camas into cakes for

storage (Thoms 1989:257-73). Such tools were likely highly valued by past inhabitants, and we would not expect to find them archaeologically until they are in a very reduced state. No groundstone has been recovered from White River pit hearth deposits, although grinding slab fragments were found in the rock element of pit hearth features at the Dutch Creek, central Colorado (Gilmore 1989:24).

Together, the small size of the pit hearths and the lack of evidence for dogs or for additional processing suggests that pit hearth food processing was related to household consumption rather than to commodity production or generation of large winter supplies.

Intensified Harvesters?

Could pit hearths represent the material remains of intensive harvesters tethered to restricted ranges? To evaluate this possibility, I consider the evidence for a restricted range size, specialized tools, and the presence of capital investments in the landscape. First, the range utilized by past groups is estimated by the distance between the toolstone source and archaeological location. For the small quantity of chipped stone coming from White River badlands pit hearth locations, the source is very local, i.e., nearby Chadron formation gravel deposits or Scenic chalcedony (Wandsnider et al. 1995). No exotic materials, for example from eastern Wyoming, have been reported, suggesting a small range. In contrast, Gilmore (1989) reported the presence of White River Group silicates Flat Top Butte chert associated with the pit hearth deposits along with the occurrence of locally available toolstone at the Dutch Creek site in central Colorado just east of the Front Range. If his determination is correct—we know that White River Group silicates outcrop at a variety of locations on the High Plains and are not easily visually distinguished (Hoard et al. 1993)—then a more extensive range of several hundred kilometers would be indicated.

Other than the pit hearths themselves, which appear designed for processing foods with specific properties, few other specialized tools have been recovered. Groundstone is rare and cord-roughened ceramic sherds are infrequently reported for pit hearth locations. The ceramic vessels yielding these sherds can be quite substantial. For example, a complete vessel, 53 cm in height, was found with a man interred in Sioux County, NE (Gill and Lewis 1977). Ceramic vessels are empirically and technologically associated with the cooking of starchy seeds (Stiger 1998; Rice 1999). On the High Plains, it is presently unclear if such vessels were used for specialized seed cooking, or, more generally to cook a wide variety of foods.

We have no direct evidence of capital investments made in the landscape to increase harvest. Such activities and associated features may be difficult to identify, and they may preserve poorly. For example, people may burn patches to remove competing plants and to increase soil nutrients, as documented for Australian and Northwest Plateau groups (Hallam 1989; Thoms 1989). They may till the patch with desired plants to increase drainage and soil oxygen (Thoms 1989). They may modify spring outlets to create artificial meadows, as described root patches utilized by Southwestern Australian Aborigines (Hallam 1989:139). And, they may develop specialized technologies to more efficiently exploit a patch or process its harvest. For example, communal bison hunting represents a specialized bison harvesting technology with both capital investments in drive lines, corrals and pounds, and with assembly-line processing of bison carcasses by specialized teams (Frison 1991).

In the White River badlands, we have found no evidence for such investments, other than the pit hearths themselves. These pits appear to be both designed for the short- rather than the long-term. Root or bulb patches may have been burned to increase their productivity, but cultural burning and fires started by lightening are difficult to differentiate. Some researchers, however, have inferred unnaturally regular patterns of burning from the charcoal lenses found at forested locations in British Columbia (Sandra Peacock, personal communication 1998). Wet meadows in which camas and other bulbs thrive may have been encouraged through damming, but we have no direct evidence for this practice. We have also found no indicators of patch ownership, such as field demarcators. It may be that bulb and root resources were too sparse, or responded poorly to attempts to manipulate them, precluding major investments to enhance their productivity.

In sum, the weight of the present evidence suggests that groups were not ranging far (5-20 km), and that they were not engaging in intensive harvesting practices beyond those required for increasing the extraction of calories from pit-processed foods.

Reliable Diet?

