Archeology and Paleoeconomy of the Central Great Plains

A Volume in the Central and Northern Plains Archeological Overview
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ABSTRACT

The status of archeological research and current archeological interpretations in the northern Kansas, Nebraska, and northeastern Colorado region, referred to herein as the Central Great Plains has been addressed by a team of archeologists with the aid of bioanthropologists, geographers and paleontologists. The goal was to bring together current perspectives on human occupation of the region as viewed through the archeological, biological, and paleoenvironmental records, and to define research agendas, data limitations, and problems in need of further investigation. The consideration of prior research in spatial and temporal scales aids in the definition of critical research issues. The integration of information from paleoecological studies, late Pleistocene and Holocene paleoecology, human skeletal evidence, and insights from archeological specialists enables a new assessment of our knowledge of the archeology of the central plains region. Although thousands of archeological sites occur in the region of concern here, relatively few of these have received intensive study and documentation. A summary of the current and past environments provides a framework within which to review and discuss changes in prehistoric and historic subsistence economies, technologies, mobility/sedentism, organization, and group interactions. A brief history of archeological investigations in the region outlines some of the developments and changing methods and goals of archeological research. A traditional cultural historical summary is provided for the region from about 20,000 years ago to the historic period. One integrative chapter uses the concept of Adaptation Types to summarize the current status of information and research needs from a broadly defined ecological-functional perspective across the region as a whole.
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Foreword

This research was coordinated by the Arkansas Archeological Survey under the Department of Defense Legacy Resource Management Program. The contracts were administered by the Tri-Services Cultural Resources Research Center at the U.S. Army Construction Engineering Research Laboratories (USACERL), Champaign, IL. The contract manager and Principal Investigator was Dr. John S. Isaacson. Col. James T. Scott is Commander and Dr. Michael J. O’Connor is Director of USACERL. Mr. Larry Banks, formerly U.S. Army Corps of Engineers Southwestern Division archeologist, consulted extensively on the project.

The Central and Northern Plains Archeological Overview project includes four studies: the northern Great Plains (the Rockies east to the Minnesota River), the northwest woodlands (the Minnesota River east to the Great Lakes), the central Great Plains, and the central prairie-timberlands of Missouri. Using the concept of human adaptation, these overviews place cultural resources within cohesive environmental and cultural areas rather than arbitrary political boundaries such as states. These syntheses make clear why properties are significant, where there are gaps in archeological and bioarchaeological knowledge, and what the future directions are for cultural resources planning by Department of Defense installations, the U.S. Army Corps of Engineers, and other federal agencies. In addition to the four archeological volumes, all citations are being entered in the National Archeological Citation Data Base. Other volumes included as part of this project are management guidelines, an executive summary, the bioarchaeological sections of each area combined into a single volume, and a citations CD. Taken together with the volumes from the Southwestern Division of the U.S. Army Corps of Engineers Overviews (Arkansas Archeological Series Nos. 31-38), there are now syntheses of the current archeological record for almost one-half of the United States.

The Legacy Resource Management Program was established by the Congress of the United States in 1991 to provide the Department of Defence with an opportunity to enhance the management of stewardship resources on over 25 million acres of land under DoD jurisdiction.

Legacy allows DoD to determine how to better integrate the conservation of irreplaceable biological, cultural, and geophysical resources with the dynamic requirements of military missions. To achieve this goal, DoD gives high priority to inventorying, protecting, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner, in partnership with Federal, State, and local agencies, and private groups.

Legacy activities help to ensure that DoD personnel better understand the need for protection and conservation of natural and cultural resources, and that the management of these resources will be fully integrated with, and support, DoD mission activities and the public interest. Through the combined efforts of the DoD components, Legacy seeks to achieve its legislative purposes with cooperation, industry, and creativity, to make the DoD the Federal environmental leader.
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1 Introduction, by Jack L. Hofman

The Central Plains archeological overview represents part of a continuation and expansion of the U.S. Army Corps of Engineers overview project completed for much of the trans-Mississippi South. The current Central and Northern Plains archeological overview is divided into four principal regions with the Central Plains region joining the area already covered by the Southern Great Plains and Southwest overviews (Hofman et al. 1989; Simmons et al. 1989). The Central Plains region includes the northern half of Kansas, all of Nebraska, and northeastern Colorado (Figure 1). Because information has been developed at the state level, the base maps used here will generally include all of Kansas, Nebraska, and Colorado. This region extends from the Rocky Mountains on the west to the Missouri River trench on the east. From north to south the region encompasses much of the Niobrara, Platte (South Platte), and Kansas river basins. This is an area of approximately 140,000 square miles (ca. 364,000 square km). While this specific area was the focus of the present volume, in reality southern Kansas has been included in many of the discussions which follow, generally with more detail and updated from that found in the Southern Plains volume (Hofman et al. 1989). Also, sites, finds, and complexes from areas adjacent to the study area are often included when relevant or critical information occurs outside the “boundaries” of the study area.

The overview is intended to provide a synopsis of available information about the paleoecology, bioarchaeology, and archeological record from the period of earliest human use of the region through the historic period. One aspect of the project is to assist in the development of a national archeological literature data base (NADB). The Central Plains project has added approximately 600 new entries to this already expansive archeological bibliography which will be of value to researchers interested in accessing local or topical literature available for the region. This volume of the overview was completed by a number of researchers with complementary expertise in archeology and related fields.

On a regional scale archeological problems of preservation, recovery, pattern recognition, and interpretation need to be addressed through multiple perspectives and from a variety of research frameworks. These multiple approaches are critical because of the diverse contents and nature of the archeological record and the variety of questions that we ask of it. Therefore, in developing the present overview the aid of several archeological and nonarcheological specialists was enlisted.

Figure 1. The states of Colorado, Kansas, and Nebraska in the Central Plains study area.
Given that the environments of this region are diverse and have been dynamic throughout the period of human habitation (Dort and Jones 1970; Caldwell et al. 1983; W.C. Johnson 1987), research specialists in paleoecology are working to summarize available studies of importance to archeology. Bill Johnson and Kyong Park of the Department of Geography at the University of Kansas have prepared the geographic and paleoecological background for the region using geomorphology, soils, palynology, and the invertebrate records. This perspective is critical to developing realistic and useful models of paleoecology and land surface changes which have affected the archeological record and therefore site preservation, burial, recognition, and interpretation (e.g., Holliday 1987a; W.C. Johnson 1987; Johnson and Logan 1990; Mandel 1992, 1995).

The evidence from skeletal biology for the region is provided by Doug Owsley and Karen Bruwelheide. Information on more than 3,900 burials is provided for northern Kansas, Nebraska, and northeastern Colorado. This detailed analysis provides a summary of information by time period, cultural groups, patterns of mortality, pathologies, stress, warfare, and behavioral patterns.

The zooarchaeological record and developments in the study of archeofaunas in the Plains region is also addressed. To an important extent developments in taphonomic research in the Plains region have been mutually beneficial between paleontology and archeology with significant feedback and interaction between practitioners in each discipline. Also, the paleobotanical evidence acquired primarily through the region’s archeological record is reviewed by Mary Adair. This evidence, like that from zooarchaeology, is critical to effective economic and seasonal interpretations from the archeological record. Such study is central to the problems of cultural change in the region (Adair 1988). Also, spatial and temporal data gaps in the paleobotanical record are evident. Adair has also prepared the summary of Woodland or early ceramic period archeology for the region. The record for the late prehistoric or Plains Village tradition is reviewed by Brad Logan, Museum of Anthropology, University of Kansas, and a synopsis of the archeological record for the historic period was completed by Bill Lees of the Oklahoma Historical Society. Some emphasis was given to the synopses for the preceramic hunter-gatherer cultures on the Central Plains, as these groups have often been lumped into overly simplified and stereotypic categories of Paleoindian and Archaic in the past with little concern for the diversity and variety of economies and technologies represented.

Adaptation types are used as a framework for grouping and comparing multiple archeological taxa or complexes into broadly similar economic-social groups which span large regions and crosscut modern political boundaries. These relatively static and functional summaries provide a useful basis for addressing some major research needs and problems in archeological interpretation.
2 Late Wisconsinan and Holocene Environmental History, by William C. Johnson and Kyeong Park

This chapter is intended to summarize what is currently known about the paleoenvironmental history of the Central Plains, i.e., the states of Kansas, Nebraska, and eastern Colorado (Figure 2). Objectives are to summarize the current status of knowledge about environmental changes in the Central Plains during the late Quaternary and to briefly identify gaps that exist in the data base. Such a summary provides necessary context for understanding the cultural history of the region. Archeologists have long recognized that the data base is not inherited in a pristine state, i.e., the archeological record preserved in the landscape is an incomplete rendering of past cultural activities that formed vulnerable fossil remains subjected to a variety of postdepositional processes. Consequently, the record must be extracted and the extent of modification be appreciated.

Less is known about environmental conditions in the Central Plains during the late Pleistocene and Holocene than many other regions of North America, due primarily to an inability to widely apply the more traditional investigative tools such as palynology and dendroclimatology. Consequently, that which is known has been and is being derived using some of the newer approaches to late Quaternary environmental reconstruction such as stable isotope analysis, opal phytolith analysis, and rock magnetism. Those sedimentological contexts being explored include loess, eolian sand sheets and dunes, alluvial fill, and to a lesser extent isolated lake and peat deposits. The loess deposits of the region, which represent some of the thickest and most complete loess accumulations in North America, hold the potential to provide a particularly promising avenue for the pursuit of the paleoenvironmental record.

We address only the Wisconsinan Stage of the Pleistocene and the Holocene since this is the period for which the most data are available and of greatest relevance to a prehistoric cultural context. Further, the establishment of radiocarbon chronostatigraphies permits correlations with the cultural overlays. First, however, the climatic and physiographic settings are presented as a backdrop.

Climatic Setting

The principal climatic features of the Central Plains are its continentality and Rocky Mountain-induced rainshadow. The Prairie Wedge, which dominates the study region, is a consequence of the zonal westerly airflow crossing the western mountains and penetration of modified Pacific air mass (Borchert 1950, 1971). Isohyet patterns exhibit a longitudinal orientation, with mean annual precipitation decreasing from over 40 inches (1,000 mm) at the southeastern margin to less than 15 inches (380 mm) in the western and northern parts (Figure 3). Winters are typically cold with relatively little precipitation, mostly as snow; summers are hot with increased

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Figure 2. Physiographic map of the Central Plains study area.
precipitation, chiefly associated with collision of Pacific (mP) and Arctic (cA) air masses with warm, humid air masses (mT) from the Gulf of Mexico. Since it determines the carrying capacity of the region, drought is the most significant climatic element of the Great Plains environment from the ecological, historical, and prehistoric standpoints (Weakley 1943; Barry 1983; Wedel 1986). Vegetation is mostly prairie grassland, due to the subhumid-semiarid, markedly seasonal climate. The mean tropical Atlantic airflow (mT) that influences the grassland east of about the 100th meridian in normal summers has tended to give way during the summers of drought years to continental flow (Figure 4).

The prairie crosses the region from north to south in three broad zones (Figure 5). In the west, the grama-buffalo grass prairie consists of short grasses, while the bluestem prairie with its tall grasses and many forbs prevails in the east. Between them lies the mixed prairie with tall, medium, and short grasses (Küchler 1964; 1974). In the sand sheets of southeastern Colorado, west-central Nebraska and central Kansas, edaphic conditions promote the existence of a sand sage-bluestem prairie. The sensitivity of prairie composition and boundaries to short-term climatic variation during the historical period is well documented for the region (Tomanek and Hulett 1970). Similarly, long-term prairie expansion and contraction, presumably in response to climatic variation, is documented at the prehistoric time scale (e.g., Watts and Wright 1966; Grüger 1973; Bernab and Webb 1977; Bradbury 1980). The consequence of short- and long-term climatic variations within the Central Plains and attendant changes in the vegetation probably had measurable impact on prehistoric peoples, but the magnitude of such is, however, certainly open to question (cf., Wedel 1961a; Reeves 1973; Johnson 1990).

According to Borchert (1950), regional distinctiveness of the grassland climate lies basically in the precipitation. Low snowfall and low rainfall in the region are typical of winter. There is a greater risk of a large rainfall deficit in summer within the grassland than in the bordering regions of forests. The short-grass steppe receives markedly less rainfall than the remainder of the continental United States east of the Rockies during the summer. The grassland is distinguished from the forest region to the north by fewer days with precipitation, less cloud cover, and lower humidity, on the average, during July and August. The grassland is characterized by large positive departures from average temperature and by frequent hot winds during summer.

Physiographic Regions

The Great Plains physiographic region lies east of the Rocky Mountains and extends from southern Alberta and Saskatchewan almost to the United States-Mexico border (Figure 2). The Central Plains is a large region of generally low relief sloping eastward from the Rocky Mountains toward the Missouri and Mississippi rivers. Multiple continental glaciations, starting perhaps as early as 2.5 million years ago (Boeblstoffer 1978), caused reorientation of the Missouri River system southeastward to the Mississippi River, resulting in many stream captures and other geomorphic changes (Wayne et al. 1991). Each time the ice blocked eastward-flowing rivers, proglacial lakes formed, spilled across divides, and developed new courses around the glacial margin. The present course of the Missouri River through North and South Dakota is chiefly along a late Illinoian ice margin. The Platte River evolved through spasmodic uplift of the Chadron arch (Stanley and Wayne 1972) and several early and middle Pleistocene glacial advances into eastern Nebraska and northeastern Kansas (Aber 1991). In the middle Pleistocene, the Platte River joined with the glacially diverted Missouri River and formed a wide alluvial plain across east-
central Nebraska and northeast Kansas. Quaternary erosion of the Central Plains, which largely is drained by the Missouri River, has been mostly by fluvial processes. However, the channel network in much of the Missouri River basin is the result of drainage rearrangements by glaciation.

In extreme southeastern Kansas, a small portion of the Ozark Plateau extends into Kansas. The streams of this region have carved the thick, flint-bearing Mississippian limestones into the present-day topography. To the west of the Ozark Plateau is the broad Cherokee Plain, a region developed on thick shale beds of the Cherokee Formation of middle Pennsylvanian age. The low-gradient, shallow streams have planed the surface of this low-relief region.

West and north of the Cherokee Plain, the topography consists of a series of parallel northeast-southwest trending cuestas. Cuesta topography is developed as a series of ridges having a sharp slope on the east side and a gentle slope on the west side. A series of relatively erosion-resistant limestone strata exposed at the surface descend gently westward until they dip under the outcrop of thick overlying shale. The shale underlying the capping limestone is less resistant to weathering and erodes to form an abrupt east-facing escarpment.

To the west of the Osage Cuestas is a band of grass-covered limestone hills, the Flint Hills, a preserve of the Kansas tallgrass prairie. The Flint Hills are located at the eastern edge of a huge expanse of grass-covered plains that extends continuously westward to the Front Range of the Rocky Mountains, northward into Canada, and southward into northern Texas.

At the western margin, the Flint Hills dip gently under younger rocks which, on the north, slope gently westward under the Smoky Hills escarpment. To the south, these strata dip below the McPherson-Wellington Lowlands. Extending from north of Salina, Kansas southward to the Oklahoma border, the McPherson-Wellington Lowlands mark the outcrop belt of the thick Wellington shale.

Along the southern border of Kansas, from Harper and Kingman counties to eastern Meade County, erosion has exposed the Red Hills. The badlands topography of the Red Hills is unique to the Central Plains. In some areas, erosion-resistant dolomite caps the red Permian strata resulting in buttes and mesas.

Extensive areas of grass-covered sand dunes lying south of the Arkansas River constitute the Great Bend Sand Prairie. A similar region exists south of the Cimarron River in the southwestern corner of Kansas. During the late Pleistocene and Holocene, strong winds eroded fine sediments from alluvial surfaces of the Arkansas River and transported them to the dune area, which covered hundreds of square miles. North of the Great Bend Sand Prairie, Cretaceous rocks, exposed over a large portion of western Kansas, constitute the Smoky Hills, named such because of their dark shales.

From Saskatchewan to northern Texas, lie the High Plains. Viewed from a broad perspective, the whole of the High Plains surface is upheld by a huge wedge-shaped, alluvial apron consisting of sediment derived from erosion of the eastern Rocky Mountains. These sediments, the Ogallala Formation,
represent Miocene stream deposition similar to that presently occurring in the Arkansas River to the south. The Ogallala Formation is composed not only of river-borne sands and gravels, but also of loess, volcanic ash beds, and diatomite deposits.

The eastern part of the Central Plains is an area of rolling hills that was invaded by one or more glacial ice masses during the Pleistocene. With the abandonment of the classic Nebraskan and Kansan nomenclature for glacial stages, the intrusions of ice into this region are designated as pre-Illinoian, with the exception of extreme northeastern Nebraska, which experienced glaciation during the Wisconsinan Stage. The use of the traditional terms has been confused and has become ambiguous, e.g., coring "Nebraskan" till yielded three separate tills separated by distinct soils (Hallberg 1986). Despite the lack of a chronology and nomenclature, glaciers occupied the eastern fifth of Nebraska and northeastern Kansas. Glaciers apparently advanced into Kansas twice from two different directions, the second of which did so between 600 ka and 700 ka (Aber 1991).

Central and western Nebraska is mantled by extensive deposits of Wisconsinan to late Holocene eolian sands known as the Sand Hills. The age and origin of this spectacular eolian feature are yet uncertain. Ahlbrandt et al. (1983) suggested that the dunes are late Holocene features, possibly derived from older, unconsolidated sediment that mantled the Great Plains. In contrast, Wells (1983) regarded the Sand Hills as a coarse, upwind facies of a single late Pleistocene sand-silt unit.

There are three dune fields in northeastern Colorado (Figure 6). The relatively small Greeley dune field is located immediately north of the South Platte River, and the larger Fort Morgan dune field lies south of the river. The Wray dune field, the largest, is on the High Plains to the east and southeast of the other two. The Fort Morgan and Wray sands were probably derived from sediment of the South Platte River under northwest winds during late Holocene time. The source and direction of movement of the Greeley sand hills are, however, uncertain (Muhs 1985).

Late Wisconsinan Stage

Due to its relative youth, the Wisconsinan Stage has the greatest chronostratigraphic resolution. Based on the chronology from Illinois, five substages of the Wisconsin have been traditionally recognized: the Altonian (70,000-28,000 yr B.P.), Farmdalian (28,000-22,000 yr B.P.), Woodfordian (22,000-12,500 yr B.P.), Twocreekan (12,500-11,000 yr B.P.), and Valderan (11,000-5000 yr B.P.) (Willman and Frye 1970; Frye and Willman 1973). This chronology of substages has, however, limited stratigraphic application in Nebraska, Kansas and eastern Colorado, and has therefore not been adopted literally.

In Nebraska, Reed and Dreeszen (1965) identified four Wisconsinan units: the Gilman Canyon Formation (an upland loess with soil development), Peoria Formation (fluvial sand and silt in valleys and loess on the uplands), Brady Interstadial soil, and Bignell Formation (dune sand and loess). For the Wisconsin of Kansas, Frye and Leonard (1952) recognized early Wisconsinan alluvial deposits and the Sanborn Formation. The late Wisconsinan units of the latter included the Peoria loess, Brady soil and Bignell loess (Figure 7). Since these early statements of stratigraphic succession, the Bignell loess has been assigned to the Holocene.

During the 1960s, the record of past climate was based primarily on continental deposits, but these were rarely continuous sedimentary records, and consequently the picture of past climatic variations that developed was therefore incomplete (Bradley 1985). In the next decade, studies of marine sediments revolutionized our understanding of climatic variations and enabled models of the causes of climatic changes to be tested. Undoubtedly, studies of marine sediments have provided data bases which continue to expand in quantity and quality (Ruddiman 1985). However, the 1980s experienced a renewed focus on continental records of climate, which complement the perspective provided by marine sediment (COHMAP Members 1988). Continental deposits often provide

Figure 6. Distribution of dune fields and sand sheets in the Central Great Plains (after Muhls and Holliday 1995).
Figure 7. Late-Quaternary stratigraphic succession in (a) Kansas (Bayne and O’Connor 1968) and (b) Nebraska (Reed and Dreeszen 1965).
more detailed information about short-term (high-frequency) changes of climate than most marine records (Broecker et al. 1986).

Geomorphology and Stratigraphy

From Nebraska, loess deposits in the Central Plains extend west across eastern Colorado and south across most of Kansas. The thickest deposits of loess are adjacent to and underlie the Nebraska Sand Hills (Kollmorgen 1953; Ahlbrandt et al. 1980). The oldest laterally extensive loess unit in the region is the Loveland loess, found at least as far west as the Colorado/Kansas state line. In Kansas, exposures of Loveland loess are patchy and are found mostly on ridges near drainages (Welch and Hale 1987). The Peoria loess is the thickest and most laterally continuous loess deposit (Frye and Leonard 1951), whereas the overlying Holocene Bignell loess is found discontinuously in the Central Plains and is not identified east of the Missouri River.

Until recently, little age control existed for the timing of loess deposition in the Central Plains; age assumptions were based largely on the classical continental glaciation sequence, similar to that used for the loess stratigraphy in the Mississippi and Missouri river valleys. However, younger loess and associated paleosols exposed at a number of localities in Kansas and Nebraska have been systematically radiocarbon dated and, to a lesser extent, thermoluminescence-dated (e.g., Souders and Kuzila 1990; Johnson 1993a; Martin 1993; May and Holen 1993; Feng et al. 1994a, 1994b; Maat and Johnson 1996). According to these age estimates, the Gilman Canyon Formation was deposited from at least 40 ka to about 20 ka, Peoria loess about 20 ka to 10.5 ka, and Bignell loess from about 9 ka to at least 5.5 ka.

Unconformably overlying the Loveland loess and the Sangamon soil that caps it is the loess of the Gilman Canyon Formation (Reed and Dreeszen 1965). The upper two-thirds of this loess are organic-rich and contains one or more cumulic A horizons that represent a period of slow accumulation and pedogenesis. Similarities in stratigraphic position, soil development and mollusk assemblages indicate it may be equivalent to the Farmdale interstadial soil (Johnson 1990, 1993). Recent age estimates also support correlations with the Roxana silt of the Upper Mississippi River valley (Leigh and Knox 1994) and the Pisgah Formation of western Iowa (Forman et al. 1992a). A transitional zone of loess, characterized by upwardly decreasing organic content and increasing color value (brightness), represents a slowly accelerating rate of loess deposition and separates the Gilman Canyon Formation from the overlying Peoria loess.

Peoria Loess

Late Wisconsinan loess deposits mantle much of upland surfaces of the region covering the Central Plains from the North Dakota/South Dakota border to that of Kansas and Oklahoma and provide a terrestrial record of late Quaternary climate. Thickest deposits lie adjacent to the Missouri River and its major tributaries (Ruhe 1983).

Leverett (1899) first proposed the name Peoria for an interglacial period between the Iowan and Wisconsinan glacial stages. When Alden and Leighton (1917) demonstrated the Peoria was younger than the Iowan, usage shifted to that of a loess, rather than of a weathering interval. Within the Midcontinent, several names have been used for post-Farmdalian loess. Ruhe (1983) preferred the term "late Wisconsinan loess" because of the uncertainties in the stratigraphic equivalency from one region to another.

The Peoria loess is typically eolian, calcareous, massive, light yellowish-tan to buff silt that overlies the Loveland loess or an approximate equivalent of the Gilman Canyon Formation. Based on conventional and accelerator radiocarbon ages, deposition of the late Wisconsinan Peoria loess in Kansas and Nebraska began about 19.5-21 ka. In cold and arid conditions of the late Wisconsin, a high depositional rate was probable; at the Bignell Hill type section in southwestern Nebraska, for example, the sedimentation rate for the late Wisconsinan Peoria loess averaged 5.7 mm/year. This rapid deposition rate seems to be comparable to marine records and rapid enough to preserve high-resolution data for the late Wisconsinan environmental changes. The rate of accumulation for the Peoria loess was certainly variable, but apparent annual laminae are present at many localities near the Platte River valley of Nebraska, including the Bignell Hill and the Eustis ash pit sites (Johnson 1993b). Loess accumulation rates decreased as the regionally expressed Brady soil began developing between 10.6 and 10.1 ka.

The lack of any well-developed, buried soils or other inconformities suggests that Peoria loess in the region represents a continuous deposit and that the faunal zonation reflects a change in the rate of deposition. Evidence that Peoria loess deposition was episodic has emerged from western Iowa (Daniels et al. 1960; Ruhe et al. 1971), central Kansas (Arbogast 1995) and southwestern Illinois (McKay 1979), where deposits exhibit dark, organic-rich bands that are thought to represent incipient soils formed during periods of slower deposition. Differential abundance and preservation of fossil mollusks in the loess have also been cited as evidence of episodic loess deposition (Frankel 1957).

The loess thickness decreases gradually with distance to the south and southeast of the Platte River valley. Except for the loess of the Loess-Drift Hill area in southeast Nebraska, loess south of the Platte was deposited rather evenly on a nearly level surface of old alluvial sands and gravels. In the Loess-Drift Hill area of southeast Nebraska and in most of the area north of the Platte River, the loess mantles a previously dissected and hilly topography.

Little is known about the environmental conditions in the Central Plains during Peoria loess deposition. Early studies, however, postulated that loess likely accumulated under dry conditions (e.g., Schultz and Stout 1948). Evidence from modern depositional environments suggests, however, that well-vegetated rather than barren surfaces favor loess deposition (Martin 1993). Additionally, the rich land snail fauna of Peoria loess in the Great Plains implies deposition on a
vegetated surface (Leonard 1952; Ostlie 1986; Wells and Stewart 1987a).

Recent findings indicate that trees were present in the Central Plains during Peoria loess deposition, although the distribution and density of tree cover is unknown. Wells and Stewart (1987b) recovered *Picea glauca* (white spruce) cones, needles, and wood from Peoria loess at several sites in south-central Nebraska; radiocarbon ages on the wood range from 14,700 to 13,600 yr B.P. (Johnson 1989). Wells and Stewart (1987) also report charcoal in Peoria loess at two locales in north-central Kansas. At the Coyote Canyon site in south-central Nebraska, bands of charcoal near the base of the Peoria loess afforded additional radiocarbon ages which range from 21,250 to 19,730 yr B.P. (Martin 1993). At the nearby Sint Point site, Johnson also reports an additional age determination of 21,440 yr B.P. for *Picea* (spruce) charcoal (Table 1). An upland pollen record from southeastern Kansas suggests that a *Populus* (aspen) parkland was present during the late Pleistocene (Fredlund and Jaumann 1987). Watts and Wright (1966) conclude that *Picea* was the dominant vegetation cover in the Nebraska Sand Hills until 12,500 yr B.P., when it was gradually replaced by *Pinus* (pine) and herbaceous vegetation. Recent surveys of the Midcontinent pollen record by Webb et al. (1983) and Baker and Walin (1985) postulate parkland vegetation with treeless openings on the Central Plains during the late Pleistocene.

Ruhe (1983) noted three major features of late Wisconsinan (Peoria) loess: it thins downwind from the source area, decreases in particle size systematically away from the source area, and is strongly time transgressive at its base. The last feature is problematic and causes correlation problems. Ruhe (1969) realized a decrease in the age of the soil under the loess from 24,500 yr B.P. near the Missouri River to about 19,000 yr B.P. eastward across southwestern Iowa. A decrease from 25,000 to 21,000 yr B.P. was noted for the base of the loess along a transect in Illinois (Kleiss and Fehrenbacher 1973). The top of the loess also seems to be time transgressive, ranging from about 12,500 yr B.P. in Illinois (deKay 1979) to about 14,000 yr B.P. in central Iowa (Ruhe 1969).

Despite the attention given to the Peoria loess in Central Plains, the source of the silt is not completely certain. From their review of available data, Welch and Hale (1987) concluded that a single source was not likely for all loess deposits in Kansas and that the loess was derived from a combination of three.

**Table 1. Wood and Charcoal Ages from Late-Wisconsinan Deposits in Kansas and Nebraska.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Material</th>
<th>Sample</th>
<th>Age</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coon Creek, Graham Co.</td>
<td><em>Picea</em> charcoal</td>
<td>GS-9356</td>
<td>17,830±550</td>
<td>Wells and Stewart, 1987b</td>
</tr>
<tr>
<td>Courtland Canal, Jewell Co.</td>
<td><em>Picea</em> charcoal</td>
<td>Beta-9320</td>
<td>14,450±140</td>
<td>Wells and Stewart, 1987b</td>
</tr>
<tr>
<td>Nebraska</td>
<td><em>Picea glauca</em></td>
<td>Beta-12986</td>
<td>14,700±100</td>
<td>Walls and Stewart, 1987b</td>
</tr>
<tr>
<td>Coyote Canyon, Harlan Co.</td>
<td><em>Picea</em> charcoal</td>
<td>TX-7295</td>
<td>19,730±300</td>
<td>Martin, 1993</td>
</tr>
<tr>
<td>Sint Point, Harlan Co.</td>
<td><em>Picea</em> charcoal</td>
<td>TX-7711</td>
<td>21,440±200</td>
<td>Johnson (unpublished data)</td>
</tr>
<tr>
<td>Bloomington, Franklin Co.</td>
<td><em>Picea</em> or Larix</td>
<td>Beta-42015</td>
<td>18,830±180</td>
<td>May and Helen, 1993</td>
</tr>
<tr>
<td>South Loup River, Buffalo Co., Grant Co.</td>
<td><em>Abies balsamea</em> fragments</td>
<td>Beta-27758</td>
<td>13,160±450</td>
<td>May and Helen, 1993</td>
</tr>
</tbody>
</table>

**sources:** glacial outwash river floodplains, present sand dune areas, and fluvial and eolian erosion of the Ogallala Formation. The Platte River undoubtedly contributed massive quantities of loess during glacial stages, as presumed (Swineford and Frye 1951). Loess is thickest immediately south of the Platte River valley, which suggests that the alluvium in the valley was the source of the loess, at least for those deposits adjacent to the valley (Kollmorgen 1965). Some local thickening of loess occurs to the southeast of the Platte River wherever streams enter from the Sand Hills to the northwest. With prevailing northwesterly winds, these locally thick deposits are probably partially derived from alluvium brought into this valley by these streams. In addition, nonglacial rivers in western Kansas and Nebraska probably contributed substantially more to the volume of loess in the area. Local loess deposits in excess of 23 m have been measured along the southeastern bluffs of the Arkansas and Republican rivers (Swineford and Frye 1951). Swineford and Frye (1951) concluded that the Arkansas River carried too sandy a sediment load to act as a major loess source and suggested that most of the loess deposited south of the Arkansas River in southwest Kansas was derived from northern sources.