Could pit hearth processing suggest that past diets had been modified to include reliable foods? At this point, we have no criteria for deciding which food resources were more stable or less sensitive to fluctuations in moisture and temperature. Remains at pit hearth sites, however, imply frequent, short term occupations of the locale. Thus, if pit processed resources were less sensitive to moisture and temperature fluctuations than other

possible resources, they must also have been of low abundance and slow rebound. Both negative and positive evidence support these suggestions.

For negative evidence, occupations associated with pit hearth sites do not appear to have been extensive. We find little evidence of long term settlement associated with pit hearths (Wandsnider 1996). In contrast, Hallam (1989) reported long-term settlements, characterized by numerous beaten paths, wells and clay-plastered huts, associated with dense, highly productive root patches for historic Aboriginal groups in Southwestern Australia. Turney-High (1937:112) suggest that Flathead people returned to the same camas grounds year after year to harvest camass, based on materials and other unspecified evidence suggesting frequent re-occupation. The Arner Site, on the Oglala National Grasslands in northwestern Nebraska (Figs. 4, 5), is one of the few pit hearth sites where horizontal excavation has been undertaken. Domestic activities may have occurred on a paleosurface to the north of one pit hearth, which has now been flushed into the White River; however, there is no current evidence for either structures or structured deposition of refuse, such as commonly seen at camps that are occupied for weeks to months and that are deliberately reoccupied (Wandsnider 1996). Interestingly, few material remains are associated with pit hearth sites along the White River badlands. When deposits with multiple artifacts are found, pit hearths are lacking (Meston 1976; see Johnson 1996 for similar findings in Badlands National Monument). Sheldon (1905) reported a thick cultural layer, but, this may represent a buried soil with cultural material. These data suggest that the populations responsible for the Arner site, and for similar deposits, did not stay at these locations for more than a few days.

For positive evidence, hundreds of pit hearths have been found throughout the badlands in all areas where recent paleosols are present and exposed. On the Oglala National Grasslands, we have found about one pit hearth for every linear 200-500 m of paleosol exposure, yielding an estimate of 2,000 to 5,000 per km² (Wandsnider 1996, 1997). This pattern suggests that whatever the resource processed in pit hearths, it was not abundant but could be counted on season after season.

Galloping Gourmets?

Could pit hearth food processing have been incidental to other activities? The primary mission of pit-hearth processors may have been less immediate, such as assessing the forage potential for bison or antelope, visiting relatives, seeing about potential spouses for children, and so forth.

At present, we cannot rule out the possibility that pit hearth food processing represents a “galloping gourmet” option, in which travelers made due with the foods available to them while en route to other parts of the High Plains.

Current Conclusions on Foraging Strategy

Evidence of foraging in the White River badlands between 2000 and 1100 B.P. appears consistent with that practiced by collectors who exploited reliable and stable, but not abundant, resources that needed immediate processing. There is no strong evidence that pit-hearth processors were participating in a commodities market or were engaged in the intensive exploitation of this area. However, the lack of exotic chipped stone suggests that foraging range may have been quite limited.

Cessation After 1100 B.P.

Pit hearth use in the White River badlands appears to have effectively ceased after 1000 B.P. What causes this cessation? How did foraging options change? The paleoclimate of the High Plains appears to have become relatively drier, and likely relatively more variable, after 1100 B.P. and up until the Little Ice Age. This aridity may have reduced root and bulb habitat. The candidate roots and bulbs flourish under wetter conditions (Table 2). For example, Sego lily (Frison 1991:337; Craig Smith, personal communication 1999) and camas (Ann Johnson and Craig Smith, personal communication 1997) thrive and blossom under annually moist conditions today. In the White River badlands, extended periods of dry conditions may have reduced root patch size and plant abundance, making the exploitation of such foods too costly.