In Nebraska and Kansas, radiocarbon and thermoluminescence dating indicates that Peoria loess in those areas correlates temporally with the Peoria loess of Iowa, Illinois, and Indiana (e.g., Johnson et al. 1993a; May and Helen 1993; Martin 1993; Maat and Johnson 1996). However, much of the loess in Kansas and Nebraska occurs upwind of or distant from late Wisconsinan continental glacial outwash sources. In addition, some of the thickest deposits of loess in Nebraska occur upwind of the Platte River (Swinehart 1990). Flint (1971) pointed out that the volume of loess on the Great Plains is surprisingly high if it was all generated from glacial outwash derived from the Rocky mountains. At the present time, the source of loess in the Kansas and Nebraska portion Central Plains is unknown, and more than one source may be involved (Welch and Hale 1987).

Welch and Hale (1987) concluded that loess in northwest, north-central, west-central, central, southwest, and south-central Kansas was derived from regional sand dune areas in central and western Nebraska (Sand Hills area), whereas loess in southwest Nebraska, eastern Colorado, southwest and south-central Kansas from alpine glacial-outwash sediments of the floodplains of the Platte and Arkansas rivers and from floodplain
sediiments of nonglacial rivers such as the Arickaree, Republican, Solomon, Saline, Smoky Hill, Pawnee, and Cimarron.

Trace element analysis (e.g., cerium, strontium, yttrium, zirconium) is being employed to gain insight into loess source and paleowind directions (Johnson et al. 1993b). Concentrations of many of the considered elements decrease south/southeastward away from the Platte River valley and Sand Hills of Nebraska. Superimposed on the overall trend is an increase in concentrations at sites adjacent to major river valleys due to a “refreshening effect” (Johnson and Muhs 1996).

Peoria loess deposition appears to relate to the formation of the Sand Hills of Nebraska. Kutzbach and Wright (1985) argue that the Sand Hills of Nebraska is the source for much of the Peorian loess in the region, and that formation of the huge transverse dunes within the Sand Hills must have occurred during a period of extreme aridity. Although strong circumstantial evidence links the Sand Hills to the adjacent body of Peoria loess, this hypothesis is not universally accepted (e.g., Ahlbrandt et al. 1983).

The question of the Sand Hills formation and Peoria loess deposition is germane to the investigation because, if the arguments of Kutzbach and Wright (1985) are correct, the Woodfordian, or at least some portion of it, was relatively xeric. This presumed Woodfordian aridity conflicts with at least some paleobotanical evidence in the region, particularly that related to the widespread occurrence of spruce and other taiga-like plant taxa (Table 1). These taxa, typically associated with the modern boreal forest, do not suggest moisture stress. The Woodfordian macrofossil record from the Central Plains includes several well-documented and dated occurrences of Picea remains, indicating a cool, mesic environment.

Leonard (1952) subdivided the Peoria loess of Kansas into four zones on the basis of the mollusk fauna assemblages present. The basal zone is equivalent to a leached interval above the Gilman Canyon Formation and is void of mollusk material. The lower mollusk zone, or Iowan, produced an assemblage containing 14 species, two of which are diagnostic of the zone. A transitional zone, located between the upper and lower faunal zones contains elements of both assemblages and does not imply any abrupt changes in the depositional environment, although the depositional rate may have slowed somewhat. The upper mollusk zone, or Tazewellian, contains 26 species, 14 of which do not occur in the lower zone. Because of the relative youth of the Peoria loess, little of the upper zone has been removed from the upland.

Although readily visible stratigraphic breaks, such as the Jules soil recognized in Illinois (Frye and Willman 1973; Ruhe 1976; McKay 1979) and the soil zones in Iowa (Ruhe et al. 1971), have not yet been widely identified in Kansas and Nebraska, evidence of one or more stable or vegetated surfaces is common. One of the few indications of soil development recognized is that of a Bt horizon in the Medicine Creek valley (May and Holen 1993); interestingly, the soil has a probable Paleoindian association (May 1990, 1991). Other indications of soil development in the Peoria loess come from the magnetic data obtained at Fort Riley, Kansas (Johnson 1996b).

Many of the age determinations were made from Picea remains, indicating a cool, moist environment. For example, a radiocarbon age of 18,830 yr B.P. on Picea charcoal was obtained from the Woodfordian/Peoria-age deposits near Bloomington, Franklin County, Nebraska (May and Holen 1993). Although radiocarbon data documents the burial of vegetative material throughout the Woodfordian, two temporal clusters of ages appear from the limited data: 18-17 ka and 14-13 ka. The 18-17 ka time interval represents the Last Glacial Maximum, and the 14-13 ka interval represents the time of major deglaciation (Ruddiman 1987). By interpreting ice-core data from Greenland, Paterson and Hammer (1987) recorded a dramatic decrease in atmospheric dust content from about 13 ka; this period of reduced atmospheric dust may relate to the time of relative surface stability and tree establishment. May (1989) identified deposition of the Todd Valley Formation in the South Loup River of central Nebraska at about 14 ka; the Todd Valley was subsequently buried by loess. Furthermore, C. Martin (1990) identified entrenchment in the Republican River of southeastern Nebraska at about 13 ka, after which valleys were filled with late Peoria loess.

Eolian Sand Deposits

Perhaps the most controversial of the geologic aspects of the Sand Hills is the age of eolian activity that produced the dunes. Traditionally, they have been considered to be as old as the late Pleistocene Peoria loess. Lugen (1968), Wright et al. (1985) and others have hypothesized that deposition of loess and the development of large sand dunes occurred contemporaneously. Smith (1965) hypothesized two main periods of eolian activity in the late Pleistocene. The first period formed the large crescentic dunes, and, following a period of dune stabilization, the second episode rejuvenated the earlier dunes and produced linear dunes. Recent attempts to model climatic changes of the last 18,000 years (COHMAP Members 1988) have modeled the Sand Hills as dating primarily from the late Pleistocene. However, no stratigraphic evidence has been reported that would lend support to these hypotheses. Some eolian sand was deposited during the last glacial episode, but the sand dunes of the Nebraska Sand Hills appear to have formed during the episodes of aridity and eolian activity occurring within the Holocene (Ahlbrandt and Fryberger 1980).

Landscape stability has also been episodic on the Great Bend Sand Prairie in the last 20,000 years (Arbogast 1995). During the late Wisconsin, Peoria loess accumulated periodically, and the prevailing northwest winds created lunettes on southern margins of playa-lake basins. A brief period of soil formation occurred during the Last Glacial Maximum about 18 ka (Figure 8). Floral materials recovered from the late Wisconsinan sediments suggest that the climate was more mesic than at present (Johnson 1991b).

Alluvial Deposits

Much of the chronology of late Wisconsinan landform evolution for the region was compiled in the 1940s and early 1950s, prior to the use of radiocarbon dating (e.g., Lugen 1935;
Schultz and Stout 1945; Frye and Leonard 1951), and focused to a large degree on the upland rather than valley deposits. Additionally, erosion has removed a large part of late Quaternary record from most drainage basins in the Central Plains (Knox 1983). Accordingly, a comprehensive sedimentation and erosion chronology for the region during the late Wisconsin is lacking.

It is becoming increasingly apparent that entrenchment occurred in the channels of the Kansas River basin sometime during the late Wisconsin. A basal soil buried within the fill of both tributary and major stream valleys of the Kansas River basin has an age of 10,500-10,000 yr B.P. (Johnson and Martin 1987; Johnson 1987; Johnson and Logan 1990), thereby providing a minimum age on the entrenchment. May (1989) has radiocarbon dated the Todd valley fluvial sand of central Nebraska to about 14,000 yr B.P., although Condra et al. (1950) had postulated a much earlier Wisconsinan age. Martin (1990, 1993) recognized a late Wisconsin fill in the Republican River valley that was largely removed through entrenchment about 13,000 yr B.P. A radiocarbon age of 14,700 yr B.P. was obtained on spruce wood situated above crossbedded fluvial sand and gravel at the North Cove site located in that reach of the Republican River valley (Wells and Stewart 1987b; Johnson 1989). At the Prairie Dog Bay site in the Republican River valley, the stratigraphy and radiocarbon ages suggest downcutting before 11,800 yr B.P. (C. Martin 1990, 1993). Speculation about the cause of this entrenchment centers on an increase in effective moisture as climatic conditions ameliorated towards the end of the Pleistocene. Spring deposits dating to this time at the North Cove site possibly formed during the increase in moisture (Johnson 1989, Martin 1990).

Brice (1964) studied alluvial fills and terraces in the valleys of the North Loup, Middle Loup, and South Loup rivers of central Nebraska, and identified two major terraces in the Loup valleys. The Kilgore terrace occurs as remnants 26 to 30 m above stream level along the South Loup River. Brice suggested that valley fill underlying the Kilgore terrace is Peorian (late Wisconsin) in age. The adjacent Elba terrace, which stands 11 to 12 m above stream level, is the most prominent and extensive terrace in the main valleys with fill dating to the late Pleistocene and Holocene.

Climatic Proxies

Two general quantitative methods have been applied to the reconstruction of past climates. The first is to determine past climate through the analysis of local or regional field data with the aid of transfer functions. The other method uses large-area climate modeling with the boundary conditions determined by calculation or from field data. Neither supplants the other, for the reconstructions have different spatial scales and degrees of precision. Most models of past climates also require inputs that can only be obtained from field investigations (Smiley et al. 1991). Transfer functions refer to a quantitative relation between a climatic indicator, such as δ18O data from buried soils, as an independent variable, and a climatic element or complex of elements, expressed as a dependent variable. The use of analogs for estimating past climates involves considerable uncertainty, brought about both by the complex mix of factors that constitute climate and by the complex response of most proxy climatic indicators in the record. In a sense, the use of analogs involves the construction of a mental transfer function based on the assumption of appropriate modern analog selection (Smiley et al. 1991). Because each source of paleoenvironmental data records a somewhat different aspect of climate, comparing reconstructions based on two or more environmental sensors can broaden and deepen our understanding of past climate changes.

With few suitable species and settings for dendroclimatological study and few natural wet environments to preserve fossil pollen for palynological studies, the nature and timing of late Quaternary vegetation and climate change in the Central Plains remain poorly understood. The region's late Quaternary climate and vegetation conditions are inferred from the palynological records obtained from sites peripheral to the Central Plains or from limited pollen records available at a limited number of sites in the region (Fredlund and Jaumann
However, some of the climatically sensitive parameters that have recently been examined in the Central Plains include fossil pollen, opal phytoliths, stable carbon isotopes, and rock magnetism. In addition to an expanding proxy base, recent research has indicated that the extensive loess deposits of the region contain an extractable climatic proxy record comparable to the marine isotopic record.

**Fossil Pollen and Botanical Macrofossils**

Several factors in the interpretation of Great Plains fossil pollen assemblages warrant consideration. Any interpretation of pollen assemblages for vegetational reconstruction must be based on appropriate analog studies of modern vegetation and pollen (Fredlund and Jaumann 1987). Additionally, in the Central Plains region where ideal wet depositional sites are rare, differential pollen preservation is a problem. Modern analogs are a basis for late Quaternary environmental reconstruction only where pollen deterioration has not significantly biased the informational content of the fossil pollen assemblage (Delcourt and Delcourt 1980). For example, differential preservation has been shown to be responsible for tremendous over representation of *Pinus* in some situations, while elsewhere rendering *Populus* invisible. Poor pollen preservation is therefore the limiting factor for many of the late Quaternary records in the Central Plains. Although temporally and spatially limited, several sites in the region have produced a picture of past environments (Figure 9).

By the time ice lobes in Iowa and the Dakota had reached their maxima at about 14 ka (Clayton and Moran 1982), *Picea* had begun to spread its range northward into the Des Moines area (Baker and Wahl 1985). By 12 ka, spruce forest was replaced along its southern margin by prairie in southern South Dakota. About 11 ka, *Quercus* (oak), *Populus*, *Fraxinus* (ash), and other hardwoods, which were probably confined to the central United States in glacial time, expanded their northern ranges and mixed with *Picea* in the eastern part of the northern Great Plains and the Midwest. This admixture of trees has no close analogs in the present day, but the vegetation is presumed to have been open and dominated by spruce, with some hardwoods and no pine.

The western limit of the forest is not known. At two sites in the glaciated region of northeastern South Dakota (Pickerel Lake; Watts and Bright 1968; Medicine Lake; Radle 1981), deciduous tree pollen replaced that of *Picea* about 11 ka, and prairie taxa appeared at about 10 ka. Pollen data from east-central North Dakota indicate a similar sequence. From the eastern fringe of the Central Plains, in Iowa and Missouri, pollen and macrofossil evidence suggests that open jack-pine forest of the FARMADIAN period yielded rapidly to open white spruce forest around 22 ka (Fredlund and Jaumann 1987). A similar record of Woodfordian spruce forest comes from Muscota Marsh in northeastern Kansas. According to Grütter (1973), a somewhat open vegetation, with pine, spruce, and birch as the most important tree species and local stands of alder and willow, changed about 23,000 yr B.P. to a spruce forest, which prevailed in the region until at least 15,000 yr B.P. Because of a hiatus in the sedimentary record, vegetation changes resulting in the spread of a mixed deciduous forest and prairie present in the region from 11,000 to 9000 yr B.P. remain unknown.

According to Wells and Stewart (1977b), the central and northern Rocky Mountains harbor extant populations of most of the boreal-subalpine species thus far recovered from Pleistocene sediments in the Central Plains. Moreover, even within the Northern Plains, there are numerous refuges for Pleistocene-relict species of trees, land snails and small mammals on forested ecological islands surrounded by steppe, an outstanding example being the Black Hills of South Dakota. Cones and needles from Harlan County, south-central Nebraska enable the positive identification of the spruce as *Picea glauca* (Johnson 1989), the boreal white spruce of the neartic taiga that now grows from Alaska to Newfoundland and along the eastern flank of the Rocky Mountains to Montana, with outliers to the East on the Great Plains in the Cypress Hills of Saskatchewan and Black Hills of South Dakota.

The Rosebud site, near the northern edge of the Sand Hills on the Nebraska-South Dakota border, provides an pollen record of late Pleistocene vegetation. The pollen and plant macrofossil records indicate that a boreal forest existed at that location about 12,600 yr B.P. and that soon afterward a pine forest and subsequently prairie vegetation rapidly replaced the spruce (Watts and Wright 1966). Seeds and leaves of aquatic macrophytes at the site suggest that a fresh, open-water basin existed when spruce was prevalent, and that conditions changed to a species-poor, alkaline reed swamp with the change to prairie vegetation. This vegetational and limnologic history implies change from a cooler, probably somewhat moister climate to one of increased aridity and higher temperatures that characterizes the Sand Hills today. The pollen record of prairie vegetation at Rosebud does not significantly differ from that of modern surface samples in this area. The rapid disappearance of *Picea* pollen and its immediate replacement by *Pinus* and prairie herb pollen suggest a depositional hiatus, which makes it difficult to interpret subsequent vegetational history. It is clear that prairie vegetation existed sometime after 12,600 yr B.P. and that the lake subsequently dried up and either the upper pollen-bearing sediments were destroyed, or intermittent fluvial deposition with poor pollen preservation occurred.

The association of nonarboreal taxa from sand pits near Wichita, Kansas indicates a substantial presence of steppe or grassland taxa on the late Pleistocene landscape of south-central Kansas (Jaumann 1991). Not only do these taxa represent a significant portion of the pollen spectra, but they also occur in consistent numbers and presently comprise the most important herbaceous taxa of the North American grasslands. Some of these taxa include Gramineae (grass family), Asteraceae (sunflower family), Artemisia (sage), *Iva* cf. *xanthifolia* (marsh elder), *Xanthium* (cocklebur), *Amorpha* cf. *canescens* (lead plant), *Phlox* cf. *pilosus* (prairie phlox), *Petasites* cf. *purpureus* (purple prairie clover), *Potentilla* sp. (cinquefoil), *Ambrosia* type (ragweed), *Chenopodium*/*Amaranthus* (goosefoot, pigweed), herbaceous Rosaceae (rose family),
Fabaceae (bean family), *Epilobium cf. angustifolium* (willowherb), Euphorbiaceae (spurge family), Cannabaceae (hemp family), and *Tradescantia* (spiderwort).

The closest vegetation type showing such a compositional mix can be found along the southern rim of the boreal forest on the Canadian Prairies. Mapping of the southern limits of coniferous trees indicate that the southern natural distribution of *Picea glauca*, *Picea marina* (black spruce), *Larix laricina* (tamarack), *Pinus banksiana* (jack pine), and *Pinus contorta* (limber pine) is confined to a narrow transitional zone between the taiga and aspen parkland (Jaumann 1991). Mosaics of grasslands and forests characterize the aspen parkland. The fossil plant communities recorded in the Wichita sand pits and Mt. Hope Sand Company pit pollen assemblages look very much like the vegetation types in this narrow transitional zone, which prominently extend eastward into the prairie or aspen parkland.
According to Fredlund (1995), the high relative frequency of Artemisia (sage) pollen in the Farmfdalian record from Cheyenne Bottoms in central Kansas indicates that one or more species of sage were an extremely important element in the upland grassland-steppe. This vegetation assemblage does not, however, appear to be exactly analogous to the modern sagebrush steppe of the Northwestern High Plains. The pollen evidence suggests that the regional vegetation, although dominated by grassland-steppe, was not totally treeless. Most of the arboreal elements present are boreal or taiga-like in their modern distribution. The most common trees of the Pleistocene vegetation in the region were not, however, coniferous. The low percentages of both Picea and Pinus pollen could be the result solely of long-distance transportation; this is especially likely for Pinus which could represent forests as far away as 400 km. In the case of Picea, however, it is more likely that local populations of trees were scattered along river valleys or fire-protected escarpments. It is extremely unlikely that the Pinus and Picea pollen signals from the Farmfdalian portion of the record represent coniferous parklands or savannas, rather it is more likely that these low pollen percentages represent small populations of conifers limited to edaphically mesic and fire-protected situations.

Opal Phytoliths

Growing plants absorb water containing dissolved silica through their roots. Microscopic amorphous silica bodies are subsequently produced by the precipitation of hydrated silicon dioxide (SiO$_2$·H$_2$O) within the plant’s cells, cell walls, and intercellular spaces. Silica bodies with shapes characteristic of specific plants or group of plants are called opal phytoliths. Phytolith is derived from the Greek words phyton, meaning plant, and lithos, meaning stone, and opal is the common name for hydrated silicon dioxide. Opaline bodies formed in plants without specific shapes are simply plant opal or biogenic opal.

It is well known that three different photosynthetic pathways exist among plant species: C$_3$ (Calvin-Benson cycle), C$_4$ (Hatch-Slack cycle) and CAM (Crassulacean Acid Metabolism). Twiss (1987) suggested that grass-opal phytoliths could serve as indicators of C$_3$ and C$_4$ pathways in grasses. On the Great Plains, two grass subfamilies commonly employ the C$_4$ pathway: the Panicoideae and the Eragrostioideae. The panicoids include such common prairie grasses as the bluestems (Andropogon spp.), panicums (Panicum spp.), and Indian grass (Sorghastrum nutans), as well as domesticated grasses, e.g., sorghum and corn. The grama grasses (Bouteloua spp.) and buffalo grass (Buchloe dactyloides) of the Chloridoideae tribe of the Eragrostioideae subfamily are the two most important of these grasses in the arid southwestern region of the Great Plains. Pooidae grasses such as the bromes (Bromus spp.), wheatgrass (Agropyron spp.), fescues (Festuca spp.), and many of the cereal grains, including wheat (Triticum aestivum) and oats (Avena spp.), are C$_3$ pathway types. The overall pattern, where pooids (C$_3$) dominate the cool northern-Central Plains, panicoids on the moist, warm eastern and southeastern margins, and chloridoïds primarily in the western and southwestern Great Plains, is consistent with the pattern expected from general C$_3$ and C$_4$ adaptations of grasses.

Few workers have reported opal phytolith data from sites in the Central Plains. Among them, Fredlund et al. (1985) tabulated the abundance and type of phytoliths from a vertical loess section at the Eustis ash pit in south-central Nebraska. Pooid phytoliths were the most abundant forms, followed by significant vertical variation in the chloridoïd and panicoid types. They concluded that decreases in the chloridoïd type in paleosol complexes indicated that the soil forming periods must have been warmer and drier than the periods of loess accumulation. The phytolith assemblages from the soil of the Gilman Canyon Formation are unique at the Eustis ash pit: nowhere in the entire 620,000-year record of loess accumulation at the site has anything similar been recorded. The high relative frequencies of panicoid-class phytoliths are even higher than those found in the tall-grass, panicoid-dominated prairies today. In general, the phytolith evidence of warmer soil-forming periods and cooler episodes of increased dust accumulation fits the traditionally accepted models for loess deposition and other proxy records.

Ongoing opal phytolith analysis of the Peoria loess is producing a climatic signal consistent with that of the charcoal isotope data (Johnson et al. 1993a). Phytolith data can be represented as a composite parameter, the aridity index (Figure 10). A cool, mesic climate is apparent by the occurrence of arboreal phytolith types and C$_4$ grass types in the loess of the lower Gilman Canyon Formation and the Peoria loess.

Stable Carbon Isotopes

There are few quantitative techniques in use today for paleoecological reconstructions in terrestrial depositional systems. One recently adopted approach to quantitative reconstructions is to estimate the proportion of C$_3$ (cool-season) to C$_4$ (warm-season) plants once present at a site using

![Figure 10. Aridity index and $\delta^{13}$C curves from the Eustis ash pit, Nebraska. The abrupt change in both parameters at about 16.5 m depth is indicative of the shift from the cool season grasses of the Gilman Canyon Formation soil to the cool season grasses of the overlying Peoria loess (from Johnson et al. 1993).](image-url)
carbon isotopes from the bulk carbon content in sediments, primarily in buried soils.

The natural difference in the stable carbon isotopic composition of C₃ and C₄ plant species provides an opportunity to assess the long-term stability of plant communities and climate of a given region (Troughton et al. 1974; Stout et al. 1975). The basis of this approach is that during photosynthesis C₄ plants discriminate less against ¹³C than C₃ plants (Vogel 1980; O'Leary 1981). This difference in carbon isotope fractionation during photosynthesis results in a characteristic carbon isotope ratio in plant tissue that serves as a diagnostic indicator for the occurrence of C₃ and C₄ photosynthesis. The δ¹³C values of C₃ plant species range from approximately -32 to -20%, with a mean of -27%, whereas δ¹³C values of C₄ species range from -17 to -9%, with a mean of -13%. Thus, C₃ and C₄ plant species have distinct, non-overlapping δ¹³C values and differ from each other by approximately 14% (Nordt et al. 1994).

The stable isotope ratios for ¹³C/¹²C are measured by mass spectrometry, and the isotopic data are expressed as the difference, or delta value (δ), between the sample or standard. The δ value for a carbon isotope in soil is defined as

\[ δ^{13}C_{\text{soil}} = (δ^{13}C_{\text{C₃}}(x) + (δ^{13}C_{\text{C₄}}(1-x)), \]

where \( δ^{13}C_{\text{C₃}} \) is the average of δ¹³C values of C₃ plants (-13%); \( δ^{13}C_{\text{C₄}} \) is the average of δ¹³C values of C₄ plants (-27%); and x is the proportion of carbon from C₄ plant sources.

Isotopic composition of soil organic matter or pedogenic carbonate in soils with a high-respiration rate is a direct indicator of the fraction of the biomass using the C₃ or C₄ photosynthetic pathways. Humus from buried soils probably represents organic matter from the last few hundred years before burial, given the short residence times typical for humus in most modern soils (Birkeland 1984).

Teeri and Stowe (1976) found that the strongest correlation with the percent C₃ in the continental United States was given by the normal July daily minimum temperature, with a correlation coefficient of 0.97. This temperature was a better predictor of the percent C₃ than either the normal July average temperature or the normal July maximum temperature. Based on their analysis, the percent of C₃ species in a grass flora in the continental United States is most accurately predicted by a linear combination of the normal July minimum temperature, mean annual degree-days and the log of the length of the freeze-free period.

For the Gilman Canyon Formation, δ¹³C values exhibit a good correlation with coincident phytolith data (Figure 10). δ¹³C data acquired in association with the correction of radiocarbon ages for the Peoria loess in Kansas and Nebraska indicate that C₃ plants were dominant during most of Peoria loess deposition (Figures 11 and 12). This reflects the cooling associated with the Last Glacial Maximum within early-middle Peoria time (ca. 18 ka). Conversely, C₄ plants were dominant for most of the Gilman Canyon time of pedogenesis (Figure 10), indicating that vegetation and thus climate during Gilman Canyon time was similar to present warm, semi-arid conditions in the Central Plains (Johnson 1993b).
Site-specific factors should be borne in mind when interpreting δ13C data from soil humates. For example, the 17,000 yr B.P. buried soil on the north flank and crest of the dune at Wilson Ridge in the Great Bend Sand Prairie (17,180 ± 240, Tx-7824: 16,520 ± 200, Tx-7825) yielded a δ13C value of -11.9% (Figure 12). During the Last Glacial Maximum, the dune temporarily stabilized and a soil formed. The δ13C value suggests that warm-season or edaphic plants dominated, a finding contradictory with regional late Wisconsinan mesic climatic conditions. Following landscape stability, the soil was buried by sand, presumably during another period of increased aridity and prevailing northwesterly winds (Arbogast 1995).

Rock Magnetism

Loess is perhaps the closest terrestrial analog to marine sediments in that both result from more or less continuous deposition of fine-grained sediment. A great deal of attention, therefore, has been given to magnetic measurements of loess-paleosol sequences, particularly in China and in Europe (e.g., An et al. 1991; Kukla et al. 1988; Kukla 1977). Although much research has focused on paleomagnetic events such as excursions, recent studies in China have suggested that bulk magnetic susceptibility varies systematically in loess sections and can be visually correlated with the well-known marine oxygen curve (Kukla 1987), indicating that changes in the magnetic susceptibility of loess constitute a terrestrial proxy climatic signal. Further direct relationships between magnetic susceptibility and oxygen isotope variations have recently been demonstrated within some marine cores (Heller et al. 1991). Ongoing research is demonstrating that rock magnetism may be used to successfully reconstruct the climatic sequences of the Central Plains (e.g., Park et al. 1993; Farr et al. 1993; Johnson and Park 1996).

Magnetic susceptibility measures magnetization temporarily induced in a soil or loess by an artificially applied, low-amplitude magnetic field. The strength of the susceptibility signal depends on the concentration and grain size of the magnetic minerals. Magnetic susceptibility intensities measured at the Eustis ash pit and Bignell Hill sites in southwestern Nebraska, the Beisel-Steinle site in north-central Kansas, and Barton County landfill site in central Kansas indicate that magnetic intensities are strong in the Gilman Canyon Formation soil, i.e., susceptibilities are nearly twice that of the unweathered Peoria loess (Figure 13). Weaker intensities associated with the Peoria loess indicate that either the depositional rate was faster than in times of soil development or that biologic/soil forming activity was weaker in Peoria time, presumably the latter. Susceptibility curves from the region correlated well despite the distance from each other, testifying to the regional synchronicity and direction of change in climate.

Magnetic analysis from the Eustis ash pit produced a climatic signal consistent with that of the carbon isotope data (Figure 14). Weaker intensities throughout the Peoria time likely reflects the more moist and cooler C3 plant types and the cooling associated with the Last Glacial Maximum. The terrestrial plant ecology of the Gilman Canyon Formation apparently is characterized by primarily C4-type grasses, or warm, possibly dry climate (Johnson 1993b). From the magnetic susceptibility data, it is evident that an environment suitable for more active pedogenesis existed.

![Figure 13. Magnetic susceptibility from sites in south-central Kansas (Barton County, Beisel-Steinle) to southwestern Nebraska (Eustis ash pit, Bignell Hill). The Gilman Canyon Formation and Brady soils are well represented in the curves, as is the Last Glacial Maximum (Johnson et al. 1993).](image-url)
Recent research on the Fort Riley military reservation in east-central Kansas has produced magnetic data supporting the regional late Quaternary climatic model. The frequency dependence data extracted from a 13 m-thick loess mantle on the bluff top adjacent to the Kansas River valley exhibits the higher values anticipated for soils and lower values from the relatively unweathered loess, as well as good correlation to the \( \delta^{13}C \) curve (Figure 15). The Manhattan Airport site consists of Pleistocene and Holocene alluvial fill within a high terrace of the Kansas River valley. The bulk of the fill at this site is Pleistocene, but, on the basis of a single radiocarbon age, the upper 1 to 1.5 m is Holocene (Figure 16). Physical attributes from about 2.75 m to the bottom of the trench indicated the Sangamon soil, but the relatively weak magnetic signal, particularly for susceptibility, is probably due to poor drainage conditions of the alluvial surface during that time. The Gilman Canyon soil does not appear magnetically, but the 19,990 yr B.P. age, a terminal Gilman Canyon age, should identify the top of that soil forming period. Soils present presumably represent the alluvial, or valley phases of those expressed regionally on the uplands (e.g., Sangamon, Gilman Canyon).

Climatic Modeling

Kutzbach (1987) summarized the behavior of the North American jet streams during the late Wisconsin. In July, the split flow around the North American ice sheet modeled at 18 ka persisted to 15 ka, with almost no changes having occurred. By 12 ka, two important changes appeared: first, the northern
branch of the jet moved south, over and along the southern flank of the ice sheet, and merged with the southern branch over the northeastern United States. The second change was the reduced intensity of the North Atlantic extension. The jet at 9 ka followed about the same track as at 12 ka, but with weakened intensity. At 6 ka and thereafter, only a single jet core was simulated over Alaska and Canada, and winds were weak compared to reconstructions of earlier periods. Specifically, the modern single jet core of July follows generally the same track as the northern branch of the split jet in July during the glacial maximum.

In January, like July, the split flow around the North American ice sheet and the intense North America/North Atlantic jet cores at 18 ka persisted to 15 ka with almost no change. At 18 ka the simulated temperatures over the continent were much lower than at present, especially over the elevated and highly reflective ice sheets (COHMAP Members 1988). By 12 ka, the flow had adjusted to a single core of high velocity winds that followed the west-coast-ridge, east-coast-trough pattern of today, and the jet maximum was almost as strong as at 18-15 ka.

The north-central region, from the Rockies to the Appalachians and from immediately south of the ice sheet to 40N, had summer temperatures of 16°C at 18-15 ka, about 7°C below present. Precipitation was less than present at 18-15 ka (colder, with storm track shifted south of the region) and precipitation-minus-evaporation was slightly increased at 18-15 ka (evaporation decreased more than precipitation).

Pleistocene/Holocene Transition

The last deglaciation was a period of intense and rapid climatic changes that affected the global climate from about 20,000 to 5000 yr B.P. Paleoclimatologists have reconstructed global variations, including chemical composition of the atmosphere (30% increase in CO₂ and CH₄ decrease in dust content, etc.), temperature of the atmosphere and surface of the ocean (mean global change of about +4°C), and major reorganization of the ocean circulation and sea-level rise of about 120 m, followed by slow rebound of the continents below the ice caps.

The transition between the Last Glacial Maximum and the present inter- or postglacial episode has drawn much attention from investigators for many decades. At first, the last deglaciation was believed to have been a simple, unidirectional shift, but more recent detailed studies revealed that it was a two-step process (Duplessy et al. 1981; Broecker et al. 1989). During the last deglaciation, intervals of rapid warming between about 13 ka and 11 ka and at about 10 ka were separated by a distinct, brief, cool climate episode occurring between about 11 ka and 10 ka.

Between about 12 ka and 9 ka, the climate and vegetation of central North America underwent dramatic changes (Wright 1970; Watts 1983; Webb et al. 1983). Spruce trees had been replaced by widely distributed deciduous trees in northeastern Kansas, and deciduous trees persisted until about 9 ka when grasslands expanded (Webb et al. 1983). It is clear that megafaunal extinction and dissolution of disharmonious faunas began about 12 ka, and the mesic conditions under which the regionally expressed Brady soil developed persisted until about 8 ka, when the modern climate first appeared. Changes in vegetation and faunal assemblages at this time reflect a shift to warmer and drier conditions with increased seasonality (COHMAP Members 1988) and stronger zonal air flow at the surface (Kutzbach 1987). This was a time of major atmospheric circulation change within the Central Plains, as well as elsewhere.

Geomorphology and Stratigraphy

The beginning of the Holocene, about 10 ka (Hopkins 1975), is a time of dramatic environmental change and attendant stratigraphic discontinuities. In general, this boundary is considered only geochronometric without specific stratigraphic reference, although a stratotype in Sweden has been proposed for the boundary (Mörner 1976); the Swedish unit has a reported age of 10,000 ± 250 yr B.P. (Fairbridge 1983). According to Richmond and Fullerton (1986), a stratigraphic boundary of regional extent of the Pleistocene-Holocene boundary age has not been identified in the United States, and that major climatic or environmental changes at 10,000 yr B.P. are documented only locally (Watson and Wright 1980). This contention seems faulty on the regional scale in that research of the last several years in the Central Plains has identified the Brady soil (Schultz and Stout 1948) as a major pedostratigraphic marker (e.g., Johnson and Martin 1987; Johnson and Logan 1990; Johnson and May 1992).

Brady Soil

Classically, the Brady soil was associated with the upland loess deposits, but recent investigations have identified a contemporaneous soil in upland eolian sands and in alluvial valley fill (Johnson and May 1992). It therefore appears that the Brady soil development represents a time of extensive, broad-scale landscape stability. The Brady soil represents the most important break in the sedimentation recorded since development of the cumulic soil of the Gilman Canyon Formation, and also marks the position of a distinct faunal discordance (Frye and Leonard 1955). At least the early and perhaps all of the Brady soil-forming interval coincides with the Younger-Dryas cold interval of the North Atlantic region.

The Brady soil was first named and described by Schultz and Stout (1948) at the Bignell Hill type locality, a loess sequence exposed along a roadcut in the south valley wall of the Platte River of western Nebraska. The soil is developed within the Peoria loess and is overlain by the Bignell loess. The name was subsequently adopted by researchers in Kansas (Frye and Pent 1947; Frye and Leonard 1951; Frye et al. 1949). The soil is regionally extensive only in the northwestern and west-central parts of Kansas, but even there it occurs discontinuously on the landscape. Frye and Leonard (1951) and Caspall (1970, 1972) recognized Brady development in northeastern and other parts of Kansas. Without the overlying Bignell loess, the Brady
soil does not exist; the modern surface soil has incorporated post-Bradyan loess fall into its profile. The Brady soil is typically dark gray to gray-brown and better developed than the overlying surface soil within the Bignell loess. Strong textural B horizon development and carbonate accumulation in the C horizon are typical, although it occasionally displays evidence of having formed under poorer drainage conditions than have associated surface soils (Frye and Leonard 1951). Feng (1991) noted that the Brady soil, as expressed in Barton County, is strongly weathered both physically and chemically.

Until recently the age of the Brady soil was uncertain, even at the type section: Dreeszen (1970) reported two ages of 9160 and 9750 yr B.P., both of which were believed to be too young because of contamination. Lutenegger (1985) reported an age of 8080 yr B.P. without any stratigraphic context. Johnson (1993) reported two ages of 10,670 and 9240 yr B.P. on the lower and upper 5 cm, respectively, of the Brady A horizon at the type section. Souders and Kuzia (1990) dated a core at a site in the Republican River valley and reported an age of 10,130 yr B.P. Similar ages from the eolian phase have been obtained in south-central Nebraska and north-central and central Kansas (Table 2). According to age data, soil development began at about 10.5 ka and ended 9.9-9.5 ka, suggesting a soil forming interval of greater than 1,000 years.

Arbogast (1995) obtained several Brady era radiocarbon ages from soils buried within the eolian sand of the Great Bend Sand Prairie. Following a period of instability after a short period of stability during the Last Glacial Maximum, soil formation occurred at the Pleistocene/Holocene boundary, which correlates temporally with the loessal Brady soil. Two radiocarbon ages of 10,330 ± 100 and 10,360 ± 100 yr B.P. were obtained at Wilson Ridge, a lunette in the Great Bend Sand Prairie.

The Brady soil is also well expressed in an alluvial facies, i.e., an isochronous alluvial soil found throughout the region is temporally equivalent to the Brady soil identified within loess of the uplands. Since a large number of radiocarbon ages have been obtained from alluvial fill in the Central Plains (Johnson et al. 1996), the patterns of alluviation, erosion and particularly soil formation during the late Pleistocene through Holocene have become relatively well established.

In northwestern Nebraska, Agenbroad (1978) examined alluvial deposits at the Hudson-Meng site (25SX115) in Whitehead Creek Valley. Four stratigraphic units were identified within the loess-mantled terrace. The lowermost unit, designated Unit I, consists of alluvium and contains a bonebed and many artifacts; charcoal from the bonebed yielded a radiocarbon age of 9820 yr B.P., and bone apatite and collagen yielded ages of 8990 and 9380 yr B.P., respectively. Agenbroad suggested that the site was buried by alluvial sands and silts sometime after about 9000 yr B.P., and that a soil developed at the top of Unit I (ca. 4800 yr B.P.) during Alithermal time.

The two ages of 8274 yr B.P. and 9880 yr B.P. determined from alluvial fill (Fill 2A) at archeological sites Ft-50 and Ft-41 on Harry Strunk lake in southwestern Nebraska (Schultz et al. 1951; Libby 1955) were the first radiocarbon determinations obtained on the Brady soil. At Cooper's Canyon, which is southeast of Elba, Nebraska, May (1990, 1991), in a reinvestigation of site studies by Brice (1964), reported radiocarbon ages on humates in the silt and clay fractions of buried soils, of which two ages agree well with both those in the fill from other localities in the Loup River basin and eolian facies. Ages included, 10,290 yr B.P. from the lowest 10 cm of Cooper's Canyon gley soil, and 9250 yr B.P. on the uppermost 10 cm of the Brady soil (Figure 17).

In Kansas, Holien (1982) derived a radiocarbon age of about 10.5 ka from a well developed soil situated in the lower part of Newman terrace fill along the lower Kansas River. Johnson (Johnson et al. 1996) obtained an age of 9820 yr B.P. from a soil buried in alluvial fill at the Ade site within the Saline River valley near Salina, Kansas.

Clovis Level Soil of the Colorado High Plains

The Dutton and Selsby sites lie on the High Plains of eastern Colorado in shallow, internally drained, surface depressions. The Dutton site contains a Clovis level between two clay-rich paleosols formed in reworked Peoria loess that fills the depression. A collagen age of 11,710 ± 150 yr B.P. on mammoth bone from near the E-B horizon boundary of the lower soil may be related to the Clovis level (Reider 1990). Camel bone ages from the bonebed in Peoria loess, in conjunction with the Clovis or perhaps largely pre-Clovis level, provide evidence that the lower soil formed between about 13,600 yr B.P. and the time of

<table>
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<th>Site</th>
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<th>Lab. No.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
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<td>n.a.</td>
<td>Lutenegger, 1985</td>
</tr>
<tr>
<td></td>
<td>9,160±250</td>
<td>W-234</td>
<td>Dreessen, 1970</td>
</tr>
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<td></td>
<td>9,750±300</td>
<td>W-1576</td>
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<td></td>
<td>9,240±110</td>
<td>T-7425</td>
<td>Johnson, 1992</td>
</tr>
<tr>
<td></td>
<td>10,670±130</td>
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<tr>
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</tr>
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Note: Ages represent the eolian phase only. An alluvial phase has been well documented throughout the Kansas River basin (Johnson and Martin 1987, Johnson and Logan 1990) and adjacent river systems, such as the Loup River of central Nebraska (Brice 1964; May 1990) and the Pawnee River (Mandel 1991, 1994) and Walnut River (Mandel 1991) of the Arkansas River system.
Clovis occupation (ca. 11,400 yr B.P.). Both paleosols are regarded as late Pleistocene, but the upper soil (and to a lesser extent the lower soil) were altered by Holocene pedogenesis. Stratigraphic correlation with the Brady soil has not, however, been made at this point.

Climatic Proxies

Fossil Pollen and Botanical Macrofossils

The most detailed description of the nature of late Pleistocene/Holocene environmental changes in the Central Plains comes from palynological studies undertaken along the eastern and northern periphery of the region. At Muscotah and Arlington Marshes in northeastern Kansas, Gruger (1973) documented spruce forest from 23,000 to 15,000 yr B.P. followed by the spread of a mixed deciduous forest and prairie, which was present in the region from 11,000 to 9000 yr B.P. The nature and duration of the climatic changes which precipitated vegetation changes are not certain, because of a hiatus in sedimentation. Fredlund and Jaumann (1987) have suggested that pollen records represent an expansion of an aspen parklandlike community across the Great Plains.

According to Wright (1989), pollen records from the Great Plains can not show the effects of minor climatic fluctuations like the Younger Dryas because climate had become too warm by 11 ka to permit introduction of spruce. General circulation model results also show that the temperature for winter was deeply depressed far across Eurasia but was little changed in North America (Mathewes et al. 1993). The critical vegetation change identified by Shane and Anderson (1993) in east-central North America involves the recurrence of spruce, which is limited in its southern range by summer rather than winter temperatures. The southerly position of the polar front across the North Atlantic could have resulted in a southward displacement of the jet stream and associated storm tracks, thus enhancing the cyclonic storms that could deliver cold northwesterly winds not only to the Maritime Provinces, but inland to the Ohio area as well (Wright 1989).

Another source of paleoenvironmental information comes from peat beds and logs, radiocarbon dated from 10,500 to 8400 yr B.P., buried in valley fills associated with the North Loup River (Bradbury 1980). The peat is buried by alluvium which is in turn mantled by dune sand. The stratigraphic association of these deposits and the presence of marsh plants like *Equisetum* (horsetail) indicate that locally, fluvial processes and riparian environments, similar to those that exist today, were followed by sand movement (Bradbury 1980). Most recently, Ponte et al. (1994) dated a peat recovered in a core from the central Sand Hills and radiocarbon dated it to 12,260 yr B.P.; the peat contained 70% *Picea* pollen, indicating that the spruce forests of the late Wisconsin existed farther south into the Sand Hills than previously reported.

Stable Carbon Isotopes

Temporal changes in δ¹³C data derived from carbon contained within soil and sediment (Figures 11, 12, and 15) are sufficiently large to show major shifts in vegetation during the late Wisconsin. The interval between 12,000 and 9000 yr B.P. can be interpreted as transitional between the cooler and more xeric late Pleistocene to warmer and drier Holocene. Based on a slight decrease in the δ¹³C values from the Brady soil at six sites in the region, climatic conditions shifted to more xeric conditions (C₃ to C₄) from the beginning to the end of the Brady time, a period of major landscape stability and pedogenesis (Table 3).

The isotopic data agree with that of other climatic proxies for the region. The fossil pollen record from Muscotah Marsh in northeastern Kansas indicates that spruce had essentially disappeared from the region by about 10,500 yr B.P. As this decline occurred, deciduous tree species increased until about 9000 yr B.P. From a site in central Texas, Nordt et al. (1994) interpreted the time between 11,000 and 8000 yr B.P. as transitional between late Pleistocene conditions and warmer and drier Holocene conditions based on a slight increase in the abundance of C₄ plant biomass using stable carbon isotopic data.

Rock Magnetism

The Eustis ash pit, Beisel-Steinle site and Barton County landfill site each produced magnetic susceptibility curves characterized by a pronounced increase in the upper Peoria loess as the depositional rate decreased dramatically and Brady
pedogenesis began (Figure 13). Frequency dependence of susceptibility exhibited a notable but not dramatic increase in the basal Brady soil for the Summer Hill site on Fort Riley, Kansas (Figure 15), suggesting perhaps that the intensity of Brady pedogenesis varied spatially according to microclimatic conditions.

Magnetic susceptibility intensities measured at the Bignell Hill site in Nebraska and the Beisel-Steinle and Barton County landfill sites in central Kansas indicate that magnetic intensities are very high in the Brady soil, e.g., susceptibility intensities (80-100×10^4 m^2/kg) are nearly twice that of the unweathered Peoria loess (40-50×10^4 m^2/kg) and slightly higher than the modern soil (Figure 18). On a hemispheric scale, the abrupt decrease in atmospheric dust noted in the Greenland ice core at about 10,750 yr B.P. (Paterson and Hammer 1987) reflects decreased loess transportation and deposition, and probably increased Brady-age pedogenesis associated with relative terrestrial stability.

Climatic Modeling

Significant deglaciation did not begin until 14 ka and ended by 6 ka. This conclusion is validated by maps of ice area, by marine δ¹⁸O records, and by terrestrial and marine records (Ruddiman 1987; Crowley and North 1991). With increased summer insolation during the termination, the mass imbalance of ice sheet would have increased. Ice sheet decay may also have been affected by a number of processes. For example, CO₂-induced air temperature changes were apparently sufficiently large enough to cause disintegration of the extensive marine-based ice sheet on Eurasia. Broecker et al. (1988) suggested that changes in the coupled ocean-atmosphere circulation in the North Atlantic were responsible for the changes.

The structure of deglaciation within this 8000-year interval is uncertain. There is evidence supporting (1) a smooth deglaciation model with fastest ice wastage centered on 11 ka; (2) a two-step deglaciation model with rapid ice wasting from 14 to 12 ka and 10 to 7 ka, and a mid-deglacial pause with little or no ice disintegration from 12 to 10 ka; and (3) a Younger Dryas deglaciation model with two rapid deglacial steps as in (2) above, interrupted by a mid-deglacial reversal with significant ice growth from 11 to 10 ka.

The critical data supporting the smooth deglaciation model are maps of Laurentide ice area based on radiocarbon-dated glacial deposits. Although there are subtle suggestions of more rapid retreat at or near the time of the two steps mentioned above, these curves indicate a steady progressive retreat of North American ice, with significant oscillations in retreat rate only at local spatial scales. Some marine δ¹⁸O curves also show a smooth progressive decrease toward Holocene values.

The step deglaciation model is also supported by some marine δ¹⁸O records (Mix 1987). In addition, the distinctive patterns of change in sea-surface temperature of the North Atlantic Ocean and in Greenland ice-core δ¹⁸O values also show abrupt step-like warmings at 10 ka and approximately 13 ka; these warmings might be associated with step-like decreases in Laurentide ice volume. Regionally integrated rates of pollen change in eastern and central North America also show a rapid change centered on 13.7 and 12.3 ka. (Ruddiman 1987).

![Figure 18. Magnetic susceptibility from two loess sites, and the δ¹⁸O curve from a Greenland ice core. A Younger Dryas-type climatic fluctuation is apparent at the Pleistocene/Holocene boundary (Johnson et al. 1993; Dansgaard et al. 1985).](image-url)
The Younger Dryas deglaciation model is suggested by sea-surface temperature cooling between 11 and 10 ka in the North Atlantic Ocean. At least early and perhaps all of Brady pedogenesis coincides with an abrupt and brief cool interval correlative with the classic Younger Dryas cold interval of the North Atlantic region.

Younger Dryas

The Younger Dryas, as the last glacial cold spell, was an abrupt and well-defined event (Dansgaard et al. 1989; Broecker et al. 1988), which has been absolutely dated at about 11 ka to 10 ka. (Table 4). In this short period of time, the return to near-glacial conditions interrupted the Pleistocene/ Holocene climatic transition, during which most of the Northern Hemisphere ice sheets melted. A leading explanation for the Younger Dryas cooling depends primarily on a mechanism for cooling of North Atlantic waters, rather than on the radiation distribution or directly on the presence of the ice sheets (Wright 1989). During deglaciation, large quantities of meltwater flowed from the melting Laurentide Ice Sheet. Appreciable evidence exists to suggest that the Younger Dryas coincided with changes in the routing of meltwater between the Mississippi and St. Lawrence drainage basins (Broecker et al. 1988; Broecker et al. 1989; Lehman and Keigwin 1992; Taylor et al. 1993). The influx of fresh water to high latitudes of the North Atlantic has been suggested as inhibiting the generation of dense, saline North Atlantic deep water, which, in turn, led to a reduction in heat transport to the North Atlantic (Broecker et al. 1988). For this reason, the Younger Dryas was recorded much more distinctly in Europe and Greenland than in North America, and is thought to be confined to amphitropical regions. General circulation model results also support that conclusion, i.e., they show that temperatures for winter were deeply depressed far across Eurasia but were little changed in North America (Bird et al. 1986).

Many recent studies, however, demonstrate that the varied climatic deterioration was felt well beyond the North Atlantic (e.g., An et al. 1993; Mathewes et al. 1993; Kudrass et al. 1991; Engstrom et al. 1990; Wright 1989). In their study of pollen and chemical stratigraphy in southeastern Alaska, Engstrom et al. (1990) suggested that a significant climatic reversal occurred in this region between about 10,800 and 9800 yr B.P. The temporary return of tundra after full development of lodgepole pine parkland is regarded as a clear response to climatic reversal, even though it is not contemporaneous with any known readvance of glaciers in the area or elsewhere in the Pacific Northwest. More recently, Mathewes et al. (1993), in their study of the British Columbia coast, also reported a shift from forest to open, herb-rich vegetation after 11,000 yr B.P., in response to colder and wetter conditions identified by a pollen-climate function. Shane and Anderson (1993) argued that the recurrence of spruce between about 11,000 and 10,400 yr B.P. supports the interpretation of regional temperature decrease in the Till Plains region of Ohio, Indiana, Michigan, and Illinois.

Johnson and Park (1993) suggested that the timing of a magnetic susceptibility reversal within the Brady soil forming interval at the Bignell Hill type section matches with the Younger Dryas cooling record from the oxygen isotope data of a Greenland ice core. This minor but notable drop in the susceptibility intensity occurs immediately below or within the lowermost Brady soil, which may indicate climatic degradation comparable to the Younger Dryas cold spell (Figure 18). Extended use of AMS dating may provide the chronological framework needed to develop estimates of time and rates of changes during Younger Dryas time within the region.

Table 4. Chronology of Younger Dryas.

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Area</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,000</td>
<td>Greenland Icecore</td>
<td>Dansgaard et al. 1989</td>
</tr>
<tr>
<td>10,000</td>
<td>Sully Sea, SE Asia</td>
<td>Kudrass et al. 1991</td>
</tr>
<tr>
<td>10,000</td>
<td>Ohio</td>
<td>Shane, 1987</td>
</tr>
<tr>
<td>10,000</td>
<td>ENGOPO, Draca Basin</td>
<td>Broecker et al. 1988</td>
</tr>
<tr>
<td>10,000</td>
<td>Alaska</td>
<td>Engstrom et al. 1990</td>
</tr>
<tr>
<td>10,190</td>
<td>British Columbia</td>
<td>Mathewes et al. 1993</td>
</tr>
<tr>
<td>10,000</td>
<td>Atlantic Canada</td>
<td>Mott et al. 1988</td>
</tr>
<tr>
<td>10,000</td>
<td>North Atlantic</td>
<td>Lehman and Keigwin 1962</td>
</tr>
<tr>
<td>10,500-10,950</td>
<td>China</td>
<td>An et al. 1993</td>
</tr>
<tr>
<td>11,010±170</td>
<td>South Portugal</td>
<td>Bard et al. 1987</td>
</tr>
</tbody>
</table>

Holocene

Geomorphology and Stratigraphy

Bignell Loess

The Bignell loess was first described and named at the same type locality as the Brady soil (Schultz and Stout 1945). It is typically a gray or yellow-tan massive, calcareous silt, seldom more than 1.5 m thick. Although Bignell loess is often less compact and friable than the underlying Peoria loess, no certain identification can be made without the presence of the Brady soil (Caspall 1970). The Bignell loess does not form a continuous mantle, but is most prevalent and thickest adjacent to river valleys, particularly the south side, and often occurs in depressions on the Peoria surface. Of the loesses comprising the late Quaternary stratigraphy of the Central Plains, the Bignell is the only one that appears to have been deposited during a warm, nonglacial climate.

Eolian Sand Deposits

Holocene history documented for the sand sheets of Nebraska, Colorado and Kansas has indicated significant activity. Global climate change, resulting in shifting temperature and precipitation patterns, has been the focus of many of the studies focusing on the sand sheets of the Central Plains (e.g., Forman et al. 1992b; Yuhas 1993; Arbogast 1995). For example, numerous years of drought during the spring growing season is an effective mechanism for reducing vegetative cover and resultant dune destabilization. In fact, during historic drought, the coverage of native short-grass vegetation was reduced, and soils were extensively eroded by eolian activity (Tomaneck and Hulet 1970).

A record of late Holocene dune activity comes from the Nebraska Sand Hills through the research of Ahlbrandt and Fryberger (1980) and Ahlbrandt et al. (1983). The latter work, producing the first stratigraphically controlled radiocarbon ages
from this large sand sea, reported that the most recent period of dune activity was not during the Wisconsinan glaciation, but rather during the late Holocene (ca. 3000-1500 yr B.P.). Their conclusions were based on data from seven stratigraphically controlled sites, three with maximum-limiting radiocarbon ages of about 3000 yr B.P. and four with maximum-limiting ages of about 10,000-5000 yr B.P. They correlate their age estimates for stabilization of the dunes around 1500 yr B.P., based on archeological and pollen evidence, with the interstadial between the Triple Lakes and Audubon glacial advances in the Colorado Front Range, as reported by Benedict (1973). Further evidence for a Holocene age of dunal development offered by Swinehart (1990) was a radiocarbon age of 13,160 yr B.P. obtained in alluvium 3-4.5 m below the 52-85 m-high barchan dune in the central Sand Hills. Vibecores from lakes in Cherry County in the central Sand Hills collected by Ponte et al. (1994) indicated multiple peat layers. Radiocarbon ages outlined two major periods of eolian activity during the middle Holocene and two subsequent periods at about 3500-2800 yr B.P. and after 1000 yr B.P.

The Great Plains region of northeastern Colorado is also an area of extensive sand dunes. Parabolic dunes in the region provide primary paleoclimatic information: dunes are elongate parallel to prevailing winds, causing the limbs of parabolas, anchored by vegetation, to point up wind. The dominant northwest-to-southeast orientation indicates that winds from the northwest shaped the landforms. Strong prevailing winds on the High Plains are associated with air masses originating from the North Pacific or Canadian Arctic, and they preclude significant influence of tropical or subtropical air masses (Borchert 1971). These dunes exhibit evidence for a late Holocene dry period (Mehs 1985), i.e., soils developed on these dunes have morphological and textural properties similar to soils on stabilized dunes in the Nebraska Sand Hills with maximum limiting radiocarbon ages of about 3000 yr B.P. Forman and Maat (1990), using thermoluminescence and radiocarbon dating, obtained ages of 7-9 ka on soils buried in dunes near Hudson, Colorado. Forman et al. (1992b) documented a succession of paleosols buried by eolian sand during the Holocene, indicating that there were four possible periods of eolian sand deposition in the Holocene—about 9500 to 5500 yr B.P., 5500 to >4800 yr B.P., >4800 to >1000 yr B.P., and <1000 yr B.P., separated by relatively short intervals. Using radiocarbon dating, archeological data and other information, Madole (1994) observed that the sand sheet of northeastern Colorado was mobilized within the last 1000 years. Stratigraphic evidence from Nebraska and northeastern Colorado indicates extensive sand sheet reactivation and dune formation during the late Holocene, with significant mobilization during the last 1000 years in Colorado. Global climate change, resulting in different temperature and precipitation patterns, has been the focus of these studies of sand sheet activity in the Central Plains (e.g., Forman et al. 1992b; Yuhas 1993; Arbogast 1995).

Johnson (1991a) and Arbogast (1995) documented periods of dune activity in the Great Bend Sand Prairie of Kansas. The most intensive period of dune formation in the region apparently occurred between 9 and 6 ka, an interval of sand mobility widely recognized on the Great Plains. In the late Holocene, loess accumulated episodically on relatively flat landscapes, while sand sheets and dunes were mobilized from about 5700 - 4800, 2300 - 1700, 1600 - 800, and 200 yr B.P. The orientation of parabolic and barchan dunes indicates that prevailing winds during the Holocene have been generally southwesterly.

Recent geomorphic research in the Great Plains (Holliday 1987; Forman and Maat 1990; Swinehart 1990) has indicated that the middle Holocene, or Alithermal (Antevs 1955), was an episode of decreased precipitation and increased erosion. A number of studies suggest an Alithermal age for dune sand on the Great Plains. On the Southern Plains, Holliday (1985, 1989) identified two periods of dune sand movement at about 6500-5500 and 5000-4500 yr B.P. These latter episodes of dune sand movement have been correlated with similar-aged dune deposits in Bailey County, Texas (Benedict and Olson 1978). Thus, geomorphic evidence strongly supports Benedict's (1979) reconstruction of Great Plains paleoclimate based on archeological data.

It has been proposed that the Alithermal was the most likely time during which the large dunes of the Sand Hills formed (Swinehart 1990). Following about 2000 years of stabilization, the climate became dry enough to allow reactivation of much of the sand in the eastern part of the Sand Hills.

Alluvial Deposits

During the last decade, a great deal of attention has focused on the development of alluvial chronologies in the Central Plains, typically in connection with geoarchaeological investigations. As a consequence, this research has resulted in a number of studies and a sizable radiocarbon date base; well over 400 radiocarbon ages have been obtained from alluvium in Kansas and Nebraska (Johnson et al. 1996). Only a sampling of the many studies is presented below.