If so, agricultural intensification, especially in areas with reliable water, coupled with deliberate house construction and a settled lifestyle to defend the artificially more productive patches, may have become a viable option. Although starchy grains have been found in earlier deposits, it is at this time, especially after 1000 A.D., that an apparently more productive subspecies of maize appeared on the Central Plains, becoming part of a subsistence repertoire that also included beans and sunflower (Adair 1988, 1994). In the Upper Republican River Valley (Fig. 1), Plains Village archaeological deposits indicate occupations of more than several weeks by High Plains occupants with specialized agricultural technology, such as bison scapula hoes and ceramics (see Wedel 1986). The picture appears

TABLE 2
Preferred Conditions of Candidate Species (Genders 1973)

Species	Common Name	Preferred Conditions
<i>Allium</i> sp.	Onion, garlic	wet, high meadows; dry hills, flanks, ridges
<i>Calochortus</i> sp.	Lily	well-drained soils
<i>Camassia</i> sp.	Camas	summer/spring moist but winter dry
<i>Erythronium</i> sp.	Glacier lily	cold, dry mountainous slopes
<i>Helianthus tuberosa</i>	Jerusalem artichoke	moist soil

different further west however. Except for ceramics, specialized agricultural tools are lacking. Little evidence exists for houses (Wood 1990:5). Thus, small, highly mobile likely groups likely relied on a very broad diet (Roper 1990:17).

Finally, it is possible that pit processors moved out of this area around 1100 B.P.. We currently lack information to evaluate this alternative explanation.

Conclusions

Starving nomads? Affluent foragers? In this article, I have tried to share our evolving picture of human use of the High Plains during the Late Prehistoric time period, relying heavily on principles of human ecology. Clearly, the picture is more complex than conveyed by the terms "starving nomads" or "affluent foragers." Mulloy (1954) and Kornfeld (1994), who coined these terms, recognized this complexity at least in part.

For the early portion of the sequence surveyed, the Plains Woodland time period (500 B.C.-A.D. 900), the High Plains included multiple, perhaps small territories anchored to well-watered drainages, as indicated by the locations of ossuaries and houses. In addition, the evidence suggests populations ranged into areas far from the major drainages to exploit patches of

low abundance, presumably reliable resources that could be pit processed. The lack of exotic chipped stone at the pit hearth locations in the White River badlands suggests very small range sizes and little intercourse between populations, even though White River silicates were reported in one instance at the Dutch Creek site in eastern Colorado, far from their natural occurrence (Gilmore 1989). The tremendous number of small pit hearths in the region suggests repeated use of the resource patches by small family units who soon consumed, rather than stored or exchanged, the fruits of their labor. Alternatively, the small hearth size may have reflected low resource density.

Importantly, from the exotic materials appearing in Late Plains Woodland mortuary contexts such as ossuaries, it is clear that small groups were inter-connected at some level, perhaps as part of a loosely coupled trading network. Relatively small territories were likely permitted by a High Plains environment that was moister or cooler than today, at least for large stretches of time. With the onset of the Little Climatic Optimum (around 1100 B.P.), drier or warmer conditions prevailed. At this time, resource patches with low abundance and slow recharge appear to have become either too risky or too costly to exploit. Pit hearth construction in the White River badlands ceased at this time. Plains Village occupations, associated with agriculture appeared, especially on the Central High Plains and further east. On the western High Plains, populations remained highly mobile, with a subsistence regime that likely included some grass seeds, as indicated by the presence of ceramics. Where agriculture or other modes of intensification could not be supported, for example on the western High Plains, we expect territory size to have increased from Plains Woodland to Plains Village time periods. Ceramic paste analysis and chipped stone sourcing may assist in evaluating this prediction.

Human foragers on the High Plains may indeed have been both starving nomads and wealthy in the amount of leisure time they possessed. Human ecology and foraging theory allows us to critique and revise these characterizations, providing us with new insights into how human groups may have grappled with the high variance environment of the High Plains. In conjunction, our archaeological tools permit us to document mechanisms by which such groups coped.

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