Much of the research in Nebraska has focused on the Loup River basin. Brice (1964) recognized two major terrace systems in the basin and obtained early Holocene radiocarbon ages of 10,500, 9000, and 8500 yr B.P. on fill beneath the lower of these terraces, the Elba. In a recent reexamination of the Elba terrace, May (1990, 1991) secured radiocarbon ages ranging from nearly 11000 to 4670 yr B.P. from the Cooper’s Canyon area (Figure 17). On the South Loup River, May (1986, 1989, 1992) recognized four alluvial fills, with the oldest one dating between about 10,200 and 4700 yr B.P., thereby correlating temporally with the Elba terrace of the North Loup. Elsewhere in the basin, Ahlbrandt et al. (1983) dated organic accumulations in alluvial sands at 8410 yr B.P. from a site on the Dismal River.

In the Kansas River basin, alluvial geomorphic studies have a relatively long history, beginning in the 1950s. The first dating of alluvial stratigraphy on the Kansas River proper was done by Holien (1982), who obtained an age of 10,450 yr B.P. on a soil buried within lower Newman terrace fill at the Bonner Spring site. Subsequent radiocarbon dating of Newman fill at this locality (Johnson and Martin 1987; Johnson and Logan 1990)
and others (Bowman 1985) produced more early Holocene ages. The lower Holliday terrace was dated about 4300 yr B.P. and younger (Johnson and Logan 1990).

Many studies have been conducted elsewhere in the Kansas River basin on the many tributaries. Some of the first radiocarbon dating was carried out on samples collected from the Republican River basin by Schultz and his colleagues at the University of Nebraska; from varied locations they secured early to middle Holocene ages from buried soils. The most recent research in the basin was conducted by C. Martin (1990, 1992) who concluded from dating various alluvial fills that the majority of the fill was deposited less than about 4600 yr B.P.

Several geoarchaeological studies were done in conjunction with cultural resource management projects focusing on federal impoundments within the Kansas River basin. Mandel (1987), in a study of the lower Wakarusa River, recognized two terraces, the lower of which produced radiocarbon ages of about 2900 yr B.P. and less. A study of the alluvial history of the Smoky Hill River in the vicinity of Kanopolis Lake (Mandel 1988, 1992) revealed a striking absence of early and middle Holocene fill in small valleys, and middle Holocene fill in the main valleys and in alluvial fans.

In their study of Wolf Creek basin in Kansas, Arborgast and Johnson (1994) (Figure 19) observed that alluviation of early Holocene floodplains in this small basin was episodic, with at least one period of floodplain stability and soil formation about 6800 yr B.P. During the middle Holocene (ca. 6500–5300 yr B.P.), lateral erosion and entrenched flushed most early Holocene fill from the main valley of Wolf Creek and the lower reaches of its larger tributaries. Following the interval of mid-Holocene erosion, sediment accumulated on floodplains between 5300 and 3000 yr B.P. Late Holocene alluviation was episodic, with intervening periods of floodplain stability and soil formation about 1800, 1500, and 1200 yr B.P.

A number of studies have been conducted in the Arkansas River basin area of south-central and southeastern Kansas. Mandel examined terraces and associated fills in the Neosho (Mandel 1992, 1993) and Verdigris rivers (Mandel 1993), obtaining radiocarbon ages on fill to about 4200 yr B.P. The most extensive study in the Arkansas River basin was that of the Pawnee River basin by Mandel (1988, 1991, 1994). Two terraces were recognized in the higher order tributaries, with fill of the high terrace dating between about 10,000 and 5000 yr B.P., and that of the low terrace to 3000 yr B.P. and younger. Of the three terraces present in the lower part of the system, the lowermost one has Holocene fill and the others are Pleistocene. Holocene valley fills in the Pawnee River basin appear to lack soil development from about 7000 to 5000 yr B.P.

The alluvial record is temporally and spatially fragmented, i.e., the history of valley and stream evolution stored in alluvium is scattered and wrought with gaps. So, it is only by assembling this fragmentary information that one obtains a unified perspective on the record of stream evolution. Out of the many studies conducted in recent years, a pattern of change is emerging. Large stream valleys appear to contain, more or less, alluvial fill dating throughout the Holocene, whereas small stream valleys typically contain only fill dating in the late Holocene. This model has an intuitive basis in that the probability of survival of early and middle Holocene fill in smaller streams is greatly diminished by the limited storage capacity for alluvium and the relatively high stream gradients, large area in hillslope, and associated peaked flow waves. Exceptions to this pattern do, of course, exist (e.g., Lime Creek, Nebraska: May 1996; Wolf Creek: Arborgast and Johnson 1994), but are likely due to locally unusual valley width and other discernible factors.

A first approximation of this alluvial model was presented by Johnson and Martin (1987) in an examination of radiocarbon ages obtained from alluvial fill in the Central Plains. In recent years, the model has evolved with a vastly expanded data base and been articulated recently by Mandel (1995). He noted that fill in small valleys appears to be less than 4000 years old, and that the missing early and middle-Holocene record is frequently

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**Figure 19.** Late-Holocene alluvial stratigraphy from Wolf Creek in west-central Kansas. The T-1 surface complex has been created through cutting of the T-2 and through cutting and filling (after Arborgast and Johnson 1994).
preserved at the lower end of small stream valleys as terrace fill or alluvial fans.

From the alluvial chronologies, it is obvious that regional synchrony of stream behavior exists in the Central Plains (Johnson and Martin 1987; Johnson and Logan 1990; Mandel 1995). When erosion and sedimentation are considered in a stream hierarchical sense, patterns of coincidence appear, such as similar times of floodplain stability and attendant soil formation. A frequency distribution of over 400 radiocarbon ages from alluvium of Kansas and Nebraska (Figure 20) provides an indication of the synchrony. The high frequencies of the last 5,000 years reflect the age of the alluvium in large and small streams, whereas those prior to about 8000 yr B.P. represent the ages from the large valleys alone. Alluvial fans ages account for many ages within the 4000 to 8000 year range (Mandel 1995). The greatest frequency of ages occurs about 1200 yr B.P., a time when pronounced low terrace stability and soil development occurred throughout the stream systems. Another notable feature of the distribution is that when the ages obtained from alluvial fans are not considered, very few alluvial ages fall within the 5000 to 7000 yr B.P. period. This paucity of ages suggests little floodplain stability and/or preservation of alluvium from that interval, which coincides with the Alithermal climatic episode. Stream activity of this dry period may have been characterized by rapid sedimentation, thereby precluding soil development, in response to low-frequency, high-intensity convective storms (Knox 1976, 1983).

Regional synchrony in Holocene fluvial behavior suggests that climatic fluctuation is the dominant external variable in stream systems (Wendland 1982; Knox 1976, 1983). Changes in climate during the Holocene were frequent and episodic (e.g., Wendland and Bryson 1974; Kuzbach 1985; COHMAP Members 1988), resulting in discrete periods of stream stability and instability (Knox 1983).

The concept of a middle Holocene, or Alithermal (ca. 7000-5000 yr B.P.) cultural hiatus on the Great Plains has become well-entrenched within the archeological literature. Of the various theories put forth to explain the hiatus (Reeves 1973), fluvial erosion or aggradation sufficient to dramatically alter the record for the region during the interval 7000-5000 yr B.P. is most pertinent (Johnson 1987; Mandel 1995). Some argued that the similarity in the alluvium stratigraphic record from eastern humid portions of the region to the more arid western areas, as well as with chronologies further afield, indicates that regionally anomalous erosion and deposition do not explain the hiatus completely; rather, the increased dryness during the Alithermal was likely sufficient to reduce populations on the Plains (Wedel 1961; Knox 1978; Wendland 1978). However, the rapidly expanding alluvial radiocarbon and stratigraphic data base for the region is indicating that much of the cultural record, namely that of the Archaic period, is buried, often deeply, or lost to erosion.

**Climatic Proxies**

**Fossil Pollen**

Palynological documentation of vegetation and climatic change within the Holocene presents some special challenges (Fredlund and Jaumann 1987). These problems are, at least in part, the result of the taxonomic limitation of pollen analysis. Many major grassland pollen types encompass entire families of plants (Fredlund 1991), and, consequently, large changes within grasslands can occur but not be readily apparent within the pollen record (Wright et al. 1985). This taxonomic limitation explains the lack of clear palynological definition of the middle-Holocene climatic drying in the Central Plains. Because of the limited records and inability to differentiate grass pollen, little Holocene climatic drying is apparent in the fossil pollen record (Baker and Wahl 1985).

Abundant palynological evidence exists for middle-Holocene eastward migration of the prairie/forest ecotone.

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*Figure 20. Frequency distribution of alluvial radiocarbon ages from the Holocene obtained in Nebraska and Kansas (Johnson et al. 1996).*
Several palynological studies from areas peripheral to the Central Plains document middle-Holocene expansion of the prairie (e.g., Brush 1967; Watts and Bright 1968; Durkee 1971; Van Zant 1979). Barnosky et al. (1987) subsequently documented the eastward ecotonal shift between about 8,000 and 6,000 years ago through a review of data from the northern Great Plains. Using pollen/climate transfer functions, Bartlein et al. (1984) estimated that precipitation in the Minnesota area was about 20% less during the middle Holocene than it is today, but that temperature was only slightly higher.

In Nebraska, a paleoecological record comes from Sears’ (1961) study of Hackberry Lake in the north-central part of the Sand Hills. A radiocarbon age indicates that organic deposition began at this site about 5040 yr B.P., and the sediments also record a fluctuating dominance of prairie vegetation that persists to the present, but with no discernible record of the Alithermal. Since the sand dunes that enclose the Hackberry Lake basin are well-preserved barchan and barchanoid-ridge dunes that indicate prevailing wind directions to the southeast, this site appears to represent a post-Alithermal stabilization of the dunes. On the southwestern margin of the Sand Hills at Swan Lake, Wright et al. (1985) analyzed a core with a basal radiocarbon age of about 8000 yr B.P. Sedimentation in Swan Lake appeared to be continuous to the present, and pollen analysis indicated a prairie vegetation with minor fluctuations of herbs and grasses throughout this time, but no Alithermal signal.

Two sites in Kansas provide palynological information for the Holocene: Muscotech Marsh (Grüger 1973) and Cheyenne Bottoms (Fredlund 1995). The Holocene portion of the record at Muscotech Marsh in north-central Kansas contains unconformities and lacks close-interval radiocarbon ages, but clearly portrays middle Holocene prairie expansion and contraction. At Cheyenne Bottoms in central Kansas, the Holocene is markedly different from the late Pleistocene. Farmdalian grassland-steppe assemblage: lower Artemisia percent ages and lower relative frequencies of arboreal pollen types characterize the Holocene. These differences suggest that the Holocene regional upland vegetation in the Holocene lacked the sage component which was so important during the Farmdalian. The Holocene vegetation also lacked diversity of tree and shrub taxa regionally present during the Farmdalian. Of all tree and shrub pollen taxa identified, only Ulmus (elm) and Celtis (hackberry) are more common during the Holocene. Fredlund (1995) divided the Holocene into four microzones based on changes in the local pollen signal. The latest Pleistocene-earliest Holocene zone (>9690 yr B.P.), through its abundance of diatoms and gastropods, suggests increasing moisture at the site. The soil developed above this zone appears to correlate temporally with the Brady soil. The high relative frequencies of Chenopod-A (Chenopodium sp. - Amaranthus sp.) type pollen throughout the Holocene are associated with the existence of mudflats periodically exposed as fluctuations of water levels occurred within the basin. In the middle Holocene (ca. 8500 to 3700 yr B.P.), frequencies of Chenopod-A pollen types decreased significantly, suggesting more stable, perhaps lower, water levels. The increase in Ambrosia (ragweed) pollen during the middle Holocene indicates less fluctuating and lower water levels. The late Holocene (>3700 yr B.P.) was characterized by a return to fluctuating water levels and exposed mudflats.

The timing of the Holocene dry/warm interval appears to vary geographically. In Minnesota the maximum of Alithermal warmth and dryness occurred between about 8000 and 4000 yr B.P., peaking at 7200 yr B.P. (Wright 1976). In the northwestern United States most sites register greatest drought in the early Holocene, although at some sites it was delayed until the middle Holocene, concurrent with the Midwest (Barnosky et al. 1987). In the Southern High Plains, widespread eolian activity began in some areas by 9000 yr B.P. and culminated 6000-4500 yr B.P., probably because of warmer, drier conditions that reduced vegetation cover (Holliday 1989).

Stable Carbon Isotopes

A gradual shift to drier and warmer conditions occurred during the late Pleistocene. Using stable oxygen and carbon isotopes from lacustrine and soil carbonates collected at Fort Hood in north-central Texas, Humphrey and Ferring (1994) demonstrated that mesic conditions continued until 7500 yr B.P., except for a brief drying period between about 12,000 and 11,000 yr B.P. The slow replacement of cool-season plants by warm-season plants at Fort Hood agrees with an extended warming and drying climatic transition during the early Holocene.

By the middle Holocene, drying had reached a maximum according to most studies. Northwestern Texas was experiencing conditions of maximum temperatures, minimum precipitation, and eolian activity between 6000 and 4500 yr B.P. (Holliday 1985, 1989; Pierce 1987). δ13C values derived from paleosols in this region revealed a shift from -23% in the early Holocene to -15% in the middle Holocene (Haas et al. 1986), i.e., a shift in dominance from cool-season C3 grasses to warm-season C4 grasses. Based on enriched δ13C values in soil carbonate from their Texas study, Humphrey and Ferring (1994) identified a middle-Holocene xeric episode, although the δ18O values from these same carbonates did not indicate a significant temperature change.

Despite an aberrant value, limited δ13C data from the Sargent site, an upland loess exposure in southwestern Nebraska, suggest a gradual increase in dryness through the Holocene (Figure 21); this is interpreted as a shift in the abundance of C4 species from slightly under 50% during the late Pleistocene to 80-90% in the middle Holocene. δ13C data derived from the correction of radiocarbon ages obtained from soils buried in alluvial fill of the Central Plains (Johnson et al. 1996) also indicate a gradual increase in C4 plants from about 12,000 yr B.P. through the Holocene, but these data are relatively noisy, however, due to the edaphic conditions encountered on bottomlands.
fill may have originated from an unnamed tributary entering from the west, rather than from the Kansas River proper; contributions of Bignell loess may also be present.

The DB site, located on the loess-mantled bluff overlooking the Missouri River valley in northeastern Kansas, yielded cultural material dating from the early Holocene (Johnson 1966a). A buried soil, believed to be the Brady, is truncated down to its Bt horizon, and the surface soil, developed on overlying loess, is welded to the soil below. The frequency dependence curve derived from the site increases from the unaltered Peoria loess below at about 1.3 m and exhibits two bulges in the upper meter, the lowermost being the buried soil and the upper being the surface soil (Figure 22). Cultural material is associated with the buried Bt horizon as well as with the surface soil.

Tree Rings

Variations in tree-ring widths from one year to the next have long been recognized as an important source of chronological and climatic information. The mean width of a ring in any one tree is a function of many variables, including the tree species, tree age, availability of stored food within the tree and of important nutrients in the soil, and a whole complex of climatic factors, including sunshine, precipitation, temperature, wind speed, humidity, and their distribution through the year (Bradley 1985). The tree is essentially a filter or transducer which, through various physiological processes, converts a given climatic input signal into certain ring-width output which is stored and can be studied in detail, even thousands of years later (e.g., Yapp and Epstein 1977; Fritts 1983).

Unfortunately, the tree-ring record extracted from the Central Plains covers only the last few hundred years, but does provide us with an impression of the recent variability in climate. Information on latest Holocene drought episodes comes from the ring sequences in logs buried at the Ash Hollow site in western Nebraska (Weakley 1962). According to that record, droughts longer than 15 years occurred in A.D. 1276-1313, 1438-1455, 1512-1529, 1539-1564, 1587-1605, and 1688-1707.

In the North Platte area of western Nebraska, Weakley (1945), in a study of red cedar and ponderosa pine, found 13 more or less severe droughts lasting five years or more during the past 400 years. Drought appeared to recur at ill-defined intervals of 15 to 25 years.

Climatic Modeling

Using a modified version of the Blytt-Sernander scheme of climatic episodes, Bryson et al. (1968) produced a model that subdivided the Holocene into the pre-boreal, Boreal, Atlantic, sub-Boreal, sub-Atlantic, Scandic, neo-Atlantic, and Pacific episodes. For example, during the Atlantic episode (8450-4680 yr b.p.), the wedge of modified Pacific air that characterizes the grassland climate was expanded northeastward into central Minnesota and eastward towards the Atlantic seaboard (Bryson et al. 1970).

Figure 21. Composite stable carbon isotope values from the Sargent site, southwestern Nebraska for the past 11,000 years. Values are by-product of correcting radiocarbon ages for effects of fractionation (Dort 1996).
According to recent model simulations, by around 9 ka, summer insolation had increased but was still secondary in influence to the shrinking Laurentide ice sheet (COHMAP Members 1988). The glacial anticyclone persisted in eastern North America, but was much smaller than at 12 ka. With the Pacific subtropical high gaining strength adjacent to the west coast of North America, northwesterly winds replaced westerly winds along the coast in the Northwest. The Midcontinent was still cooler and more moist than at present in July. By the early Holocene (9 ka), the ice had wasted appreciably, the jet stream was no longer split, orbital parameters were favoring increased temperatures, and zonal flow was dominating (Kutzbach 1987).

For the Alithermal, i.e., 6 ka, model results produced mean summer temperatures 2° to 4°C higher than present (COHMAP Members 1988) and annual precipitation up to 25% less than at present in the region (Kutzbach 1987). Surface westerly winds in the midcontinent were stronger than today, with warmer and drier conditions prevailing. Since 6 ka, simulation indicates that westerly flow has weakened and summer temperatures have decreased.

Nature of the Record

A substantial body of knowledge exists concerning the paleoenvironmental history of the Central Plains. This body of knowledge is, however, somewhat awkward to synthesize because of its uneven distribution both geographically and chronologically, and its derivation from many different types of proxy data using many different types of methods. Nonetheless, when making a comparison with the level of knowledge two to three decades ago, we certainly have a much better impression of late Quaternary environments today.

To extract the paleoclimatic signal from proxy data, the record must first be calibrated, which involves using modern climatic records and proxy materials to understand how, and to what extent, proxy materials are climate-dependent (Bradley 1985). It is assumed that the modern relationships observed have operated, unchanged, throughout the period of interest. All paleoclimatic research, therefore, must build on studies of climate dependency in modern-day natural systems, but not all environmental conditions in the past are represented in the modern times. Obviously, situations existed during glacial and early postglacial times which defy characterization by modern analogs (Martin and Martin 1987). Accordingly, one must be aware of the possibility that erroneous paleoclimatic reconstructions may result from the use of modern climate-proxy data relationships when past conditions have no analog in modern world.

Although there is considerable paleoenvironmental data from the Central Plains, very little can be interpreted quantitatively, e.g., in terms of temperature or precipitation. Quantitative paleoclimatology seems to be conceptually quite difficult, with the few attempts thus far based on tree rings (e.g., Weakley 1962), pollen (e.g., Webb et al. 1993), phytolith morphology (Johnson et al. 1993), and stable carbon isotopes (e.g., Nordt et al. 1994; Fredlund 1993; Johnson et al. 1993). However, the application of mathematical techniques such as transfer functions to proxy data sets of the region holds the promise of allowing quantitative reconstruction of climate by relating quantitative data on modern environments to past environmental data. The use of such transfer functions requires systematic modern baseline data for both the proxies and modern climate.

A major problem in environmental reconstruction is that studies tend to produce paleoenvironmental data which lack the necessary chronological control. Such control for paleoenvironmental information must exist, or it is almost impossible to make spatial correlations; the data cannot, therefore, contribute to regional understanding. Until recent years this had been a serious problem for the Central Plains, but chronostratigraphies are rapidly developing for the alluvial and eolian deposits. The late Pleistocene vegetation cover of the region has provided only scattered wood and charcoal in loess, eolian sands, and alluvium; the grass cover of the Holocene has furnished even fewer datable materials. For radiocarbon control in this region, researchers have frequently used humates preserved in buried soils. Despite general acceptance of radiocarbon dating by Quaternary scientists, some debate still exists regarding the accuracy of humate-derived ages. Thermoluminescence dating has been employed in several studies (e.g., Oviatt et al. 1988; Feng et al. 1994; Maat and Johnson 1996). Together, radiocarbon and thermoluminescence dating are, however, producing consistent ages, resulting in an ever-increasing resolution of the chronology for late Quaternary deposits of the Central Plains.
3 A History of Archeological Research on the Central Plains, by
Matthew E. Hill, Jr., Jack L. Hofman, and Karolyn Kinsey

In comparison to the numerous histories of North American archeology (e.g., Meltzer et al. 1986; Trigger 1989; Willey and Sabloff 1993; Wilsen 1965; Wissler 1942) there are only a few detailed summaries of the development of archeology on the Great Plains (Wedel 1951a, 1961b, 1982; Strong 1935, 1942; Frison 1973). The present study attempts to add information to these histories with special attention given to the Central Plains. Archeology on the Central Plains did not occur in a vacuum; political, social, economic, and intellectual influences from other regions of North America and Europe both stimulated and helped frame archeological activity there. One cannot fully understand Plains archeology without examining it from a national context. The development of Central Plains archeology did not simply mirror that of other regions, but rather Central Plains archeologists were influenced by national trends in archeology and vice-versa. In fact, some unique features of Central Plains archeology are best examined in contrast to the archeology taking place in other areas of North America.

Willey and Sabloff’s (1993:7-10) work is the baseline for the present study. For convenience, their seven historical periods are adapted to fit the history of research in the Great Plains. Although, as Schuyler (1971) demonstrates, the specific chronological-explanatory framework used in national histories of archeology often do not accurately represent the evolution of regional research. As a result we modify the chronology of Willey and Sabloff’s system to fit this region’s archeological research history. Four periods have been identified for the Central Plains.

Exploration and Speculation (1492-1840s)

Immediately following the voyages of Columbus, several Europeans began to speculate on the origin and age of the inhabitants of the Americas (Haven 1856; McGee and Thomas 1905; Trigger 1989). Despite their interest, few Europeans had direct observations of the inhabitants or antiquities of the New World. The only people to collect information about the inhabitants of the New World were explorers, colonial administrators, or priests. This information was used to support a myriad of conclusions on the origin and age of aboriginal inhabitation of the Americas (Wauchope 1972; Willey and Sabloff 1993). Most accounts record information on the distribution and activities of native groups, while only a few discussed the native antiquities, such as mounds and earthworks.

In the Great Plains region, early Spanish and French and later American explorers were the first to observe and document the cultures of native Plains groups. Expeditions of Coronado, Onate, Ulisbarri, LaHarpe, Du Tisne, Villazur, and others between 1541 and 1800 provide initial information on some Southern and Central Plains groups (Gunnerson 1984; Hammond and Rey 1940; John 1975; Schlesier 1994; Wedel 1959:19-47, 1986; Wedel and DeMallie 1980; Winship 1896). The Lewis and Clark and later Pike expeditions in the early 1800s provided further insights into the native Plains culture groups.

Following the War of Independence, westward expansion increased and the European settlers encountered the great earthen mounds of the Ohio and Mississippi valleys. Questions about these earthen works were the impetus for a direct study of Native American antiquities. The work of Thomas Jefferson (1844) and Benjamin Smith Barton (1797) at earthen mounds in the eastern United States were the earliest systematic investigations into North American archeology (Trigger 1989; Wilsen 1965; Willey and Sabloff 1993). However, most archeology done before the 1800s was performed by explorers and travelers.

Antiquarian interests were the basis for most early archeological research. These centered mainly on questions of who built the earthen mounds and their relationship to the Native Americans who inhabited the country during historic times. It was commonly believed that the Moundbuilders were a separate and more advanced race than the historic Native American groups. Native Americans were thought to be culturally static and “savages” by many Europeans (Trigger 1986), and they were considered responsible for the destruction of the Moundbuilder culture (see Trigger 1989; Silverberg 1968; Willey and Sabloff 1993; Wilsen 1965). These negative views of Native Americans and the belief of a separate Moundbuilder culture had a major influence on the interpretations of the archeological record.

By the early 1800s, only a few attempts had been made to systematically investigate the earthen mounds and publish the results of their finds. In 1820, Caleb Atwater surveyed a series of mounds along the Ohio River, recognizing different functions and distributions of the mounds. Wilsen (1965) attributed Atwater’s works as being the first systematically controlled archeological observations in America. Squier and Davis’ (1848) mapping and excavation of a series of mounds in the Ohio Valley marked a major change in the approach to archeological research. The major change was not Squier and Davis’ interpretations, for they concluded that the Moundbuilders were an old, extinct race of stationary agriculturists and unrelated to the contemporary Indian populations (see also, Williams 1991; Willey and Sabloff 1993). The difference was that they systematically investigated a problem and replaced speculation with descriptions. As Willey and Sabloff (1993: 41) stated:

Squier and Davis used rudimentary functional classification for the mounds and asked some questions about the probable use or purposes of such archeological structures. These questions were formulated as quite explicit hypotheses, and they went further in suggesting lines of investigation that might be pursued to verify or disprove their
supposition. In so doing, they anticipated, in a
degree, the modern method of formulating
hypotheses and testing expectations.

After this it became increasingly evident that excavation and
description of archeological material were critical steps in
answering most archeological questions.

Central Plains

During this period numerous explorers and traders made
observations on the activities of aboriginal Plains groups (see
summaries in Gunnerson 1984; Schlesier 1994; Strong 1935;
Wedel 1959). Most of these observations were about location,
customs, environments, and daily activities. These observations
continue to be used by archeologists to help interpret the late
archeological record. The antiquities of the Plains groups were
generally ignored by these explorers, with the exception of the
Lewis and Clark expedition.

No actual "archeological" research occurred during this
period. Blakeslee (1987) claimed that the first investigation
into the archeology of the Central Plains is contained in a late
eighteenth century narrative. This narrative, of dubious
historical reliability, describes John Peyton’s alleged 1774
excavation of a mound in Kansas.

Classificatory-Descriptive (1850s-1930s)

This period represents the development of systematic
archeology. At the beginning of this period there was limited
professional involvement in archeology. By 1930, however, the
field was dominated by professional archeologists, numerous
artifact typologies and chronologies had been developed, and
field techniques became more sophisticated.

Developments in the mid-1800s in Europe eventually had a
strong influence on the development of American archeology
(Wilmsen 1965). In 1833, Lyell published Principles of Geology
which established several key things: a long antiquity for the
earth, the value of index fossils, and the principle of uniformitarianism. A quarter century later, the work of Darwin
on evolution and the discoveries of Boucher de Perthes along
the Somme near Abbeville demonstrated the long chronology
of human history and a biological mechanism for change over
time (Grayson 1984). These changes, especially the European
Paleolithic finds, made researchers in North America aware that
the antiquity of human occupation in North America may have
considerable depth. Not all researchers agreed; some were
opposed to ideas of evolution and a long human occupation in the
Americas. However, by the end of this period, both
evolution and a long human antiquity were generally accepted
by all North American geologists and archeologists.

Following the Civil War, there were two major research
interests in American archeology: (1) the identity and antiquity of
the Moundbuilders, and (2) the origins and antiquity of Native
Americans.

Moundbuilders

Despite the quality of work by Squier and Davis, some
researchers during this period favored an opposite view of the
relationship between the Moundbuilders and contemporary
Native Americans (Willey and Sabloff 1993). Scholars, such as
Samuel Hauen (1856) and H. R. Schoolcraft (1854), accepted
that the Moundbuilders were simply the ancestors of the
modern Native American population. However, the
Moundbuilder debate continued until the early 1890s. What
finally put an end to debate over the origins of the
Moundbuilders was the work of Cyrus Thomas for the Bureau
of American Ethnology (BAE). The involvement of the BAE
started in 1882 when the U.S. Congress ordered them to spend
$5,000 a year on mound research. Thomas directed the
excavation and mapping of numerous mounds in the Mississippi
and Ohio valleys which resulted in the monumental publication
of Report of the Mound Exploration of the Bureau of Ethnology
(1894). Thomas concluded that there was a direct historical
link between the Moundbuilders and contemporary Native
Americans.

Antiquity of Native Americans

Discoveries in France in the midnineteenth century,
established that people lived with extinct animal species during
the Pleistocene (Graysen 1983; Lubbock 1865). These finds
stimulated researchers in America to look for similar deposits
(Nelson 1933; Meltzer 1983; Wilmsen 1965). Some of the initial
finds that attributed human presence during the Pleistocene
times included the Natchez finds (Lyell 1869), Koch's
mastodons (Koch 1857), and the Calaveras Skull (Whitney
1880). As summarized by Meltzer (1983), these American finds
were very different from the European Paleolithic finds. The
skeletal remains and artifacts found in these American deposits
were not analogous to those found in Europe. For example, in
America fully modern human remains were found in potential
Pleistocene deposits, whereas in Europe similar deposits
contained more "primitive" human forms.

As a result of these problems, researchers used artifact
morphology as an important component in arguments that
artifacts were of Paleolithic age (artifacts that were "crude" in
form). The first major American claim for discovery of
"Paleolithic" artifacts was by Charles Abbott on his farm in
Trenton, New Jersey (Abbott 1876; Claypoole 1896; Holmes
1919). By 1888 Abbott had recovered approximately 60 artifacts
along with human and elephant bones. This find stimulated
workers to report similar finds all over the United States in the
1880s and 1890s (see summaries in Hrdlicka 1907; McGee and
Thomas 1905; Holmes 1919). By the 1890s, Jenness (1933:93)
stated that over 8,500 "Paleolithic" artifacts had been reported
in approximately 35 states and Canada. The major "Paleolithic"
finds in the Central Plains were Winchell's (1913) finds in
northeast Kansas and discoveries of artifacts and fossils in the
loess of Iowa and Nebraska (Schultz 1943).

Many critics argued against the numerous claims of
Paleolithic artifacts. The most vocal group were scientists at
the BAE—especially William Henry Holmes and Ales Hrdlicka.
They had two main objections. First, the American Paleolithic
artifacts were not analogous to the artifacts from Europe. Based
on his work at the Piney Branch Quarry, Holmes (1892) claimed
that all lithic artifacts go through a standardized reduction
sequence. Therefore, he believed that the American Paleolithic artifacts were actually early stage rejects of recent artifact production. Another objection was that many of these Paleolithic sites had evidence of potential contamination, inconclusive stratigraphic evidence, or else questions concerning the ability of the collector (Chamberlin 1919). The proponents of the American Paleolithic artifacts responded to these criticisms by stating that Holmes "rejects" would not be confused with Paleolithic artifacts (e.g., Haynes 1893). Their other response was to criticize the opponents (especially Holmes) who assumed that contamination was a problem at these sites rather than demonstrating that it was.

By 1900, the debate over the antiquity of human occupation in the New World changed in orientation. The cause of this change was the discovery of skeletal remains in apparent Pleistocene contexts. Meltzer (1991:13) reports that between 1900 and 1926 some three dozen skeletons from apparently ancient deposits were discovered throughout North and South America. The most significant include Vero and Melbourne, Florida (Loomis 1924, 1925; Sellards 1916a, 1916b), Lansing, Kansas (Chamberlin 1910; Upham 1902; Shimek 1903, 1908; Williston 1902; Winchell 1902, 1903), and Gilder Mound, Nebraska (Barbour 1907; Barbour and Ward 1906a, 1906b; Gilder 1911).

As with the Paleolithic sites, the antiquity of these skeletons was quickly attacked by several critics. These critiques took two forms. The first was the position that many of these skeletons, such as found at Lansing and Gilder Mound, were not actually in Pleistocene-age deposits. Hrdlicka (1907, 1917, 1918, 1928) argued that none of these skeletons represented Archaic or premodern humans. Hrdlicka believed that an ancient skeleton of Pleistocene age would show "primitive" anatomical features similar to those of Neanderthal specimens from Europe. Proponents of these finds countered that these sites were in primary Pleistocene deposits and that Hrdlicka's theory of primitive features was unrealistic. The debate between these two camps continued for about two decades with neither side conceding defeat.

The debate over possible Pleistocene-age human occupation of the Americas finally reached a resolution with the discoveries at the Folsom type site in New Mexico (Figgins 1927; Cook 1927; Meltzer 1983). At Folsom several fluted projectile points were found associated with an extinct form of bison in undisturbed Pleistocene-age deposits. The Folsom site was not the first to associate extinct bison and human artifacts. Sites such as 12 Mile Creek (Williston 1902; Rogers and Martin 1985), Lone Wolf Creek (Figgins 1927), and Meserve site (Meserve and Schultz 1932) were similar to the Folsom site in both setting and composition but did not have the same historical impact. Several researchers (Haynes 1968; Stanford 1969) have suggested that the reason the Folsom site was accepted as a Pleistocene-aged site was that it met three important "requirements." These include: (1) presence of human skeleton or distinctive artifacts, (2) the evidence is within undisturbed geological deposit, and (3) the age of the site must be demonstrated by association with fossils of known age or suitable radiocarbon dates.

According to Meltzer (1983, 1991), another key reason for the acceptance of the Folsom site was that the investigators notified outside observers and requested visits to help validate the in situ finds while the excavation was in progress.

Central Plains Archeology

By the end of the nineteenth century, several local researchers began systematic investigations into a series of prehistoric and historic sites (Strong 1935; Wedel 1959). In 1888 James E. Todd investigated a series of flint quarries in Cass County, Nebraska, and argued for their human origins (see Strong 1935; Wedel 1982). Between 1881-1890, J. A. Udden, a professor at Bethany College, worked at the Paint Creek Village site south of the Smoky Hill River in Kansas (Udden 1900; see summary in Wedel 1959). As was later claimed about Udden's work, "his report stands as one of the few bright spots in Kansas archeology to date" (Wedel 1959:86). Wedel's praise is based on the clarity of Udden's artifact description and careful conclusions that the inhabitants of the Paint Creek Village were probably related to the modern Wichita Indians. In retrospect, it is clear that linking archeological remains with specific ethnic groups has been a major concern of Plains archeology for its entire history.

Beginning in 1895, J. V. Brower, with some local help, searched for sites in central Kansas to relocate the route of Coronado and to find traces of the Quivira (land of Wichita) and Harahay (land of Pawnee) (O'Brien 1984; Roper 1994b; Wedel 1959). Wedel (1959:88) noted that some of his interpretations may be in error, but his two-volume report (Brower 1898, 1899) is an important record for the early archeology of the Plains.

Just before the end of the nineteenth century, S. W. Williston and H. T. Martin excavated a seven-room pueblo in Scott County, Kansas (Williston 1899; Williston and Martin 1900; Martin 1909). While initial interpretations viewed it as a Spanish settlement, Hodge (1900) correctly noted that the site was probably the pueblo of El Quarteojlo occupied in the late seventeenth and early eighteenth century by Pueblo Indians who had fled Spanish domination in the upper Rio Grande region of New Mexico.

From the end of the nineteenth century through the first decade of the present century, a series of sites were excavated which played important roles in the debate over the antiquity of humans in North America.

In 1895 paleontologists with the University of Kansas Museum of Natural History recovered a fluted lanceolate projectile point under the right scapula of a complete skeleton of Bison bison occidentalis (Williston 1902a). The site, 12 Mile Creek, was located on the bank of a small tributary of the Smoky Hill River in Logan County, Kansas. The bison bonebed contained the remains of 12 bison and was covered with approximately 5.5 m of sediment. As noted, this site was similar to the Folsom site but it did not impact the embryonic
anthropological community at the time the way Folsom did 30 years later (Rogers and Martin 1984). However, other scientists, especially paleontologists, viewed 12 Mile Creek as an important Pleistocene deposit with an indisputable human component (Figgins 1927; McClung 1908; Osborn 1910). Melzer (1991, 1994) and Romer (1933) have separately argued that only in retrospect was 12 Mile Creek recognized as being of great antiquity, and moreover, at the time of the excavations the Pleistocene age of the deposits was equivocal. However, these conclusions are not supported by the available information. Williston (1897, 1902a) clearly recognized that 12 Mile Creek dated to the Pleistocene and explicitly stated the importance of the association of the point with an extinct form of bison. Recent archeological research has demonstrated that 12 Mile Creek was a Paleoindian-age bison bonebed, which had been 14C dated to ca. 10,350 B.P. (Rogers and Martin 1984). Later interest in the site centered on projectile point typologies (Howard 1935; Brown and Logan 1987; Rogers and Martin 1984; Wedel 1959); the historical importance of the site (Hill 1994; Jackson and Thacker 1992; Melzer 1991; Rogers and Martin 1984); and analysis of the faunal remains and site formation processes (Hill et al. 1993; Rogers and Martin 1984).

In February, 1902, skeletal remains of two humans—an adult male and a 6- or 7-year-old child—were accidentally discovered beneath 20 feet of sediment along the Missouri River near Lansing, Kansas (Williston 1902b). The skeletons had modern cranial characteristics and were similar to historic Plains Indian groups (Holmes 1902; Hrdlicka 1907; Wedel 1959). The antiquity of the remains was based on the age of the 20 feet of loess covered the deposit. Williston, Upham, Winchell, and Haworth all argued that the overburden was an undisturbed loess deposit contemporary with the Iowan interglacial (Winchell 1903). The opposition, including Chamberlin, Salisbury, and Holmes, supported the theory that the overburden was redeposited sediment which dated to the Holocene period (Chamberlin 1902). Unfortunately, the debate over the Lansing site—like other American Paleolithic sites—became quickly stalemated with neither side changing its position. Wedel (1959: 93) concluded that the Lansing site represented an early ceramic or late preceramic burial, but a series of radiocarbon dates on the bones indicate a middle Holocene age (O'Brien 1984).

Four years after the discoveries at the Lansing site, Robert F. Gilder, of Omaha, Nebraska, excavated human remains from an artificial mound at the Long's Hill site (Strong 1935). The site contained a large number of human bones located above and below a burned clay layer which was 4 feet below the surface. The bones from the lower level were thought to be of a "primitive" form (Barbour 1907; Gilder 1907). Hrdlicka (1907) examined the skeletal material from Long's Hill and stated that the human remains were a modern form, and rodent activity in the mound has caused a high degree of disturbance. Even though the argument against the great antiquity of the Long's Hill remains was very convincing (Strong 1935:46), the debate continued for decades and finally ended in a stalemate.

Intensive archeological research in Kansas dwindled following the work at Lansing and was not resumed until the appearance of Waldo Wedel in the 1930s. An exception to this was the notable work of Gerard Fowke who conducted a surface survey of the Missouri Valley from Doniphan County, Kansas, to Omaha, Nebraska (Fowke 1922; Wedel 1959).

The beginning of the twentieth century witnessed the inception of professional archeology in Nebraska. Elmer E. Blackman was selected as the first state archeologist of Nebraska in 1901. His early work consisted of trying to dispel the myth that human occupation of the Plains was limited to the historic period (Paul 1986). To this end he excavated several historic and protohistoric Pawnee villages (Blackman 1903, 1905, 1906). Frederick Sterns of Harvard University also was very active in the southeastern portion of Nebraska and northeastern Kansas during this period. He carried out extensive excavation of numerous village sites of the Nebraska culture, throughout this area (Hill and Cooper 1938; Strong 1935). Unfortunately, except for Sterns' work at the Walker-Gilmore site in Cass County (Sterns 1914, 1915a) and Strong's An Introduction to Nebraska Archeology (1935) most of his data is unpublished (Sterns 1914, 1915a, 1915b). From 1926 to 1929 Asa T. Hill excavated numerous historic Pawnee houses at the Hill site (25WT1).

Professional Archeology and Federal Involvement (1930-1965)

During this period, archeology became dominated by university-trained archeologists. Associated with increased professionalism, archeologists began to organize into professional and avocational societies, such as the Society of American Archaeology (1934), Plains Anthropological Conference (1931), and the Colorado Archeological Society (1935).

Federal Involvement in Archeology

This period witnessed a tremendous increase in the amount of fieldwork in archeology, which was a direct result of federal support. In 1928 Congress authorized the Smithsonian Institution to cooperate in anthropological research with any qualified state, educational, or scientific institution (Wedel 1982). This law (Public Law 248) supplied $2,000 a year for archeological research in any state for the next five years. Wedel (1982:95) reported that 20% of this money went towards work in the Plains and supported several early surveys in Central Plains states (Hill and Cooper 1938; Hill and Wedel 1956; Renaud 1930, 1931; Strong 1935; Wedel 1959). During the Great Depression, one aspect of the Works Progress Administration (WPA) was to support archeological fieldwork. Despite the monetary support and large numbers of fieldworkers devoted to archeological fieldwork the WPA's main purpose was for work relief and not scientific research (Grosser 1981).

Following World War II, federal support of archeological research greatly increased with the River Basin Survey Project. In the 1920s and 1930s the U.S. Army Corps of Engineers and
Bureau of Reclamation planned to construct hundreds of dams. The actual construction of these dams was held up until after the war. In June, 1945, the Committee for the Recovery of Archeological Remains (CRAR) was created to develop a salvage plan for the archeological sites which would be inundated by the construction of the dams. On October 9, 1945, the Inter-Agency Archeological Salvage Program was established.

Because of the massive size of the projects, almost the entire archeological profession was mobilized. While four regional headquarters (Lincoln, NE; Austin, TX; Eugene, OR; and Berkeley CA) were established to oversee work, it was local universities, museums, and historical societies who performed much of the work (Jennings 1983). Stephenson (1967:4) reported that by 1965 the River Basin Survey crews had worked in 273 reservoirs in 29 states. A total of 5,250 sites were identified with 576 sites in 58 reservoirs being tested or excavated. Table 5 lists reservoir archeological projects in Central Plains.

There were both positive and negative results of the 20-year River Basin Survey program. While there were over 700 publications resulting from the River Basin Survey (Petsche 1968; Stephenson 1967), Jennings (1985: 285) estimated that this represents only 25% of the data collected. Other problems included erratic funding and difficulties in finding qualified personnel (Jennings 1985; Grosser 1981). Some of the more positive accomplishments resulting from the River Basin Survey include the following (Grosser 1981; Jennings 1985; Lehner 1971; Stephenson 1967; Wedel 1967):

1. advances and standardization in field techniques, such as application of dendrochronology and interdisciplinary studies, use of power equipment in excavations, and the acceptance of the Smithsonian trinomial site designation system;
2. increase in archeology education, such as field training for ca. 1000 students, and the establishment of graduate programs and laboratories of archeology;
3. large increase in amount of cultural data recovered which resulted in the establishment of a 10,000-year cultural sequence in North America.

Following the end of the River Basin Surveys, the federal government continued to support archeology through numerous research grants (e.g., National Science Foundation), federally supported salvage operations, and legislation which would protect threatened archeological sites. Some of the more important federal regulations pertaining to archeology are listed in Table 6. The 1966 National Historic Preservation Act insured that any federal undertaking that affected sites on, or eligible for, the National Register would have to consider the impact of the project on those properties. The 1971 Executive Order 11593 provided for an inventory of cultural resources on federal lands for nomination to the National Register. The 1974 Moss-Bennett Bill (Public Law 93-291) authorized all federal agencies to expend funds on preservation of historical/archaeological data. This body of legislation, especially the Moss-Bennett Bill, has finally secured funding for federal construction projects and established the basis for Cultural Resource Management programs.

Theoretical Changes

During this period, museums across the country were filling with artifacts which had been collected during the previous decades. In addition, many excavations, especially in the Southwest and East, were uncovering stratified sites. As a result, archeologists recognized the need to organize and arrange these collections into geographically and temporally meaningful categories (Willey and Sabloff 1993).

This organization required definition of diagnostic artifacts through use of distinctive attributes. Variation in artifacts types and attributes could be used to observe spatial and temporal variation in the archeological record. In areas of the country where stratified sites were prevalent, artifact types in the stratigraphic levels were used as the basis for developing cultural chronologies (e.g., Ford and Willey 1941; Kidder 1924; Strong 1935; Webb and Defarnette 1942). However, during the 1930s and 1940s, very few stratified sites were known in the Midwest and Plains. As a result, the Midwestern Taxonomic System was developed as an organizational framework for archeological assemblages (McKern 1939). This classification system began with the component as its basic unit. The component was composed of artifact types and features—e.g., ceramics, houses, burials—from an archeological site. Similar components were then organized into larger spatial units of foci, aspects, phases, and patterns. In McKern’s system the scale of cultural similarity was documented by trait lists summarizing the presence or absence of specific traits (Spaulding 1985). McKern’s system by definition was ahistorical, but with the addition of chronological information this approach became a useful technique for organizing the regional archeological records (Bell and Baerres 1951; Griffin 1952; Wedel 1959). With the advent of dendrochronology and radiocarbon dating (Libby 1955), regional culture chronologies became increasingly precise and less dependent upon stratified sites.

By the early 1950s explicit concern for chronological ordering and integration of archeological assemblages and complexes was widely evident. Philip Phillips, Gordon Willey and others (Phillips and Willey 1953; Phillips et al. 1951; Willey and Phillips 1958) developed what has remained the primary framework of archeological unit concepts for the Plains region and eastern North America (Willey and Phillips 1958:11-57). Additions to and modifications of this system of components, phases, traditions, and horizons attest to the resilience, utility, and flexibility of this formulation (Blakeslee 1978; Lehner 1971; Krause 1969, 1982, 1989).

In the last two decades of this period archeology expanded its concern beyond chronology with increasing interest in cultural behavior (Taylor 1948; Willey and Sabloff 1993). Human behavior was approached by examining the context and function of artifacts. Willey and Sabloff (1993: 156-157) define these terms as follows:

By context, we mean here the full associational setting of any archeological object or feature: its position on or in the ground and its positional relationship to other objects and features. With
Table 5. Archeological Research in Selected Reservoirs and Watershed Projects in the Central Great Plains.

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>County</th>
<th>Funding</th>
<th>Reference</th>
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<tr>
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<td>NPS</td>
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<td>Breternitz et al. 1970</td>
</tr>
<tr>
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<td>COE</td>
<td></td>
<td>Anonymous n.d.; Hytton et al. 1973; Withers 1949a</td>
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<td>Gunnison</td>
<td>RBS</td>
<td>List 1952</td>
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<td>Yuma</td>
<td>RBS</td>
<td>Biss, n.d.</td>
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<td>US&amp;CS</td>
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<td>Gordon and Kranzush 1977</td>
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<tr>
<td>Cabin Creek</td>
<td>NPS</td>
<td></td>
<td>Morris, Metcalf, Davidson 1974; Morris et al. 1979; Chrysson, and Morisse 1979</td>
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<tr>
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<td>Larimer</td>
<td>NCWCS</td>
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<td>HCRS</td>
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<td>Calabrasi 1966a, 1967a; Quad 1969c</td>
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<td>Granger 1963b; Howard and Gant 1966; Kvett and Metcalf 1949</td>
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<td>Kvett 1947d</td>
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<td>Irish Creek</td>
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<td>Blakas and O'Shea 1983</td>
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<td>RBS</td>
<td>Gant 1963; Howard and Gant 1955; Mattison 1953, 1956</td>
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<td>Quad 1959d</td>
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<td>South Branch Drainage</td>
<td>Hitchcock</td>
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<td>Burt</td>
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<td>Weeping Water Drainage</td>
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Abbreviations
BUREC: Bureau of Reclamation
COE: US Army Corps of Engineers
HCRS: USDI, Heritage Conservation and Recreation Service
NCCWS: Northern Colorado Water Conservation Service
NJMP: North Jersey Metropolitan Recreation and Parks District
NPS: National Parks Service
RBS: Smithsonian Institution, River Basin Survey
USFS: US Forest Service
USCSS: US Soil Conservation Service
Table 6. Selected Federal Legislation That Supports Archeological Research or Preservation.

<table>
<thead>
<tr>
<th>Date</th>
<th>Legislation</th>
<th>Definition</th>
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<tr>
<td>1928</td>
<td>Public Law 248</td>
<td>Provided matching funds (up to $2000/year) to qualified institutions for archeological research.</td>
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<tr>
<td>1935</td>
<td>Historic Sites Act</td>
<td>Established the broad mandate for the Department of the Interior to identify and preserve sites and structures that are historically important.</td>
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<tr>
<td>1960</td>
<td>Reservoir Salvage Act</td>
<td>Authorized the National Park Service to seek appropriations for salvage behind dam-building agencies to cooperate in such salvage.</td>
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<td>1968</td>
<td>National Historic Preservation Act</td>
<td>Requires that archeological resources deemed eligible for the National Register be given consideration in planning.</td>
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<tr>
<td>1969</td>
<td>National Environmental Policy Act</td>
<td>Requires archeological remains be considered in making environmental impact statements.</td>
</tr>
<tr>
<td>1970</td>
<td>Executive Order 11583</td>
<td>Requires all federal lands to be inventoried for archeological remain.</td>
</tr>
<tr>
<td>1974</td>
<td>Arch. and Hist. Preservation Act</td>
<td>Established a mechanism for salvaging archeological remains threatened by federally supported projects by mandating up to 1% of the total project budget for the preservation of archeological/historic remains.</td>
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</table>

these data, archeologists order their material, relating them to assemblages or complexes, which ostensibly have cultural significance, and they may relate these material to natural environmental settings. [By function] we mean both use and function, as these terms are defined by cultural anthropologists.

Functional analysis of artifacts was not a new innovation; how prehistoric groups used projectile points, axes, or scrapers has always been of interest in archeology. The emphasis now was on how artifacts were used in human "lifeways." Artifact function was generally inferred from artifact form and context. Aspects of form and context were continually argued within archeology for the next several decades (Willey and Sabloff 1992).

Also in this period archeologists began to consider the interrelationship of environment and human culture (Hurt 1966; Weakley 1943, 1946; Wedel 1943, 1963). This whole area of interest can be discussed under the rubric of cultural ecology. It was believed that environmental factors influenced or even determined cultural development and change. Julian Steward (1955) was a principal figure in ecological anthropology, building on earlier work of Wissler, Kroeber, and others. He argued that the culture core was articulated with specific environments through technology and that the technological adaptations (core elements) of a culture would in turn influence other aspects of that culture.

Central Plains

This period was the true beginning of professional archeology on the Plains. The history of Central Plains archeology generally followed the same pattern as that of the larger American archeology. However, the works of Duncan Strong and Waldo Wedel impacted archeology on a national level, especially on the way non-Plains archeologists thought of the prehistoric occupation of the Plains.

Early work on the Central Plains during this period mainly consisted of archeological surveys of Kansas, Nebraska, and Colorado. As previously stated, this work in Kansas and Nebraska was financed largely through grants from the Smithsonian Institution Cooperative Fund. A. T. Hill (Nebraska State Historical Society) and Duncan Strong (University of Nebraska) began in 1929 a multiyear project to survey Nebraska (Hill and Cooper 1938; Hill and Wedel 1936; Strong 1935; Wedel 1934). The purpose of these surveys was twofold. The first purpose was to record sites and collect representative artifacts—mainly pottery. The second purpose was to investigate historic- age sites visited or recorded by Euro-American explorers.

It was believed that by isolating and clearly defining the archeological characteristics of the historic peoples a whole series of sites could soon be removed from the category of unknowns; and furthermore, that a comparison of materials so identified with earlier remains in the region might open lines of attack which would permit the establishment of a time sequence extending 'from the known historic into the unknown prehistoric' [Wedel 1938:1].

This research approach formed the basis of the Direct-Historical approach (Strong 1933; Wedel 1938). This approach attempted to work back through time from documented historical period sites and assemblages into prehistoric times in the same geographic area. The approach was both simple and elegant. It was based on identifying cultural traits found at documented historic sites and comparing them to traits found at prehistoric sites. When the prehistoric sites exhibit many of the same traits found at known historic sites, it was assumed they shared a similar cultural heritage.

These early surveys consisted of surface surveys and limited excavations. Since time, funding, and personnel were limited, subsurface testing was also limited to areas of human habitation—commonly village house structures (Wedel 1934, 1961).

Other researchers from the Nebraska State Museum concentrated on the late Pleistocene-aged finds in western Nebraska (Barbour and Schultz 1932a, 1932b; Meserve and Barbour 1932; Schultz and Eiseley 1933; Schultz 1932, 1943). These sites generally supported the association of human artifacts with extinct animals as previously identified at the Folsom type site.

The surveys of Colorado (Renault 1931a, 1932a, 1932b, 1933, 1935) and Kansas (Wedel 1939) followed the same lines as that of Nebraska. However, the early survey of Colorado was limited to a surface survey of the eastern portion of the state.
Excavations were not part of this survey and therefore chronological organization of the data was less feasible. Instead emphasis was placed on typological analyses, specifically for lithic tools and to a lesser extent ceramics (Renaud 1931a). Sites were not organized in reference to age but rather pseudo-"functional" classifications, such as camp sites, work shops, petroglyphs, and tipi-rings, and locational designations, such as blowouts, rock shelters, and lookouts. Unlike the surveys of Kansas and Nebraska, the investigations into Colorado elicited more information on the Paleoindian period than the late prehistoric and protohistoric periods (Renaud 1931b, 1932b). This is partly explained by the research interests of E. B. Renaud and the exceptional finds of Paleoindian artifacts in the Yuma County area of Colorado.

Research at stratified sites such as Signal Butte and documentation of late prehistoric villages finally overturned the widespread assumption that the Plains region was uninhabitable before the introduction of the horse (Kroeber 1939; Wissler 1922; Johnson and Wood 1980; Wedel 1961a, 1982). The final blow to this theory came with Strong’s 1933 article “The Plains Culture Area in the Light of Archaeology” and his 1935 *Introduction to Nebraska Archeology*. Strong stressed that the nomadic horse tribes which have dominated ethnographic interests (Kroeber 1948; Wissler 1914) were only a recent development on the Plains and were preceded by semihorticultural and pedestrian hunting groups.

With the introduction of the River Basin Survey Program, much archeological research in the Central Plains focused on reservoir salvage programs. The largest unit of this program was the Missouri Basin Project, headquartered in Lincoln, Nebraska. This program was to deal with five major dam constructions along the Missouri River and 100 lesser projects along its tributaries (Wedel 1967). The massive number of sites that were excavated during the Missouri Basin Project has helped to establish an impressive cultural chronology for the Plains region, especially for the past 2,000 years (Lehmer 1971; Wood 1977; Schlesier 1994). An important phase of the Missouri Basin Project was the chronology program, which produced approximately 100 radiocarbon dates from various time periods (Wedel 1967), and the development of dendrochronological research (Weakley 1943, 1946). While dozens of reservoirs in the Central Plains were investigated by the Missouri Basin Project, the most intensively investigated projects occurred at Harlan County, Medicine Creek, Davis Creek and Gavins Point in Nebraska, and Glen Elder in Kansas (Wedel 1967) (Figure 23; Table 5).

Behavioral, CRM, and Interpretative Archeology 1965–1995

This period includes the last three decades of American archeology. The changes that have occurred during this period have had a profound effect on present-day archeology. Because some important changes have occurred in the very recent past, historians lack the necessary time perspective to evaluate some trends during this period. Another problem in providing a history of this period is that the volume of archeological research has been huge. It is, therefore, impossible to discuss the numerous specific projects; only general trends will be reviewed.

Theoretical Archeology

Writings on systems theory and culture process laid the foundation for the changes in archeological method and theory associated with the appearance of processual archeology in the 1960s. Processual or “new” archeology was a product of anthropologically trained archeologists who were dissatisfied with the cultural-historical approach common in the archeology of the 1950s. These archeologists, led by Lewis Binford, believed that archeology could explore how cultures work and change, i.e., cultural processes, rather than simply organizing cultural histories and reconstructing past lifeways (Binford 1962). Processual archeologists were also disappointed with the lack of testing of traditional archeological interpretations. Previously, the archeological inferences had been evaluated by two criteria: (1) the degree to which present knowledge of modern groups could be projected into the past, and (2) the confidence in the ability and honesty of the archeologist advancing the hypothesis (Binford 1968). Binford, and others, wanted archeology to become a more rigorous scientific profession in which interpretations could be objectively and independently evaluated.

We assert that our knowledge of the past is more than a projection of our ethnographic understanding. The accuracy of our knowledge of the past can be measured: it is this assertion which most sharply differentiates the new perspective from more traditional approaches. The yardstick of measurement is the degree to which propositions about the past can be confirmed or refuted through hypothesis testing...once a proposition has been advanced—no matter by what means it was reached—the next task is to deduce a series of testable hypotheses which, if verified against independent empirical data, would tend to verify the proposition [Binford 1968:17].

There are four basic tenets of processual archeology. First, cultural change can be understood through an evolutionary approach. Second, cultures are systems with interrelated components, and changes in any one aspect will necessarily influence other aspects of the system. Third, the link between human cultures and the environment is not a linear relationship—one in which environment influences culture or vice-versa—but rather humans are one part of the ecosystem. Finally, researchers need to take a generally scientific (positivist) approach to archeology. This approach should stress explicit assumptions, hypothesis testing (hypothesetical deductive approach) (Binford 1967, 1968; Watson et al. 1971), and a positivist philosophical position (Salmon 1982). This scientific approach emphasized statistical control of data through sampling techniques which permit generalization about variability (Thomas 1986; Mueller 1975). Through this
approach it was hoped that archaeologists could develop "laws" of cultural dynamics which would be relevant to the general field of anthropology (Schiffer 1976).

By the late 1970s processual archeology was criticized for not fulfilling its goal of identifying "laws of cultural change" (Willey and Sabloff 1993). This criticism was probably premature and definitely overlooked the positive contributions processual archeology made to the general field of archeology. In response to critics, processual archeologists realized that it was necessary to change the approach to studies of the archeological record. These responses included a reexamination of what the archeological record was and how archaeologists can best study it.

Many archeologists initiated ethnoarchaeological studies of modern groups attempting to associate the dynamic nature of human behavior and the static nature of the material record (see Binford 1978; Gould 1980; Gould and Watson 1982; Lee and DeVore 1968; Yellen 1977; Kramer 1979). Binford (1981) suggested bridging arguments, called middle-range theory, can be built by studying the links between the static (material record) and dynamics (human behavior) in ethnographic situations and then drawing analogies between the static archeological record and the dynamics of the prehistoric past. Binford claimed that it was not enough to draw simple analogies between the present and the past, instead archeologists must try to explain the nature of the relationship between dynamic systems and the resultant archeological records.

However, it was also realized that the archeological record was not analogous to the material culture of ethnographic groups. The primary difference is that the cultural materials result only from behavior, while the archeological record is the result of cultural and noncultural processes. Taphonomy, in its most general usage, is the study of processes which influence the formation of the archeological record. Faunal studies have led the way in taphonomic research (Behrensmeyer and Hill 1980; Binford 1981; Bonnichsen and Sorg 1989; Gifford-Gonzalez 1991; Todd 1987; Voorhies 1969), although key studies have appeared in analyses of many other materials (Schiffer 1987).

An increasingly important development since about 1980 has been an explicit concern for the study of culture change through a selectionist or Darwinian evolutionary perspective (Boyd and Richerson 1985; Dunnell 1980, 1982, 1988, 1995; O'Brien and Jolland 1991; Leonard and Jones 1987). The basic argument is that adaptationist or functional explanations do not facilitate and can actually inhibit the study of culture change. Variability, not normative patterns or behaviors, is key to understanding change from an evolutionary perspective. There is currently no viable alternative explanatory framework for the study and explanation of long-term changes in culture, behavior, and technology as reflected in the archeological record.

By the end of the 1970s, a group of archeologists in both Britain and America had grown highly critical of processual archeology. These critics have been grouped together under the single heading: postprocessual archeology (Patterson 1986; Shanks and Tilley 1994). While these researchers may differ with one another in their specific approaches, they generally agree on their criticism of processual archeology. These analysts were dissatisfied with processual archeology's continued commitment to what they see as narrow ecological and evolutionary archeology, approaches which the critics feel is out of touch with present concerns of anthropology (e.g.,
gender, power, ideology, structure, history). Irrespective of their approach—gender, Marxist, critical, contextual—postprocessualists contend that processualists have overlooked the importance of ideology to direct and determine cultural change and the impact of contemporary culture on the structuring and execution of scientific research.

Processualists have responded that postprocessualists are unscientific and rely heavily on what is essentially a direct historical approach, wherein all interpretations of the past are limited by the present. The debate between these two camps has been intensive and often personal but has generally not swayed either side. The importance of the debate is not that the participants change each other’s opinions, but rather that the strengths and weaknesses of each set of arguments are explored (Preucel 1991; Duke and Wilson 1995).

CRM Archeology

Although the past 30 years are known for many theoretical changes in archaeology, these approaches have only partially influenced the majority of archeological fieldwork during this time. Most of the field archeology since the late 1960s has been conducted in direct response to federally supported Cultural Resource Management (CRM). This applied archeology has specific requirements to fulfill and these are largely based on procedures, methodologies, and theoretical perspectives which were widespread in the Americas during the early 1970s when much cultural resource preservation legislation was put into practice. These CRM goals include (1) determining the existence of archeological remains in proposed project areas, (2) determining the impact of the project on the cultural resources, (3) assessing the significance of the affected resources according to the criteria of the National Register of Historical Places, and (4) providing recommendations regarding the disposition of archeological remains on the basis of the assembled facts (Raab et al. 1980). Such work is generally focused on the identification of archeological “sites” and some unrealistic assumptions about sampling, site significance, and the formation of the archeological record (Ebert 1991; Dunnel and Dancy 1983; Foley 1981; Smith and Wandsnider 1993; Schiffer 1987).

Federally funded contract archeology has become a dominant force in the archeology of North America. If measured by total financial expenditures and number of field projects, the vast majority of fieldwork has been performed through CRM projects. Hassler (1989:121) estimates that in 1975 total expenditures on federally supported CRM projects in North America totaled approximately $20.8 million, while five years later those expenditures reached almost $100 million. Clearly, CRM work has been a major driving force in the archeology of the last several decades.

This regulated archeology often differs with the approaches of research-oriented or academic archeology. Many critics have stated that CRM archeology does not contribute proportionately to the advancement of knowledge of the archeological record (Flannery 1982; Goodyear et al. 1978; Schiffer and Gumerman 1977). The numerous reasons for this disparity include the fact that the legal requirements of contract archeology can be fulfilled without undertaking a study aimed at significant archeological research questions. Others argue that the idea of significance in the archeological record is problematic because the knowledge that can gained from an archeological site has more to do with the approach brought to the site by the researcher than any intrinsic nature of the site itself (Raab and Goodyear 1984; Binford 1989).

Another problem arises from the fact that many contract archeological firms are private firms organized to make a monetary profit and often operate outside of academic circles where they may be isolated from ideas and developments in archeology. The profit motive has a powerful influence on the type and extent of work done by these companies and on the follow-through time allocated to research following fieldwork. This can motivate CRM companies to perform the least amount of work to fulfill its obligations, thus resulting in minimal information about the archeological resources being studied (Raab et al. 1980). Follow-through in research and publishing, low-term research in specific regions, familiarity with sites and research questions, and knowledge of the regional archeological data base are often hampered by "hit and run" CRM projects. Such problems, however, are certainly not limited to CRM archeology.

Central Plains Archeology

The work on the Great Plains has been dominated by federal CRM contracts. Grosser (1981:59) stated that 95% of all research is funded by federal government contracts. Cultural Resource Management programs began to appear on the Plains in the early 1960s, but at that time the number of projects was small. Between 1975 and 1979 the amount of work in CRM on the Great Plains increased substantially, but by 1980 economic recession caused a dramatic reduction of the available monies for CRM projects. However, the energy boom during this time continued to finance some work on the Great Plains, especially in Montana, Wyoming, North Dakota, and Colorado. While these energy projects commonly supported archeological work, this work was commonly small scale surveys and small mitigation projects such as those associated with drilling pads. Thus while more work was supported by energy projects, these projects often concerned only small areas and were generally not directed toward general research questions.

While contract work on the Central Plains has many problems, it also has contributed positively to archeology. As Hassler (1989) stated, contract archeology has financially supported many graduate and undergraduate students, as well as providing research topics for numerous student projects. Based on the volume of work, CRM archeology has contributed vast amounts of data on the human occupation of the Plains. Much of the specific fieldwork in CRM archeology occurred in reservoir and river basin studies (Table 5; Figure 23), energy projects (e.g. drilling wells, pipelines), and highway construction.

Unfortunately, much of this data contributed through contract work never reaches the larger archeological audience. The general impression of many research archeologists is that most CRM reports are unpublished and therefore "notoriously
difficult to obtain" (Roper 1987:342). However, as Roper's (1987) analysis of archeological publications in the Plains has concluded, the trend of contract archeologists’ poor publication record is improving. Roper stated that CRM archeologist publications in academic journals has substantially increased since the early 1980s. Nevertheless, academic researchers still contribute approximately 70-80% of all journal articles. One explanation of this pattern is that CRM archeologists have no research latitude on the work they perform, even though the work they do often warrants publication in archeological journals (Roper 1987).

This period has also witnessed a tremendous increase in the amount and quality of archeological research on the Plains. Several researchers (Eighty 1983; Johnson and Wood 1980) have noted the tremendous methodological advances in Plains archeology, such as computer analysis, bioarcheology, dating methods, remote sensing, settlement studies, lithic technology, ceramic studies, and faunal analyses. Methodological advances in these research areas were also associated with conceptual advances. These advances have been in archeological taxonomy, culture history and area syntheses, paleoenvironmental studies, the relationships between environment and cultural change, and fundamental changes in the perception of what the archeological record represents and how it is studied. Many of these interests are long-standing ones in Plains archeology, but new tools and ideas are now contributing to this research.
4 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures, by Jack L. Hofman

Hunting and gathering peoples have occupied the Americas for more than 12,500 years if we accept the well-documented evidence from the Monte Verde site in southern Chile (Dillehay 1989). Further evidence, considered inconclusive by many researchers, has also been reported for the even earlier presence of people in the New World (e.g., Adovasio 1993; Dillehay and Collins 1988; Ericson et al. 1982; Ochsenius and Gruhn 1979; Guidon 1986; Bryan 1986a; Meltzer et al. 1994).

When prehistoric people first came to the Central Plains region of North America remains one of many unresolved problems which can only be evaluated through study of the region's archeological record. However, consideration of the earliest archeological record in the Americas as a whole is of considerable relevance to establishing the history and patterns in the first settlement(s). Understanding the timing and avenues for entry into the New World has important implications for study of the earliest portion of the archeological record on the Central Plains.

The concern of this chapter is to provide a critical synopsis of the early and extended portion of the archeological record in the Central Plains from the time of the first human arrivals until the appearance of a constellation of traits which mark the "end" of, or a major change in or addition to, the traditional hunting and gathering way of life.

These marker traits include the artifacts associated with an increasingly sedentary and horticultural way of life: ceramics, structural remains, storage technology, and plant food processing equipment. There are problems with this distinction, usually referred to by archeologists as Archaic vs. Woodland cultures, because each of the above listed traits which we generally recognize as typical of Plains Woodland and later cultures have earlier expressions in the Archaic complexes of the Plains region. Permanent structures, storage, use of ceramic objects, and plant processing equipment all appear thousands of years before the spread of Woodland traits and horticultural economies on the Central Plains. Also, there is no evidence that the "Archaic" or hunting and gathering lifeway ended or became extinct with the onset of Plains Woodland a little more than 2,000 years ago. Instead it is likely that there were always hunters and gatherers (though representing a variety of different traditions) in the Central Plains region between the Rocky Mountains and the Missouri River trench until the aboriginal people were displaced by Euro-American encroachment and finally by the near extermination of bison.

The focus of this review, however, is on the archeological record of hunting and gathering peoples who occupied the Central Plains region prior to the appearance of ceramic vessel technology. This is simply a convenient boundary marker and is not intended to imply that the use of ceramic vessels, in and of itself, is necessarily of fundamental socioeconomic importance. Early ceramic technology on the Plains probably reflects the increasing need for effective storage and processing technology associated with intensified use of seedly plants. It may, however, signal a general change or increasing variability in aspects of some Plains cultures (such as mobility or redundancy of site use) which develops during the following centuries into the Plains Village tradition (Wedel 1986; Lehmer 1971; Schlesier 1994).

The economy of the late prehistoric Plains Village groups also exhibited a significant component of hunting and gathering (Helder 1970; Osborn 1987), as did that of protohistoric groups and historic Euro-American settlers. The significance of or relative economic contributions of hunting and gathering vs. farming are commonly discussed but remain poorly understood. Studies of bone chemistry hold the potential to inform us about the relative importance of bison and other meat in the diet as compared to garden produce and wild plants (e.g., Tuross and Fogel 1994; Habicht-Mauhe et al. 1994; Tieszen 1994).

Archeological sites and studies outside the Central Plains will be referred to as is appropriate for comparative purposes. For the most part, however, the maps, tables, and discussion will focus on this specific region. The archeological summary is presented in chronological order beginning with pre-11,500 B.P. sites followed by recognized Paleoindian complexes including Clovis, Goshen, Folsom, Midland, Agate Basin, Hell Gap, Cody, Angostura, Allen/Frederick, Preserv; and other less well-established complexes.

The Archaic complexes discussed include Frontier, Logan Creek, Oxbow, McKeen, Munkers Creek, Pelican Lake, Besant, Eldorado, and Nebo Hill. The technological characteristics, economic evidence, natural resource use, and social organization evidence for these complexes are presented as well as some basic information about the frequency and distribution of key sites and reported finds. Basic information on the scale of excavations, available radiocarbon dates, and major problems or perceived "data gaps" are also provided.

This review is based primarily on a wide variety of previous publications pertaining to the prehistoric archeology of the Central Plains region. Some relatively new or previously unpublished information is also included as appropriate. By way of historical background and to acknowledge the primary sources used here, selected key publications are listed in Table 7 in chronological order. This is not a comprehensive listing, but simply a means to recognize important sources which might otherwise be missing from the cited references, and to provide some sense of the nature and cadence of publications concerning the preceramic archeology of the Central Plains.

Pre-11,500 Archeology

Consensus on the time of arrival of the "founding populations" in western and central North America has not been reached. We do not know when people first arrived in North America and we do not know how many migrations occurred.
Table 7. Chronological Presentation of Selected Key Central Plains Prehistoric Archeological Sources.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williston</td>
<td>1902</td>
<td>An Arrow-Head Found with the Bones of Bison Occidentalis, Lucas, in Western Kansas.</td>
</tr>
<tr>
<td>Figgins</td>
<td>1927</td>
<td>The Antiquity of Men in America.</td>
</tr>
<tr>
<td>Figgins</td>
<td>1931</td>
<td>An Additional Discovery of the Association of a &quot;Folsom&quot; Artifact and Fossil Mammal Remains.</td>
</tr>
<tr>
<td>Renaud</td>
<td>1931-1935</td>
<td>Archaeological Survey of Eastern Colorado</td>
</tr>
<tr>
<td>Meave/Barbour</td>
<td>1932</td>
<td>Association of an Arrow Point with Bison Occidentalis in Nebraska.</td>
</tr>
<tr>
<td>Renaud</td>
<td>1932</td>
<td>Folsom and Yuma Artifacts, New Material.</td>
</tr>
<tr>
<td>Schultze</td>
<td>1932</td>
<td>Association of Artifacts and Extinct Mammals in Nebraska.</td>
</tr>
<tr>
<td>Figgins</td>
<td>1933</td>
<td>A Further Contribution to the Antiquity of Man in America.</td>
</tr>
<tr>
<td>Renaud</td>
<td>1934</td>
<td>The First Thousand Yuma-Folsom Artifacts.</td>
</tr>
<tr>
<td>Renaud</td>
<td>1934</td>
<td>Archaeological Survey of Western Nebraska.</td>
</tr>
<tr>
<td>Figgins</td>
<td>1934-1935</td>
<td>Folsom and Yuma Artifacts.</td>
</tr>
<tr>
<td>Strong</td>
<td>1935</td>
<td>An Introduction to Nebraska Archaeology.</td>
</tr>
<tr>
<td>Barber/Schultze</td>
<td>1936</td>
<td>Folsom and Fossil Mammals: A Preliminary Survey of Early Man in Nebraska.</td>
</tr>
<tr>
<td>Eiseley</td>
<td>1939</td>
<td>Evidence of a Prehistoric Cultural Horizon in Smith County Kansas.</td>
</tr>
<tr>
<td>Champe</td>
<td>1946</td>
<td>Ash Hollow Cave: A Study of Stratigraphic Sequence in the Central Great Plains.</td>
</tr>
<tr>
<td>Bisel</td>
<td>1950</td>
<td>Early and Late Lithic Horizons on the Plains.</td>
</tr>
<tr>
<td>Davis</td>
<td>1955</td>
<td>Recent Data from Two Paleo-Indian Sites on Medicine Creek, Nebraska.</td>
</tr>
<tr>
<td>Worthington</td>
<td>1957</td>
<td>Ancient Man in North America.</td>
</tr>
<tr>
<td>Mollay</td>
<td>1958</td>
<td>A Preliminary Historical Outline for the Northwestern Plains.</td>
</tr>
<tr>
<td>Irwin/Irwin</td>
<td>1959</td>
<td>Excavations at the LoDaleKa Site.</td>
</tr>
<tr>
<td>Wedal</td>
<td>1959</td>
<td>An Introduction to Kansas Archaeology.</td>
</tr>
<tr>
<td>Wadell</td>
<td>1961</td>
<td>Prehistoric Man on the Great Plains.</td>
</tr>
<tr>
<td>Davis</td>
<td>1961</td>
<td>Archaeology of the Lime Creek Site in Southwestern Nebraska.</td>
</tr>
<tr>
<td>Krieger</td>
<td>1964</td>
<td>Early Man in the New World.</td>
</tr>
<tr>
<td>Hurt</td>
<td>1966</td>
<td>The Archaic Traditions and the Prehistory of the Northern Plains.</td>
</tr>
<tr>
<td>Irwin</td>
<td>1968</td>
<td>The Illini: Early Late-Pleistocene Inhabitants of the Plains of the United States, Canada, American Southwest.</td>
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<tr>
<td>Voorhies</td>
<td>1969</td>
<td>Taphonomy and Population Dynamics of an Early Pleistocene Vertebrate Fauna, Knox County, Nebraska.</td>
</tr>
<tr>
<td>Bratmaniz</td>
<td>1967</td>
<td>Archaeological Investigations at the Wilbur Thomas Shelter, Carr, Colorado.</td>
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<tr>
<td>Whelpley</td>
<td>1972</td>
<td>Kettles and Chubuck Site: A Paleoindian Bison Kill.</td>
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<td>Reeves</td>
<td>1973</td>
<td>The Concept of an Archaic Cultural Horizon in Northern Plains Prehistory.</td>
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<td>Agenbroad</td>
<td>1978</td>
<td>The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains.</td>
</tr>
<tr>
<td>Wheat</td>
<td>1979</td>
<td>The Jurgens Site.</td>
</tr>
<tr>
<td>Grange</td>
<td>1980</td>
<td>Excavations in the Red Willow Reservoir, Nebraska.</td>
</tr>
<tr>
<td>Shields</td>
<td>1980</td>
<td>Investigations at the McEndree Ranch Site, 5BA30.</td>
</tr>
<tr>
<td>Cassells</td>
<td>1983</td>
<td>The Archaeology of Colorado.</td>
</tr>
<tr>
<td>Biglary</td>
<td>1984</td>
<td>Colorado Plains Prehistoric Context.</td>
</tr>
<tr>
<td>O'Brien</td>
<td>1984</td>
<td>Archaeology in Kansas.</td>
</tr>
<tr>
<td>Reid</td>
<td>1984</td>
<td>Nebo Hill and Late Archaic Prehistory of the Southern Prairie Peninsula.</td>
</tr>
<tr>
<td>Kornfeld/Todd</td>
<td>1985</td>
<td>McKean/Middle Plains Archaic: Current Research.</td>
</tr>
<tr>
<td>Wedel</td>
<td>1986</td>
<td>Central Plains Prehistory, Holocene Environments and Culture Change in the Republican River Basin.</td>
</tr>
<tr>
<td>Gunerson</td>
<td>1987</td>
<td>Archaeology of the High Plains.</td>
</tr>
<tr>
<td>Lintz/Anderson</td>
<td>1989</td>
<td>Temporal Assessment of Diagnostic Materials from the Pinon Canyon Maneuver Site.</td>
</tr>
<tr>
<td>Metcalf/Black</td>
<td>1991</td>
<td>The Wray Site.</td>
</tr>
</tbody>
</table>

Neither do we know from which direction the earliest settlers came when people first entered the Central Plains. The related questions are:

1) when did people first arrive in North America,
2) what was the general level and specific nature of their technology,
3) what was the nature and variety of their subsistence,
4) how many successful migrations by genetically distinctive populations were there,
5) did people utilize the coastal route during some periods or only the interior periodically open ice-free corridor,
6) and, how much time was required for these people to disperse throughout the continent?

These questions have stimulated archeological thought and efforts for decades, but we are not appreciably closer to resolution or consensus than were our colleagues of half a century ago (Bryan 1986; Bonnichsen and Steele 1994; Bonnichsen and Turner 1991; Carlisle 1988; Dicauze 1984;
that Clovis is the earliest widespread identified cultural complex in western North America south of the Pleistocene ice sheets, but this is not the same as arguing that Clovis is the absolute earliest evidence for occupation.

The basic position of this presentation is that Clovis as traditionally recognized and discussed stands as a monolithic, normative construct having a singular adaptive pose and which "appears" to be (is usually suggested to be) quite homogeneous and widespread in a very short time frame. When we dissect Clovis, however, and take into account the variability in site types, differences in archaeological recovery, technological diversity, bone technology, assemblage diversity, variation in projectile point form, and diverse economic evidence, then Clovis has a less homogeneous and less normative form (see also Simms 1988; Meltzer 1993b). This great variety may provide us with clues as to Clovis origins as well as to the ultimate transition from Clovis to later cultural units identified in the archaeological record. It has been stated that, "the Clovis people flourished on the Great Plains for about 500 years and then, around 11,000 years ago, they abruptly vanished, to be replaced by a multitude of different hunting-gathering cultures in the millennia that followed" (Fagan 1987:189).

There is no real justification for this position, beyond the fact that archaeologists sometimes assume that the names we assign to the archaeological record, such as "Clovis," reflect a past reality where cultural groups were discrete, normative in their behavior, and unchanging. Not a very realistic view of cultures.

Pre-Clovis Evidence in Western North America

To understand the founding populations of western North America, I believe that it is first important to focus attention on the Clovis cultural complex and to gain as clear an understanding of it as possible. The reason being that the archaeological record of Clovis holds our primary source of important clues as to what preceded Clovis. As indicated by Meltzer (1989a), however, we can not assume that any and all pre-11,500 evidence is necessarily related to Clovis. As Bryan (1986) has argued, Clovis was perhaps only one of multiple technological traditions which existed in the Americas during the end of the Pleistocene. Therefore, the investigation of pre-11,500 evidence in the New World can properly consist of two related and hopefully integrated tactics.

First we need a detailed understanding of Clovis technology, settlement, and economy as a key source for modeling Clovis origins. Assuming that Clovis did not spontaneously generate, it will eventually be possible to identify Clovis progenitors wherever they may occur. The Nenana complex of central Alaska holds some promise in this regard (Powers and Hofersecker 1989; Goebel et al. 1991). Secondly, investigation of terminal Pleistocene (ca. 20,000-11,000 B.P.) deposits and landscapes is critical in order to learn what kind of archeological record is or might be represented during that time period, independent of our expectations about Clovis.
The archaeological record cannot be understood simply by direct observation. The material record of past events has no inherent meaning (Binford 1989). Meaning must be assigned or attributed to the record by archaeologists or "prehistorians" through inference, comparisons, and through study of the material correlates of behavior and contemporary processes. Fundamental archaeological concepts such as artifact and context are often not self-evident "things" which can simply be observed in the field by trained specialists. Rather, artifact and context are concepts in the analytical realm. They are meanings ascribed by archaeologists to things and places, rather than natural inherent truths passively observed and recorded. Herein lies the primary difficulty with pre-11,500 sites in western North America and elsewhere in the New World.

Much of the controversy and discussion about the pre-11,500 record consists of arguments about whether such and such is an "artifact" and how the radiometric dates or stratigraphy, in terms of age and disturbances, should be "read." The archaeological record is not a documentary text simply to be read by anyone who is "archaeologically literate." It is instead a noncommittal material expression lacking agendas, inherent truth, or intention, and must therefore be interpreted through use of archaeological reasoning, comparison, analogical arguments, and assumption. The lack of embedded or obvious meaning in the archaeological record has resulted in the creative reconstruction of the prehistoric past by archaeologists and other specialists of various backgrounds and interests. It is not surprising that interpretations of the same material items, the same localities, the same radiocarbon dates, and the same stratigraphic profiles have sometimes varied radically (cf. Simpson 1982; Haynes 1973; Adovasio 1993; Lynch 1990; MacNeish 1976; Morlan 1988; Payen 1982; Pagan 1987).

Sites in western North America which are relevant to the study and interpretation of the peopling of the New World reflect as much about the growth and development of a discipline as they do about our knowledge of the past. Selected sites which have played important roles in the development of ideas, models, and methods for the investigation of the peopling of the New World are listed in Table 8. Previous reviews of the evidence are available in numerous sources (Adovasio 1993; Morlan 1988, 1983, 1991a, Meltzer 1989, Dinauzze 1984, Grayson 1988; Haynes 1987; Johnson and Logan 1990; Owen 1984; Waters 1985).

Investigations at sites such as those listed in Table 9 have served to focus archeological attention on critical issues, not just concerning the peopling of the New World, but on fundamental aspects of archeological inquiry as well. At issue and of central concern at all these sites and numerous others are questions of context, stratigraphic mixing, disturbance processes, artifact recognition, chronometric and stratigraphic dating, and artifact typology. The location of selected pre-11,500 sites in the Central Plains is provided in Figure 24.

Table 8. Reported Pre-11,500 B.P. Central Plains Sites with Potential Evidence of Human Action (Modified Bone).

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Evidence</th>
<th>Dates</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lasene</td>
<td>Frontier Co., NE</td>
<td>Mammoth</td>
<td>17,000</td>
<td>a</td>
</tr>
<tr>
<td>Red Willow</td>
<td>NE</td>
<td>Lithics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Cove</td>
<td>Yuma Co. CO</td>
<td>Mammoth</td>
<td>13-16,000b</td>
<td></td>
</tr>
<tr>
<td>Selby</td>
<td>Arapahoe Co. CO</td>
<td>Mammoth</td>
<td>13-19,000b</td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td>Yuma Co. CO</td>
<td>Mammoth</td>
<td>11,735 ± 95c</td>
<td></td>
</tr>
<tr>
<td>Lambspring</td>
<td>Yuma Co. KO</td>
<td>Mammoth</td>
<td>13,140 ± 1000d</td>
<td></td>
</tr>
<tr>
<td>Bonner Springs</td>
<td>Wyandotte Co., KS</td>
<td>fauna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reagan Site</td>
<td>MO</td>
<td>lithic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Dated sites of pre-Clovis age were reviewed by Waters (1985) with critical consideration given to the dating and stratigraphy. None of the sites were then (early 1980s) or are now considered as having reliable evidence for pre-11,500 occupations. Numerous sites have been found or studied more recently, such as Burnham, Oklahoma (Wyckoff 1989, Wyckoff and Carter 1994), La Sena, Nebraska (Holen et al. 1990), Lamb Spring, Colorado (Fisher 1992), and Pino de Cabe, New Mexico (MacNeish 1992) and are undergoing investigation and close scrutiny. The rules for accepting pre-Clovis sites are changing, and this is as it should be as we learn more about the archaeological record and the processes that act on it. Middle range, experimental or actualistic research is enabling us to double check and reevaluate interpretations and observations. We continually ask more of researchers and must address an ever-expanding suite of evaluative tests and cross checks on interpretations of these earliest sites from which we wish to learn about the first Americans. The role of "blue ribbon panels" and on-site visits has been discussed by Meltzer (1994:16-18), but the methods that worked in 1926 may no longer be sufficient.

We have recently witnessed a dramatic increase in our understanding and critical use of applications of radiocarbon dating (e.g., Stafford et al. 1991; Stafford 1994; Taylor 1991, 1994). Studies of bone modification by human, biological, and physical processes and resulted in the development of analytical and comparative frameworks within which to study bones recovered from all archeological sites (Binford 1981; Bonnichsen and Sorg 1989). Traditional archeological research, using (abusing) the standard anthropological axiom that cultural behavior is patterned, has sometimes unfortunately transformed this to suggest that patterns encountered in the archaeological record are necessarily cultural. This has changed dramatically in the past decade or so. Bones described as fleshing tools 20 years ago (Frisin 1970, 1974) are in some cases now recognized as representing the actions of carnivore gnawing (Binford 1981). Bones assumed to be artifacts or flaking debris are scrutinized while acknowledging the great variety of forms and patterned remains which can result from natural processes (G. Haynes 1991; B. Johnson 1985). This is a long-standing problem in archaeological interpretation (Grayson 1986), and includes stone as well as bone objects.
Table 9. Selected Western North American Sites of Relevance to the Issue of Pre-11,500 B.P. Occupation.

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Estimated Age</th>
<th>Problems</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tule Springs</td>
<td>Nevada</td>
<td>&lt;15,000</td>
<td>C</td>
<td>Worthington and Ellis 1967; Shutter 1965</td>
</tr>
<tr>
<td>Calico Hills</td>
<td>California</td>
<td>200,000</td>
<td>D, A</td>
<td>Simpson 1982</td>
</tr>
<tr>
<td>Maris</td>
<td>Washington</td>
<td>&lt;15,000</td>
<td>A, R</td>
<td>Gustafson et al. 1979</td>
</tr>
<tr>
<td>Union Pacific</td>
<td>Wyoming</td>
<td>&lt;15,000</td>
<td>C, S, D</td>
<td>Irwin-Williams 1979</td>
</tr>
<tr>
<td>Frisenhahn</td>
<td>Texas</td>
<td>&lt;15,000</td>
<td>A, S</td>
<td>Graham 1975</td>
</tr>
<tr>
<td>Lewisville</td>
<td>Texas</td>
<td>&lt;40,000</td>
<td>D</td>
<td>Crook and Harris 1957, 1958; Stanford 1983</td>
</tr>
<tr>
<td>Lamb Springs</td>
<td>Colorado</td>
<td>&lt;15,000</td>
<td>A</td>
<td>Stanford and Fisher 1992</td>
</tr>
<tr>
<td>Dutton</td>
<td>Colorado</td>
<td>&lt;20,000</td>
<td>A</td>
<td>Stanford 1979; Stanford and Graham 1985</td>
</tr>
<tr>
<td>Selby</td>
<td>Colorado</td>
<td>&lt;20,000</td>
<td>A</td>
<td>Stanford 1979</td>
</tr>
<tr>
<td>La Senda</td>
<td>Nebraska</td>
<td>&lt;20,000</td>
<td>A</td>
<td>Holen 1994; May and Holen 1993</td>
</tr>
<tr>
<td>Gilder Mound</td>
<td>Nebraska</td>
<td>&lt;20,000</td>
<td>S, D</td>
<td>Barbour 1906b</td>
</tr>
<tr>
<td>North Cove</td>
<td>Nebraska</td>
<td>&lt;20,000</td>
<td>S</td>
<td>Adair 1989</td>
</tr>
<tr>
<td>Lansing</td>
<td>Kansas</td>
<td>&lt;25,000</td>
<td>A, D</td>
<td>Wedel 1988</td>
</tr>
<tr>
<td>Cooperton</td>
<td>Oklahoma</td>
<td>&lt;30,000</td>
<td>C, S, D</td>
<td>Anderson 1975</td>
</tr>
<tr>
<td>Burnham</td>
<td>Oklahoma</td>
<td>&lt;15,000</td>
<td>C, S</td>
<td>Wyckoff et al. 199; Wyckoff and Carter 1994</td>
</tr>
<tr>
<td>Wilson Butte Cc</td>
<td>Idaho</td>
<td>&lt;15,000</td>
<td>S</td>
<td>Gruhn 1961</td>
</tr>
<tr>
<td>Smith Creek Cc</td>
<td>Nevada</td>
<td>&lt;15,000</td>
<td>S</td>
<td>Thompson 1985; Bryan 1986</td>
</tr>
<tr>
<td>Sandia Cave</td>
<td>New Mexico</td>
<td>&lt;15,000</td>
<td>S</td>
<td>Hibben 1941; Haynes and Agogino 1986</td>
</tr>
<tr>
<td>Pendeo Cave</td>
<td>New Mexico</td>
<td>&lt;30,000</td>
<td>S, R</td>
<td>MacNeil 1992</td>
</tr>
<tr>
<td>Hermita Cave</td>
<td>New Mexico</td>
<td>&lt;20,000</td>
<td>R, D</td>
<td>Howard 1935</td>
</tr>
<tr>
<td>Burnet Cave</td>
<td>New Mexico</td>
<td>&lt;20,000</td>
<td>R, D</td>
<td>Howard 1935</td>
</tr>
</tbody>
</table>

An "artifact" is no longer determined to be such based on simple observation of an object's characteristics, but a meaning assigned to objects by researchers based on comparison and controlled experiment. Some objects, even if found in situ cannot be unequivocally sorted into artifact vs. nonartifact status.

Also, refined understanding and awareness of stratigraphic relationships and the processes of potential mixing and turbation equip us with more realistic expectations and more critical interpretation of the geochronological record and site formation processes (Schiffer 1987, Johnson and Watson 1987; Stegner 1990; Wood and Johnson 1978). One hundred years
ago Wright's (1892) "Man in the Glacial Age" caused a stir of controversy (Meltzer 1991). Since the Folsom discovery in 1926—when the association of artifacts and Pleistocene fauna was documented and accepted—we have managed to unequivocally extend the period of human occupation in western North America back less than 500 years to approximately 11,300 B.P. (Haynes 1991a). Although not all researchers agree with this position, it is an interesting statement on the complexity of the issue of pre-11,500 occupation.

The Clovis Cultural Complex

It is likely we will never know who really discovered North America, and after decades of research no precise date can be fixed to the time of this "discovery" or the first movement of people into the New World by coastal or interior routes. By 11,300 years ago, sites belonging to the Clovis cultural complex were represented throughout much of western North America. The Clovis cultural complex or LLano complex as defined by Sellards (1952:17-46) has been characterized by several distinctive traits or recurrent features. The association of distinctive usually large fluted projectile points found with mammoth remains is central to most discussions of Clovis culture. Other megafauna and smaller species are also well represented in Clovis-age sites (Ferring 1994; Graham et al. 1981; E. Johnson 1987, L. Johnson 1989). Other technological features such as blades, beveled-based bone or ivory points or foreshafts, other ivory objects (Saunders et al. 1990a, 1991), and lithic tools similar to other Paleoindian industries including endscrapers, unifacial cutting and scraping tools made from large blades or biface thinning flakes also appear in Clovis assemblages. (Frison 1991b; Jennings 1974; Sellards 1952; Wedel 1978; Willey 1966; Wormington 1957).

Key sites in the early definition of the Clovis complex include Dent, Colorado where Clovis points were first found in geologic association with mammoth remains, but where the age could not be directly determined in relation to the previously defined Folsom type (Cassells 1983). The Blackwater Draw site is on the Southern High Plains in eastern New Mexico, where Clovis material was found in association with mammoth and bison stratigraphically below Folsom material (Howard 1935, 1936; Cotter 1937). Blackwater Draw is the type site for the Clovis complex, located between the towns of Clovis and Portales. The Miami site in the Texas Panhandle produced further evidence of the association between Clovis points, as they came to be designated, and mammoth remains with strong evidence that the points were actually used in the killing or processing of the animals (Holliday et al. 1994). Although it is generally assumed that Clovis people had a much broader spectrum diet than just mammoth and bison, these are the species most conspicuous and most numerous in most Clovis sites (Frison 1991b; Frison and Todd 1986; Grayson 1988; Hofman 1989; Leonhardt 1966; Meltzer and Smith 1986; Meltzer 1993a, 1993b). Additionally, evidence of mastodon, horse, ground sloth, camel, deer, wolf, fox, rabbit, and giant turtle has been documented (Graham et al. 1981; Graham and Hofman n.d.; Ferring 1994; Lundelius 1972; Walker and Frison 1986).

Recently, Clovis evidence has been well summarized (Bonnichsen and Turek 1991; Frison 1991b; Haynes 1987) with important discoveries in bone technology (Dunbar 1991; Frison 1991b; Haynes and Hemmings 1968; Saunders et al. 1990a, 1991), and in art work in the form of engraved stones of Clovis age in central Texas (Collins et al. 1991, 1992). The Sunrise Mine or Powars II site has evidence of red ochre quarrying by Clovis people (Frison 1991b; Stafford 1990). Also, the use of amber as part of the mastic in attaching projectile points to forshafts has been demonstrated (Tankersley 1994).

A development which has added substantially to our understanding of Clovis technological characteristics and variation has been the discovery and documentation of a number of caches of Clovis artifacts (Frison 1991a; Mehringer 1988, 1989; Mehringer and Foit 1990; Granly 1993; Lahren and Bonnichsen 1974; Stanford and Jodry 1988; Wilke et al. 1991; Woods and Titmus 1985; Titmus and Woods 1991). Distinctive technological aspects of Clovis reduction have become much better documented and recognized as a result (Bradley 1991, 1993). Characteristics of Clovis technology include broad bifacial flaking with common outre' passe terminations. This attribute was first explicitly summarized by Frison and Bradley (1982) based on evidence from the Sheaman site in Wyoming in comparison with evidence from the Simon site cache from Idaho and the Anzick cache material from Montana. Unfortunately, these distinctive technological characteristics are often not recognizable on recycled and broken Clovis pieces, and may not be limited solely to Clovis assemblages.

The extent of the typological problems with Clovis is hinted at by the recently documented material from the Mill Iron site in Montana (Frison 1991b; 1996). The Goshen points from the Mill Iron site and a few other localities share some characteristics with Clovis and with Folsom assemblages but are especially notable due to the absence of fluting. Dating of the Goshen assemblage at the Mill Iron site is problematic as two sets or clusters of dates are available, one indicating that Goshen is as old as the oldest well-dated Clovis material and the second set indicating that Goshen is the age of terminal Clovis or early very Folsom. The material from the Mill Iron site, however, has enabled a technological and typological reassessment of some previous artifacts, and at least some specimens which have previously been referred to as Clovis are now thought to represent Goshen (Frison 1984; cf. Frison 1991b).

Typology is also an issue in consideration of Clovis finds at Colby, Wyoming (Frison and Todd 1986, Frison 1991a) and Domebo, Oklahoma (Leonhardt and Anderson 1966). The deeply concave-based points from the Colby site are unusual for western Clovis, but recently documented specimens from the Penn Cache, found near the Wyoming-Idaho-Utah border, includes several specimens with bases comparable to the Colby points (Frison 1991a, 1991c). At Domebo, a minimally fluted and relatively gracile specimen is comparable to some Plainview
points (Leonhardy and Anderson 1966). This, like the Goshen

evidence from the Mill Iron site, indicates that not all projectile

points in the Plains region which are of Clovis age are directly

comparable to the "classic" specimens from the Blackwater

Draw, Dent, and Miami sites.

Another important development concerns information

about site structure. The major contribution to this work has

been Haynes' investigation at the Murray Springs site in Arizona

(Haynes 1982, 1991a, 1993) and Ferring's research at the Aubrey

site in north Texas (Ferring 1994). Evidence from these two

sites suggests that extensive campsite and processing areas will

occur near Clovis-age bonebeds or kill sites and these may cover

many hundred square meters. Research at the Colby site in

Wyoming also indicates an extensive kill and processing area,

probably representing multiple events. Similarly, evidence from

ethnoarchaeological research with the Efe and Hadza indicate

that the activities associated with processing elephant-sized

carcasses are spatially extensive (Fisher 1992; O'Connell et al.

1992). The implications of these studies concerns the scale at

which archeological investigations need to be conducted in

order to recognize site structural information. These

developments are just being realized by most investigators.

Also, the deeply buried nature of many Pleistocene deposits in

alluvial and eolian settings has been demonstrated repeatedly

(Ferring 1994; Leonhardy 1966; Hannus 1990a, 1990b; Hester


Environmental information derived from study of the

Murray Springs (Haynes 1991a) and Aubrey (Ferring 1990, 1994)

Clovis sites demonstrates convincingly the critical importance

of interdisciplinary studies at Paleoindian sites, and the wealth

of information which can occur in alluvial and spring-associated

settings. Although climatic change or differences are marked

when comparing later Holocene evidence with that from Clovis

times, there is no consensus as to the nature of the Plains

environment at that time. It has been argued to be a brief period

of relative drought conditions by comparison with the

preceding and following centuries (Haynes 1991a). It has also

been interpreted as a period with a highly productive

environment lacking evidence of drought (Holliday 1995).

There is significant local variability, but the dynamic nature of

the terminal Pleistocene environment remains an important

topic of study (see Chapter 2). A variety of new kinds of

evidence is being brought to focus on this subject. In addition
to pollen, phytoliths, snails, sediments, and diatoms, new

studies are incorporating evidence of hair (Bonnichsen et al.


(Humphrey and Ferring 1994; Tieszen 1994), ancient DNA

(Chambers and Purdure 1994), and other lines of research.

Also notable is the investigation of Clovis quarry sites. The

Sunrise Mine site in Wyoming is an important red ochre source

which was apparently used intensively during Clovis times and

later in the prehistoric record (Frisson 1988, 1991b; Stafford

1990). Red ochre is a recurrent element in most of the known

 caches of Clovis artifacts which have been recovered. Study of

lithic quarry sites is also of importance and includes recent work

in Wyoming and Texas (Frisson 1991b; Mallouf 1989), as well as

outside the Plains (Dragoo 1973; Gardner 1983; Sanders 1990).

The Changing Face of Clovis Culture

As research continues and we learn more about Clovis

technology, site types, site structure, contemporary industries,

and cultural variability it has become evident that we

still have much to learn (Frisson 1993). In the past few years

substantial additions to our information about Clovis have been

made by discovery and study of a few dispersed sites. Definition

of what is and is not Clovis and the basis for assignment of sites

to the Clovis or Llano complex has not been consistent or

standardized. Strict definition or standardization may not be

feasible or practical given the diverse range of Clovis

assemblages. That much remains to be learned about Clovis

lifeways, technology, organization, and land use is evident in

recent discoveries many of which are mentioned above, which

have dramatically expanded and enlightened our understanding

and impression of Clovis culture.

An Evolutionary Perspective on Clovis Variability

As long as we perceive Clovis as a successful and uniform

adaptation of highly distinctive and homogeneous character,

then we have very little potential to learn about the social,

economic, and technological transitions which took place

during the development or decline of Clovis (Meltzer 1993b;

Simms 1988). If we address Clovis variation, as witnessed by

the technological and economic evidence of the archaeological

record, we can greatly improve our potential to learn about

Clovis origins and what it developed into (Dunnell 1980, 1988,


Clovis represents a range of technological and economic

variability expressed at a variety of archaeological site types. Does

it indeed represent a homogeneous cultural entity which

appeared, developed, and spread rapidly, and just as rapidly

disappeared as has sometimes been suggested? I think the

evidence is at best equivocal. Can a change in economic focus

necessarily be equated with cultural change (or extinction of a

lifeway)? Do differences in projectile point styles and

technology reflect cultural differences in any direct way (e.g.,

Wessner 1982)? These questions are at the heart of

archaeological research and of Paleoindian studies. There are

no easy answers.

The study of variability in technology, economy, land use,

and overall patterning in the material record for earliest

Americans will provide us with an opportunity to identity, study,

and evaluate the processes and gradients of culture change

during the late Pleistocene and since. Reaffirmation of Clovis

as a discrete monolithic short-lived cultural adaptation will not

enhance our understanding of the past. Clovis should not float

untethered in prehistory and be considered totally different

and discrete from what came before and after. This building

block approach to archeological study of spatial-temporal

variation has long been recognized as very limiting (Clarke

1968). Addressing the significance of variability in this portion
of the archeological record should provide new insights into Clovis culture and to those prehistoric societies who were Clovis progenitors and descendants.

Were there non-Clovis cultures contemporary with Clovis in the Great Plains and elsewhere? The answer to this question bears directly upon the interpretation of the number of migration events, where the immediate progenitors of Clovis lived, what was the nature of contemporary non-Clovis industries and cultures in the New World, and when, by whom, and from whence were the Central Great Plains first inhabited by humans.

Clovis Environment, Economy, Technology, and Ideology


Available radiocarbon dates indicate that the Clovis activities in the Great Plains region occurred primarily between 11,000 and 10,000 years ago (Haynes 1993:Figure 1), at the close of the Wisconsin glaciation and the Pleistocene (Kutzbach and Webb 1991; Porter 1988; Wendland 1978; Wright 1991). The retreat of glacial ice from the Northern Plains and the changing climatic conditions during Clovis times reflect a trend that began by 14,000 years ago as a result of the Milankovitch radiation curves (Wright 1991). The Des Moines and James River lobes of the Laurentide ice sheet, and the associated glacial Lake Agassiz, directly impacted the habitable regions of the Plains in terms of potential human activity and prey species. For the western Great Lakes and Northern Plains region the height of the Wisconsin Glaciation occurred about 18,000 years ago. The accelerated climate and vegetational changes between 12,000 and 10,000 years ago probably reflect the maximum summer radiation of the Milankovitch cycle (Jacobson et al. 1987; Wright 1991:124). Distribution of fluted points in North and South Dakota and Saskatchewan (Buchner and Pettijou 1990; Gregg 1985; Schneider 1982) are complementary to the presence of glacial ice and Lake Agassiz during the terminal Pleistocene.

In the Plains region the late Pleistocene climate was notably different than that of modern time. A variety of paleontological and paleobotanical evidence supports the model that summer temperatures were lower than at present, at least during the early part of the deglaciation (Wright 1991:119). Equally important is that winter temperatures were apparently not significantly cooler than today and may have lacked the frequent bitterly cold snaps or extremes. This reduced seasonality offered a setting in which diverse species, which are no longer sympatric, inhabited the same environment (Graham 1987; Graham and Lundelius 1984; Graham and Mead 1987; Lundelius et al. 1983; Lundelius 1989). These “disharmonious” faunas were characteristic of the late Pleistocene in North America and continued until at least 11,000 years ago and for some species and regions as late as 9,000 years ago.

Overall, annual precipitation in the Plains region may have been less than today, but the effective moisture was almost certainly greater. Playa lakes were common on the Central High Plains during the late Wisconsin but apparently diminished significantly in number and size by 11,000 B.P. (Haynes 1991a). Winds were also an important factor and may actually have provided significant advantage to human hunters in stalking and pursuing prey animals. Extensive dunes in Nebraska were formed or modified by prevailing north and northwest winds (Kutzbach and Wright 1985). Extensive Pleistocene loess deposits in the Central Plains, often several meters in thickness, are well dated to the last 21,000 years (Johnson and Logan 1990; Johnson and Martin 1987; Martin 1993; May and Helen 1993). These late Pleistocene loess deposits usually overlay a stable surface formed in the Gilman Canyon Formation which dates between about 31,000 and 21,000 years ago. Winds during the late Pleistocene may have prevailed from the north and northwest on a year-round basis rather than seasonally as is now the case (Wright 1991). The climatic transition from the last glacial maximum of about 18,000 until the close of the Pleistocene by 10,000 years ago, was not, however, a smooth and steady directional change. There is some evidence of relatively severe droughtlike conditions during Clovis times (Haynes 1991a), and a final ameliorating cooler period, the Younger Dryas, during Folsom times from 11,000 to 10,000 years ago. Stable land surfaces and soil formation on Pleistocene loess occurred in the Central Plains between 12,000 and 9,000 years ago, with the Brady soil representing an important marker generally correlated with the Younger Dryas period (Johnson and Logan 1990; Martin 1993). Holocene loess (Bignell loess) occurs overlying the Brady soil in many localities.

Most species which became extinct in the Plains region of North America were gone by or soon after 11,000 B.P. (Martin and Klein 1984; Graham et al. 1987; Grayson 1991). The reorganization of habitats and faunal associations was a complex series of events which cannot simply be modelled on contemporary ecosystems (Lundelius et al. 1983).

Vegetation on the Plains also varied dramatically through the late Pleistocene and particularly between 12,000 and 8,000 years ago. The retreat of the glacial ice and the northern shift of the jetstream had a dramatic effect on the climate and vegetation of the region. The resurgence of grasses as dominant resulted from the changing seasonality and precipitation patterns as ultimately affected by the Milankovitch solar radiation cycle.

The economy of Clovis people is most well known from a series of bonebed sites which, in the Central Plains, consistently contain mammoth remains. At the Kimmswick site, just south of St. Louis, Missouri, Clovis artifacts were found in association with mastodon and ground sloth remains. At Blackwater Draw, New Mexico, both mammoth and bison were common in the Clovis deposits, and the Aubrey, Texas, Clovis assemblage occurs with bison, turtles, and other species (Peil 1990, 1994). The problem of background fauna in Clovis strata at various sites, including Blackwater Draw, Lubbock Lake, Domebo, and others, remains an important issue. Were these lesser species of economic importance or simply remains which accumulated independent of human action? In the Plains region, mammoth is unquestionably the key prey species.
associated with buried Clovis sites (e.g., Frison and Todd 1986; Harniss 1990a, 1990b; Cassells 1983; Hester 1972; Holliday et al. 1994; Leonhardy 1966). The question of if and how Clovis hunters actually dispatched mammoth remains a topic of debate (e.g., Gorman 1972; Saunders 1977, 1980, 1990; Frison 1987, 1989; Haynes 1986, 1988; Jelinek 1967; Hester 1966; D. L. Johnson et al. 1980; P. S. Martin 1990; Meltzer 1993a, 1993b; Sellards 1952). That they would have scavenged usable mammoth carcasses whenever possible is highly likely because of the quantity and wide variety of usable products to be gained from the bodies of these large animals. It is also very likely, if their technology and hunting skills were adequate (which they very likely were, Frison 1989; Stiner 1991), that mammoth were purposefully and intentionally hunted whenever feasible. The return for the investment would have been tremendous if the risk element could be reduced by careful training, practice, and critical knowledge of mammoth behavior and technology.

That Clovis people were also opportunistic in their economic pursuits and did not live by megafauna alone is indicated at locations such as Shawnee-Minisink in Delaware where a variety of species were recovered in an early Paleoindian context (McNitt 1985). Evidence of fish and fruit utilization were discovered at the site. There is at present no firm evidence of intensive plant food processing or utilization by Clovis people, though this may largely be the result of preservation and recovery factors. The only evidence of food storage may be that at the Colby site in Wyoming where bone piles have been interpreted as cold weather meat caches (Frison and Todd 1986).

Clovis technological variability and distinctiveness has become better documented in recent years. Large blades and bifaces are long-established elements in Clovis culture (Green 1963; Butler 1963), and recent evidence, particularly from caches, has provided even more examples of Clovis blade and biface technology (Frison 1991a, 1991c; Lahren and Bonnichsen 1974; Mehring 1988; Wilke et al. 1991; Stanford and Jodry 1988; Goode and Mallouf 1991; Young and Collins 1989). The distinctive nature of Clovis biface reduction technology has served as a diagnostic aid to further illustrate the similarity of assemblages as far removed as Washington State, Idaho, Wyoming, Colorado, Montana, New Mexico, and Texas (Bradley 1991, 1993).

The distinctive Clovis fluted points were apparently a multipurpose implement, judging by numerous reworked blades, evidence of use on blade edges, and impact-damaged tips (Gramly 1993; Meltzer 1987; Haynes 1982, Harniss 1990a; Hofman and Wyckoff 1991). Stone tools forms include unifacial tools, endscrapers, and other types. Bone artifacts include the widespread occurrence of beveled-based bone or ivory cylindrical points or foreshafts (Lahren and Bonnichsen 1974; Frison 1982a; Sellards 1952; Wilmeth 1968). Other cylindrical objects found at the Richly-Roberts site in Washington are more problematic as to function (Gramly 1993). A shaft wrench from Murray Springs, Arizona (Haynes and Hemmings 1968) is a highly distinctive artifact which has close analogs in Upper Paleolithic assemblages in Europe and Eurasia (Soffer 1985; McBurney 1976). Production of mammoth ivory artifacts is also seen in the Blackwater Draw collection (Saunders et al. 1990a, 1991). The study of pits and markings on Clovis-age bone and ivory pieces has suggested to Saunders (Saunders et al. 1990b) that these people or some individuals employed a standard "Clovis unit of measure" which was used in production of tools and weapons. In central Texas, recent research has documented the occurrence of engraved limestone tablets in Clovis and early Paleoindian contexts (Collins et al. 1992). These artifacts illustrate an artistic or ideological element in Clovis culture which has not previously been found outside the realm of technofunctional artifacts.

**Clovis Sites in the Central Plains.**

In the central Great Plains region there have been numerous finds of Clovis projectile points in both upland surface and streamed contexts (e.g., Brown and Logan 1987; Hofman and Hesse 1996; O’Brien 1972; Myers 1987; Rogers and Martin 1982, 1983; Schmitt 1987a; Wetherill 1995; Yape 1968b). A number of sites remain minimally investigated and much needed research remains to be done concerning both the distribution of finds and follow-up studies at specific sites. The known distribution of Clovis points in the Central Plains is provided in Figure 25, showing the occurrence of Clovis finds per county in Colorado, Nebraska, and Kansas. This distribution is certainly to be seen as a minimal record. Some finds are recorded by state or local rather than by county designation and so are not included on these maps. Much of the variation in the county distribution shown here is due to historical accidents of discovery and reporting. To gain an overall impression of the occurrence of Clovis material across the Central Plains region, Figure 25 simply show the counties which are known to have produced one or more Clovis points. Although Clovis artifacts are fairly widespread in the region, there are many areas which lack records and some find spots which merit considerably more detailed attention than they have received to the present.

A number of sites, however, have received more detailed study or are now under investigation. Nine of these, which provide an indication of the range of Clovis sites in the region, are discussed in more detail below. Limited information on additional Clovis sites is provided in Table 10. Examples of Clovis projectile points from the Central Plains are provided in Figure 26. A listing of Central Plains Clovis site records is provided in Table 11 and lithic cache sites in Table 12.

**Dent Site, Colorado.** Dent is located on the valley margin of the South Platte River near the railroad depot at Dent and was the first Clovis point and mammoth association documented in the New World. The site was discovered and first investigated late in 1932 by Regis College professor Conrad Bigley, who in 1933 was joined by Figgins from the Denver Museum (Figgins 1933; Cassells 1983:44-49). The most detailed recent discussion of the site is found in Cassells (1983) and Haynes (1974), but the site is currently being reinvestigated. Spring flooding in 1932 revealed gravels and large bones at the site. Excavation and recovery apparently did not include mapping of the bonebed or screening of the matrix. The full

Table 10. Comparison of Excavations and Assemblages from Selected Clovis Sites.

<table>
<thead>
<tr>
<th>Site/Location</th>
<th>Excavated area (m²)</th>
<th>Recovery</th>
<th>Number of Artifacts</th>
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<th>Ref.</th>
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* The two tools from Domebo and a fourth projectile point were found in the stream channel near the bonebed. (Meyers 1987; Hofman and Hesse 1996; Holen et al. 1996; Brown and Logan 1987; Stein 1984; Wetherill 1995; Pitblado 1994; Nelson 1969; Nelson and Breternitz 1970; Greiser 1985)."
Figure 26. Clovis point/knives of the Central Plains. a. Republic County, KS; b. Dishan site, KS; c. Cheyenne County, KS; d. Boulder County, CO; e. Sherman County, KS; f. Clay County, KS; g-h. Dent site, CO.

Figure 26. Clovis point/knives of the Central Plains. a. Republic County, KS; b. Dishan site, KS; c. Cheyenne County, KS; d. Boulder County, CO; e. Sherman County, KS; f. Clay County, KS; g-h. Dent site, CO.

extent of the excavation is not well known nor is the nature of the association between the three projectile points and portions of 12 to 14 mammoth. Several photographs of the excavation do exist (Cassells 1983:Figure 5-5). The sediments containing the bone included sandy alluvium with coarse cobble and boulder inclusions. Reinvestigation of the site by Frank Frazier indicated that the bones had probably been water transported and that the large cobbles were derived from older terrace deposits. Because the deposits have been reworked, the relationship between the Clovis points and mammoth bones remains unclear. Radiocarbon dates on the mammoth bone, however, indicate that the mammoth were of Clovis age (Stafford 1990; Stafford et al. 1991). It is quite possible that the Clovis points reflect the actions of Clovis hunters who wounded, or killed, or scavenged one or more of the mammoth represented at Dent.

Claypool Site, Colorado. Claypool is primarily known as a Cody complex and late Paleoindian site (Dick and Mountain 1960), although finds from the locality include Clovis points and Folsom evidence as well as mammoth remains (Bradley and Stanford 1987; Stanford and Albanelse 1975).

Drake Site, Colorado. The Drake site is a Clovis cache from Weld County, northeastern Colorado, which consists of 13 complete new or newly resharpened projectile points, a hammerstone, and a fragment of ivory (Stanford and Jodry 1988). Lithic material is primarily Albates flint, with one probable Edwards chert point, and an unidentified material. The points range from about 9 to 16.5 cm in length and 3 to almost 4 cm in width. The points are mostly in pristine condition, although six appear to have been resharpened. The cache was discovered partially buried in a wheatfield near the top of a low ridge. The location is in the Colorado Piedmont near Pawnee Buttes, but there is currently no particularly remarkable feature to mark this place on the landscape.

Dutton Site, Colorado. The Dutton site and the nearby Selby site are primarily known for their late Pleistocene, pre-11,500 year old faunal assemblages (Stanford 1979a, 1982; Graham 1981, 1987). Both sites are located in playa lake basins on the high plains of eastern Colorado. During heavy machinery stripping of overburden above the Pleistocene fauna level, later dated to ca. 16,000 B.P., evidence of Clovis-age activity was encountered at the Dutton site. One Clovis point was found.

Busse Cache, Kansas. The Busse cache is an example of a possible Clovis-age “cache” which highlights the problems of cultural assignment and use of the concept of caching. The term “cache” in Paleoindian literature refers to several different kinds of collections. The Busse site near Bird City in northwestern Kansas is believed, on the basis of artifact typology and technology, to represent a Clovis-age tool cache and occupation or activity site. The Busse site cache was discovered in June 1968 by Dan Busse, was minimally investigated by the Busse family at that time, and has since witnessed no further significant disturbance. The cache consists of some 90 lithic artifacts (several of which are refitted from prehistoric breaks) which were found 20-50 cm below the surface. The pieces were all lying flat and appeared to have been laid down on an old surface. Excavation around the initial find of a large biface extended for only a few feet until the primary concentration of cached pieces was exposed.

The excavation of this area yielded one large biface of jasper, one flat chalk (cortex) covered biface with evidence of intensive use as an abrader, 13 large bifaces from 29.6 cm to 10 cm long (six of these bifaces are refit from large fragments), 25 large blades and fragments including numerous scraping tools (four are refit from broken pieces), two flake tools of exotic flint possibly from southeastern Wyoming, and 48 flakes and fragments representing the reduction of large bifaces and tool making or maintenance. Some of the artifacts, notably the large bifaces and some tools, have streaks of red ochre which usually occurs on one surface only. All specimens except three are made from high quality yellow to brown Niobrara jasper with the closest quality sources located at least 100 km to the east of the site. The broad flat flaking on the large bifaces is similar to that expressed on some pieces from other Clovis-age stone tool caches including the Anzick site in Montana (Wilke et al. 1991).
and the Penn cache from the Wyoming/Utah/Idaho border (Frison 1991c). The unifacial blades include some with cortex or which are irregular in form as well as more standard pieces. The platform technology and overall form, however, are comparable to Clovis blades from the Blackwater Draw site and elsewhere (Young and Collins 1989; Green 1963; Montgomery and Dickinson 1992). A spurred end-scaper and a graver are also distinctive Paleoindian tool forms. The large biface thinning flakes, some of which refit to the large bifaces, are quite similar to specimens from the Sheaman Clovis or Goshen site in eastern Wyoming (Frison 1982a; Frison and Bradley 1982).

The site is situated on a west slope in a field which was under cultivation until the early 1960s when it was seeded back to grass. A small drainage just west of the site might have held a live spring during the late Pleistocene when the cache was deposited. There is nothing noteworthy about the specific location of the cache find spot as it appears today, and discovery of the cache occurred when Mr. Busse, checking a fence line, walked down a cattle path which had been eroded by recent rains. A small piece of jasper in the bottom of the path caught his eye and on trying to pick it up, he discovered it was just a small exposed portion of a very large biface. On removing this large biface, it hit against another one laying next to it and the discovery of the cache was made.

The likelihood of additional material still being present in the immediate vicinity of the cache find is quite good as there has been no subsequent disturbance, and a buried surface is apparently represented. If it is possible to identify and trace this late Pleistocene surface over an extended area, it should be possible to learn a considerable amount about the nature of the group who occupied the site and the organization of activities which they performed. Preliminary investigation of the site began in 1995 (Hofman 1995a).

The Busse Cache is distinctive and of particular significance for a number of reasons. It is different from any recorded Paleoindian caches in that it contains many heavily used tools, it lacks final stage preforms or finished projectile points, and many of the artifacts appear to represent the worn, damaged, or irregular pieces which we would expect to be the first to be abandoned if transport decisions were being made. The Busse Cache is arguably of Clovis or Paleoindian age because of some key diagnostic attributes of other Clovis finds. These include the large flat bifaces, the use of red ochre, the prepared core and blade technology, distinctive spurred tools on flakes and scrapers, radial break tools, and distinctive scraper forms.

Functional cues as to how the Busse Cache artifacts were used include high polish and steep-edged tools which might serve in hide processing, thick-edged tools with heavy edge damage as can occur in wood or bone working, thin-edged tools with polish and light fracture patterns indicative of butchering, and thick bifacial edges with heavy damage such as can occur in initial butchering or dismembering activities. Also, tool maintenance and recycling is evident by the flakes and refit pieces. This range of activities is what we would expect to occur in the context of butchering and processing carcasses and in repairing damaged tools. Butchering a mammoth or numerous bison carcasses would result in new products such as hides, meat, fat, marrow, bone, and others which the hunters might wish to take with them and so necessitate the reevaluation of what was to be transported when the group moved on. This could result in the caching of excess, damaged, or second quality lithic pieces with the possibility of future use. More than 16 lbs of stone are represented in the Busse Cache, and this durable material could be cached with confidence that it would remain useful should someone in the group need to return and claim it for future use. Examples of artifacts from the Busse Cache are shown in Figure 27.

**Eckles, Kansas.** Bank erosion at Lovewell Reservoir in Jewell County, Kansas has yielded a collection of Clovis artifacts made predominantly from Flattop (White River Group) chalcedony (Hoard et al. 1992, 1993; Holen et al. 1990). This collection includes projectile points, scrapers, unifacial tools, and debitage.

**Lovewell, Kansas.** The discovery of mammoth bones attracted archaeological attention to this location in the early 1960s (Witty 1970). Initial geological and stratigraphic assessment indicated that the mammoth remains were in deposits substantially older than Clovis and the site was essentially discounted. Following discovery of the Eckles site, however, re-investigation of the Lovewell Mammoth site was initiated (Holen 1993). Reevaluation of the geological and
stratigraphic position of the bonebed stratum indicated that it may indeed be terminal Pleistocene in age. Analysis of the bone material from the original excavation revealed a modified bone which may represent a section of a beveled-base point or foreshaft (Holen 1993).

**Koehn-Schneider Site.** This mammoth site, 14GL496, is located in Greeley County, Kansas near Tribune (W. C. Johnson et al. 1990). Erosion in 1987 exposed the mammoth bone about 8 m below the modern surface. In addition to the historic soil, three paleosols overlie the bone deposit and have a consistent series of radiocarbon dates on soil humates. The lowest soil, about 2 m above the mammoth, dates to 11,170 ± 170 (TX-6371), and a date on the apatite fraction of the mammoth bone of 11,050 ± 170 (TX-6405) is assumed to be slightly young. The estimated age is ca. 11,400. No Clovis artifacts were found with the mammoth bone, but Clovis points have been found within a few kilometers of the site. Possible butchery marks are present on the skull.

**Diskeau Site, Kansas.** This site is a lithic scatter in an upland setting overlooking the Big Blue River in Marshall County, northeast Kansas (Schmids 1987). Surface collecting since the 1940s has produced 123 formal lithic tools including 8 projectile points, 26 knives, 62 scrapers, 15 gravers, 2 spokeshaves, 2 preforms, 1 drill, 1 piece d’esquille, 3 discoids and 4 biface fragments” (Schmids 1987:69). Many of the scrapers are small, spurred endscrapers. Many tools exhibit evidence of multiple functional units and multiple wear types. A campsite with a variety of activities probably including retouching, working on hard substances such as wood and bone, and possibly hideworking is indicated. Lithic materials include much nonlocal stone, and only a small proportion of local Permian Flint Hill cherts. Niobrara (Smoky Hill) jasper is the most common lithic material. Flattop chalcedony from northeast Colorado and Knife River flint from western North Dakota are represented in lesser amounts as are chalcedony and other unidentified materials which may be derived from western sources in Colorado or Wyoming.

**Hiscock Cache, Nebraska.** This large collection of cores, flakes, blades, scrapers, and bifacial tools is composed Flattop or White River Group chaledony (Holen, personal communication 1994). The technology of many pieces suggest Paleoindian affiliation and a number of blades are comparable to Clovis specimens. The cache was found on Medicine Creek in Frontier County, southwest Nebraska. More recent study suggests to Holen that the site may be late prehistoric in age.

**Sailor-Helton Cache, Kansas.** This large cache of blades, flakes, and cores was found near the Cimarron River in Seward County, southwestern Kansas (Mallouf 1994). The cache is of Albates agatized dolomite from the Canadian River in the Texas Panhandle about 200 km south of the find. This cache includes some very large Albates cores and blades, some of which can be refit.

**Lange-Ferguson Site, South Dakota.** Although slightly north of the Central Plains study region, the Lange-Ferguson site in southwestern South Dakota holds some important clues about Clovis in the Plains region (Hannus 1985, 1990a, 1990b). Excavation at this mammoth bonebed and campsite revealed portions of two mammoth; a variety of mammoth bone expediency butchery tools; good climatological information from phytoliths, fauna, snails, and stratigraphy; and a small but important assemblage of stone tools. The site was buried beneath about 8 m of overburden in the White River Badlands. Remains of two mammoth represent an adult female and a young calf. Taphonomic study determined that the bones had been rapidly buried in a low-energy pond environment without impacts of severe weathering by exposure, carnivore modification, or alluvial sorting or transport. The flaked and modified bone tools represent another important addition to the Clovis technological complex, and one that might be expected to be present, especially when lithic resources are limited or depleted.

Only one chipped stone artifact was found in the mammoth bonebed, a utilized flake which would have been a very serviceable tool in butchering or dismembering the carcasses. The remaining few lithic artifacts were found in a camp and processing area about 15 m away from the bonebed. These artifacts include three Clovis points, two of which are heavily reworked and the third which is a basal fragment exhibiting an impact fracture and which was subsequently burned, probably from exposure to a hearth. Only a small group of people and a relatively short-term occupation are indicated, but whether the mammoth were killed or simply scavenged remains unresolved. The impact-damaged Clovis point suggests that some hunting was going on. It is important to note that if excavation had been limited only to the bonebed, most of the lithic assemblage and the diagnostic Clovis points would not have been recovered.

The mammoth bone expediency tools recovered at Lange-Ferguson hold important implications for Clovis technological organization and are an important reference series for other sites which lack the associated lithic assemblage. The bone use pattern seen at Lange-Ferguson suggests that we must leave open the possibility that other late Pleistocene sites or samples of Clovis and pre-11,500 age may have bone artifacts but lack substantial lithic assemblages. Therefore, Central Plains sites such as La Sena, Nebraska and Dutton, Selby, and Lamb Spring, Colorado must be evaluated with the knowledge that mammoth bone expediency tools were part of the early Paleoindian Clovis complex and may well have been part of any earlier complexes which may have existed in the region.

**Angus Site, Nebraska.** The Angus site in Nuckolls County, Nebraska was reported in 1931 (Figgins 1931), but the nature of the artifact/mammoth association at the site was considered questionable by several researchers at the time. Wedel (1961:58) offered only one sentence concerning the Angus site, “The Angus, Nebraska, find remains inadmissible as evidence of association because the circumstances of discovery of the point have never been cleared up.” Sellards (1952:36) was also skeptical and noted, “Some doubt may exist as to the certainty of the contemporaneity of the Angus point and the elephant remains.” More recent reinvestigation (Holen 1986), producing at least one thermoluminescence date, has shown
the deposit to be much older than Clovis age and has served to confirm the early suspicions. The projectile point from the site (Figgins 1931; Sellards 1952:Figure 20a) is in the Denver Museum and exhibits unusual characteristics for Clovis (full length fluting and too thick for Folsom). For the present, the Angus site is not considered to represent an artifact/mammoth association.

Summary of Central Plains Clovis Sites.

The documented Clovis sites in the Central Plains region have provided disappointingly little detail about Clovis culture. In terms of current literature, the Dent and Drake sites are perhaps the two most significant published Clovis sites in the region. Dent is historically significant despite the early date of the fieldwork and poor understanding of the site's formational history. Drake is an important example of a Clovis cache, but unfortunately the details of context were lost on discovery. These sites exemplify a common pattern and problem in Clovis archeology. Considering Clovis literature in the Plains area as a whole, we gain a better understanding of Clovis technology, economy, and lifeways. However, for the Central Plains, knowledge of Clovis is largely borrowed from other areas. Despite more than 60 years of research on Clovis sites in the region we have no direct evidence about site structure, arrangement of features, evidence for dwellings or hearths, key economic species other than mammoth, correlated radiocarbon dates, ideology, group size, burial practices, or numerous other interests. For all these things we must look to research outside the Central Plains.

There is, however, substantial progress in terms of paleoecology and terminal Pleistocene land surface studies (e.g., Johnson and Logan 1990; see also Chapter 2) and concerning lithic resource use and procurement (Hoard et al. 1992, 1995; Stanford and Jordy 1988). It should be evident that Clovis sites are still minimally reported and poorly understood in the Central Plains region and should therefore be considered of highest significance. An understanding of Clovis technology has increased and includes more information on both lithic and bone tools. It is evident in comparisons between sites such as Drake and Lange-Furgeson, for example, that the Clovis assemblages will vary widely and can look radically different from one context to another. A list of radiocarbon dates from Central Plains early Paleoindian sites is provided in Table 13.

The Goshen Complex

The Goshen complex was first identified by Irwin (1968), based on research at the Hell Gap site near Goshen Hole in Goshen County, Wyoming. Confusion surrounding this complex has had several sources. The stratigraphy at the Hell Gap site is relatively complex and the definition of the Goshen complex in Area I at Hell Gap was confounded by issues of stratigraphy, radiocarbon dates, and typology. At Hell Gap, Goshen was interpreted to be stratigraphically older than Folsom and to be a Clovis variant (Irwin 1968). It was also recognized as typologically very similar to Plainview on the Southern Plains. It was later interpreted to represent a complex intermediate between Clovis and Folsom (Irwin-Williams et al. 1973). Southern Plains Plainview evidence, however, suggested that

<table>
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<th>Material</th>
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this complex postdated Folsom, a position held by most researchers (e.g., Holliday et al. 1985; Hofman 1989), but recently questioned on the bases of typology and radiocarbon dating (Haynes 1991b). Recent investigations at Hell Gap and with the existing collections (Sellet and Frison 1994) indicate that the stratigraphy and projectile point sequence at the site is more complex than previously assumed.

Currently then, interpretation of the place of the Goshen complex in Paleoindian culture-history is unresolved. Evidence at Hell Gap initially suggested that it was pre-Folsom in age, technological comparison suggests that Goshen and Plainview are very similar (more similar than many Cody complex point types for example), but Plainview is generally interpreted as being post-Folsom. I believe it is in the realm of possibility that each view is correct and that the problems in interpretation may derive from a faulty assumption. That is, we have generally assumed that the chronological and technological variation in Plains Paleoindian projectile points was a single unilinear development. If this was not the case, if there were multiple projectile point types in concurrent use by Paleoindian groups (and recognizing that our definition of types may not correlate in any direct way to past ethnic or cultural differences), then it is possible that Plainview and Goshen projectile points are the same technological type, and that they are both older and younger than (and also contemporary with) some Folsom assemblages. Available radiocarbon dates for Folsom, Cody complex, Agate Basin, and other late Paleoindian complexes indicate that there may indeed be considerable overlap in the temporal use of these styles (cf. Frison 1993).

Research at the Mill Iron site in southeastern Montana near the intersection of the North and South Dakota borders (Frison 1988, 1991a, 1991b, 1993, 1996) has documented the first sizeable and unmixed Goshen assemblage. The site is in the Little Missouri drainage in the Humbolt Hills of Carter County, the northernmost edge of the Black Hills. This site represents a bison kill and camp preserved on a butte or erosional remnant which is about 20 m high and 35 m in diameter. The Goshen component is buried up to 2 m below the surface and extensive Holocene erosion has resulted in the isolation of this butte by about 65 m from the landform to which it was originally attached. The implications of the Mill Iron geomorphic setting for archeological site preservation and discovery in the region are substantial.

The bonebed area at Mill Iron has evidence of about 30 animals killed in the late fall or early winter (Todd et al. 1996). Projectile points found in the kill and camp/processing area are distinctive by their lack of fluting and usually precise parallel flaking. In terms of morphology and technology, the Goshen points from the Mill Iron site are very similar to (unfluted) Folsom and generally distinct from Clovis. A variety of lithic artifacts with diagnostic Paleoindian characteristics, including endscrapers, gravers, wedges, burins, and unifacial tools is represented. Interestingly, modified pieces of mammoth bone were found with the assemblage which may be evidence of contemporaneity of Mill Iron people with mammoths or it could indicate scavenging of old bone.

The extent of the typological problems in Paleoindian studies is exemplified by the Goshen problem (Frison 1991a, 1991b). The Goshen points from the Mill Iron site and a few other localities share some characteristics with Clovis and with Folsom assemblages but are unusual among early Paleoindian point types due to the absence of fluting.

Dating of the Goshen assemblage at the Mill Iron site is problematic as two sets of clusters of dates are available, one indicating that Goshen is as old as the oldest well-dated Clovis material and the second set indicating that Goshen is slightly later. The early series of radiocarbon dates (all on charcoal) include samples from both the camp area and bonebed. The mean ages of these early dates (N=5) range from 11,570 to 11,320 B.P. (Frison 1991b: Table 1). The late series of dates from Mill Iron (N=4), again from both the camp and bonebed range from 10,760 to 11,010 B.P. This difference remains unresolved. The material from the Mill Iron site, however, has enabled a technological and typological reassessment of some previous artifacts and at least some specimens that had previously been referred to as Clovis are now thought to represent Goshen (compare Frison 1984 and Frison 1991b).

Although projectile points which may be classified as Goshen have been recovered in the Central Plains, there are few excavated components. The Upper Twin Mountain site, 5GR153, near Kremling, Colorado (Kornfeld 1991; Todd et al. 1996) is the only excavated site currently reported from the Central Plains. This site is discussed with the Folsom sites below. Also, the Jim Pitts site in extreme western South Dakota (39CU1142) had a Goshen component in a stratified campsite (Donahue 1995, 1996; Donahue and Hannenberger 1993). Jim Pitts is located in the western Black Hills near the Wyoming border about 265 km southeast of Mill Iron, and about 180 km northeast of the Hell Gap site. Radiocarbon dates from Jim Pitts compare with the older series of dates from Mill Iron.

The Folsom Complex

The Folsom technological complex represents one of the more famous, distinctive, and widespread early prehistoric cultures in the Plains, Rocky Mountains, and Southwest areas of the United States. Folsom technology is well known through detailed studies of collections from sites such as Lindenmeier, Colorado; Blackwater Draw, New Mexico; and Agate Basin and Hansen in Wyoming. Isolated artifact finds, bison kill sites, campsites with ephemeral surface hearths, small assemblages of tools from hunting overlooks, and lithic workshop sites are known from Montana and North Dakota to southern Texas and New Mexico. Table 14 provides a summary listing of selected key Folsom sites outside of the Central Plains region. Some of these are listed simply because information is available in the literature, not because the sites are necessarily unique or inherently significant. Folsom sites are more numerous and better studied on average than Clovis sites. This is especially true in the Central Plains region where extensive and detailed research at the Lindenmeier site during the 1930s by Roberts has placed this site assemblage at center stage in Folsom
technological and campsite studies for more than half a century (Wilmsen and Roberts 1978).

Campsites often occur in close association with kills or lithic sources such as at Hanson and Agate Basin, Wyoming; Lake Ilo, North Dakota; Cattle Guard, Colorado; and Adair-Steudman, Texas. High quality lithic materials were generally used in artifact manufacture, and quarry activity may be indicated at the Knife River source area in North Dakota (Root 1993). Quarrying for red ochre is indicated at Sunrise Mine and the Powars II site in eastern Wyoming (Frison 1991b; Stafford 1990). Characteristic Folsom artifacts include delicately made, thin, fluted and unfluted lanceolate projectile points, distinctive projectile point preforms and channel flakes from fluting, bifacial cores, thin bifacial knives, endscrapers which often exhibit spurred corners, delicate pointed gravers, and a variety of mostly unifacial tool and composite tool forms. In addition, a variety of bone tools including projectile points, eyed needles, notched pieces, grooved bones, and occasional beads are known to occur. The use of red ochre in domestic and bison kill settings is also documented (Roper 1991).

The Folsom complex was first recognized and gained historical significance when discoveries between 1926 and 1928 at the Folsom site in northeastern New Mexico established the contemporaneity of projectile points and a Pleistocene form of bison (Figgins 1927; Cook 1927; Meltzer 1983, 1993a; Wormington 1957). Stratigraphic evidence indicated that the deposit was a minimum of 10,000 years old (Bryan 1937) which bolstered the paleontological information. This has subsequently been supported by a series of radiocarbon dates which indicate that the bison kill occurred about 10,800 years ago (Haynes 1992, 1993; Haynes et al. 1992).

The Folsom site is located about 15 km west of the town of Folsom and was first discovered in 1908 by a local cowboy, George McJunkin. Paleontologists from the Denver Museum of Natural History first excavated at the site in 1926 when the association between artifacts and Pleistocene bison was indicated. In 1927 a number of archeologists were invited to view finds of artifacts in place among the bison skeletons. In
1928 paleontologists working for Barnum Brown of the American Museum of Natural History in New York conducted more extensive excavations at the site and recovered additional bison skeletons and Folsom points (Wormington 1957). The next substantive research on the Folsom complex occurred in the 1930s at the Lindenmeier site in northern Colorado (Roberts 1935a, 1936; Wilmsen and Roberts 1978) where an extensive campsite was investigated. Also in the 1930s, research at the Blackwater Draw Locality #1 site in New Mexico yielded stratigraphic evidence that Folsom was slightly younger than Clovis in age (Howard 1935; Sellards 1952; Wormington 1957). Currently there are nearly 30 radiocarbon dates on Folsom (Table 15) which are considered reliable and these indicate a chronological period for Folsom between 10,200 and 10,800 radiocarbon years B.P. (Haynes 1993; Haynes et al. 1992). At the early end, this is only about 100 years younger than the most recent acceptable dates for Clovis, indicating that radiocarbon dating alone will not enable distinction between the latest Clovis and earliest Folsom deposits.

The distribution of Folsom sites and finds has been established based on site excavations and the study of diagnostic surface occurrences (Amick 1994; Davis and Greiser 1992; Hofman 1987, 1994b; Hooker 1982; Largent et al. 1991; Morrow and Morrow 1994; Myers 1987; Nace 1986). Evidence of Folsom technology is found from southern Canada to northern Mexico and from Illinois to Utah, Idaho, and eastern Arizona. The greatest density of sites and finds appears to be in the High Plains, dissected Plains, and Rocky Mountains foothills regions. The finds are correlated with the terminal Pleistocene records for Bison bison antiquus (e.g., Munson 1990).

Figure 28 shows the reported occurrences of Folsom finds and sites in the Central Plains region by county. The nature of this evidence varies widely and includes brief mention of finds (e.g., Wedel 1938c; Howard 1935, 1939; Barbourn and Schultz 1936), descriptive reports (e.g., Agogino and Parrish 1971; Galloway and Agogino 1961; Hurst 1943), area surveys (Nace 1986), and detailed site studies (Wilmsen and Roberts 1978). Folsom sites recorded in the Central Plains region are listed in Table 16, and examples of Folsom artifacts from the region are shown in Figure 29.

The basic elements of the Folsom technological system were documented by Roberts' investigations at the Lindenmeier site during the 1930s (Roberts 1935a, 1936a, 1937b). The extensive and varied assemblage from this site remains the most "complete" and among the better documented of Folsom assemblages (Wilmsen and Roberts 1978). Detailed studies of other Folsom sites and assemblages have enhanced the record from Lindenmeier. Notable sites with relatively large or varied assemblages include Hanson, Wyoming (Frisen and Bradley 1980; Ingbar 1992); Agate Basin, Wyoming (Frisen and Stanford 1982); Hell Gap, Wyoming (Irwin 1968); Lake Ilo, North Dakota (Root 1993); Cattle Guard, Colorado (Jodry 1987, 1992; Jodry and Stanford 1992); Blackwater Draw and the Mitchell Locality, New Mexico (Hester 1972; Boldurian 1990); Eldra, New Mexico (Hester 1962); Shifting Sands, Texas (Hofman et al. 1990); and Adair-Steadman, Texas (Tunnell 1977; Tunnell and Johnson 1991).

These site studies have documented much of the range of lithic and bone technology of Folsom. Characteristics of Folsom
Table 16. Folsom Sites Recorded in the Central Plains.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Number</th>
<th>County</th>
<th>Site Type</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lindenmeier</td>
<td>5LR13</td>
<td>Larimer</td>
<td>Camp/Kill</td>
<td>e</td>
</tr>
<tr>
<td>Powars</td>
<td>5</td>
<td>Weld</td>
<td>Camp</td>
<td>f</td>
</tr>
<tr>
<td>Johnson</td>
<td>5</td>
<td>Larimer</td>
<td>Camp</td>
<td>g</td>
</tr>
<tr>
<td>Fowler-Parrish</td>
<td>5</td>
<td>Morgan</td>
<td>Processing</td>
<td>h</td>
</tr>
<tr>
<td></td>
<td>5MR33</td>
<td>Morgan</td>
<td>Camp</td>
<td>d</td>
</tr>
<tr>
<td>Barger Gulch</td>
<td>5GA1208</td>
<td>Grand</td>
<td>Camp</td>
<td>i</td>
</tr>
<tr>
<td>(Crying Woman)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Upper Twin Mtn</td>
<td>5GA1651</td>
<td>Grand</td>
<td>Kill/Camp</td>
<td>i</td>
</tr>
<tr>
<td>*Lower Twin Mtn</td>
<td>5GA166</td>
<td>Grand</td>
<td>Camp</td>
<td>i</td>
</tr>
<tr>
<td>*Cattle Guard</td>
<td>5AL101</td>
<td>Alamosa</td>
<td>Kill/Camp</td>
<td>x</td>
</tr>
<tr>
<td>*Linger</td>
<td>5AL91</td>
<td>Alamosa</td>
<td>Kill</td>
<td>k</td>
</tr>
<tr>
<td>*Zapata</td>
<td>5AL60</td>
<td>Alamosa</td>
<td>Kill/Camp</td>
<td>m</td>
</tr>
<tr>
<td>*Radin</td>
<td>5SH77</td>
<td>Saugus</td>
<td>Kill/camp</td>
<td>a</td>
</tr>
<tr>
<td>*Bijou Creek</td>
<td>5MR1</td>
<td>Morgan</td>
<td>Camp</td>
<td>d</td>
</tr>
<tr>
<td>*Hahn</td>
<td>5EP1</td>
<td>El Paso</td>
<td>Camp</td>
<td>d</td>
</tr>
<tr>
<td>*Black Mountain</td>
<td>5N55</td>
<td>Hinsdale</td>
<td>Camp</td>
<td>n</td>
</tr>
</tbody>
</table>

Nebraska

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Number</th>
<th>County</th>
<th>Site Type</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elgin</td>
<td>2SL10</td>
<td>Blaine</td>
<td>Sandhills</td>
<td>o</td>
</tr>
<tr>
<td>Calf Creek</td>
<td>25CE27</td>
<td>Oak</td>
<td>Sandhills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25CE37</td>
<td>Chase</td>
<td>Sandhills</td>
<td></td>
</tr>
<tr>
<td>Nolan</td>
<td>25CH4</td>
<td>Chase</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25CH23</td>
<td>Chase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morrison</td>
<td>25H012</td>
<td>Hooker</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25H042</td>
<td>Hooker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Springs</td>
<td>25X77</td>
<td>Sioux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kansas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Mile Creek</td>
<td>14L01</td>
<td>Logan</td>
<td>BISON KILL</td>
<td></td>
</tr>
</tbody>
</table>


* This is a Goshen site with no Folsom points.

Figure 29. Folsom complex and other artifacts from the Central Plains. a-c. Folsom preform fragments; d-e. Folsom channel flakes; f-h. gravels or tips; i-j. engraved bone pieces; k. double spokeshave; l. spurred end scraper; m. pseudo-fluted Folsom point made on a flake (a-m. from Lindenmeier site); n. Folsom point, Prowers County, CO; o. Folsom point, Hitchcock County, NE; p. Midland point, Banner County, NE; q. Goshen point, Sioux County, NE.

A stone technology, in addition to the classic fluted projectile points (Bell 1958; Roberts 1934), include bifacial fluted and unfluted preforms which also served as tools (Judge 1973; Boldurian and Hubinsky 1994), very thin broad bifaces which probably served in cutting and butchery (Root et al. 1994), very large bifaces which served as cores for large tools and blanks (Stanford and Broilo 1981; Boldurian 1991; Hofman 1992), delicate and thin channel flakes from fluted point production which often served as tools, fine-tipped gravels made on thin flakes, endscrapers which often exhibit graver spurs at one or both corners, sidescrapers, spokeshaves or concave scrapers, notches or very small spokeshaves, denticulates or serrated-edged tools, bifacial and unifacial drills, borers, or tips, occasional burins on flakes, combination tools which combine from two to several distinct tool forms on one piece, bend break and hinged flake tools (Frison and Bradley 1980), radial break tools (Frison and Bradley 1980), utilized and informal flake tools, choppers made on cobbles, hammerstones, abrading stones, and small grinding stones (sometimes with red pigment-stained surfaces). This relatively rich lithic tool variety is represented in widely differing proportions at different sites dependent upon numerous situational factors. These include the length of occupation, number of people, composition of the group, proximity to a quality lithic source, whether kill, butchery, or processing activities are conducted, season, ground cover (which influences artifact loss), and a variety of other conditions.

Complementing this lithic technology is a rich variety of bone tools and artifacts. These artifacts are primarily from a few excavated sites which have relatively good preservation due to dry climates and rapid burial. Collections from Lindenmeier and the Folsom components at the Agate Basin site are most notable (Wilmes and Roberts 1978:126-134; Frison and Craig 1982). A key tool type is the eyed needle which is also documented at other Folsom-age sites including Hanscom (Frison and Bradley 1980:103) and Winkler #1 (Blaine and Wendorf 1972). These needles were generally very delicate, but reached at least 8 cm in length (Frison and Craig 1982: Figure 2.111a). Needles were apparently used in sewing skins or hides with sinew or fiber. At both Lindenmeier and Agate Basin eyed needles were clustered in what were apparently domestic work areas. Other bone tools include a variety of modified long bone implements, which may have served many tasks, but include serrated flesher and probable knitting tools. Bone projectile
points are documented from Agate Basin (Frison and Zeimens 1980; Frison and Craig 1982) which adds an interesting dimension to the hunting technology. Foreshafts or tool handles may be represented by hollowed rib sections (e.g., Frison and Craig 1982; Hester 1972), and possible Folsom point fluting tools are represented by a T-shaped elk antler section and bone pieces from Agate Basin (Frison and Bradley 1981, 1982). A hollow tube bone bead made from a small animal long bone is reported from Lindenmeier, and the remnants from manufacture of such beads were found at Agate Basin. Also, manufacturing by-products from needle manufacture are probably represented by cut scapulae fragments at Agate Basin. Experimental work has shown the flat bone from scapulae to be particularly resilient and suitable for needle manufacture (Frison and Craig 1982:166). Numerous small bone objects, roughly circular or elongated, with small regular edge notches are also reported and generally referred to as decorative pieces or gaming objects. Also, sections of rib and long bone have been found which have narrowly spaced parallel grooves. Specific functional interpretations have not been offered for these, but I suspect they may represent manufacturing steps in the production of objects such as needles or beads. A very small (<2 mm diameter) bone bead was recently found at the Shifting Sands Folsom-Midland site in western Texas. Such small ornamental objects were probably made in sets, and the grooved segments of bone may represent an initial step in the manufacture of such artifacts (Hofman 1996).

In general terms, the Folsom lithic technological system was highly portable and centered upon the production of bifaces and large biface thinning flakes which could be routed through a variety of possible functional and morphological stages depending upon immediate requirements and on the long-term plans of the group. Judge’s discussion of Folsom technology in the central Rio Grande valley was an early and largely successful attempt to explain this technology as a highly curated and versatile lithic reduction system of a mobile group. Judge (1973:192) argues,

Folsom people were quite conservative in their use of lithic material and...this is manifest in the production of a preform as a primary focal unit. By-products of this process served as blanks for other tools, which then served multipurpose rather than specialized needs. It is tempting to suggest that this efficiency in utilization of raw material and the multipurpose usage of a minimum number of tool types represents an adaptation to a highly mobile way of life. This is certainly a possible explanation for this phenomenon in the central Rio Grande valley.

Continued research generally supports Judge’s conclusion (Boldurian 1991; Hester 1972; Jodry 1987; Ingbar 1992, 1994; Amick 1994; Hofman 1991, 1992; Root and Ahler 1994). Even in Folsom site situations where raw material is abundant (with a nearby source), such as at the Hanson site in Wyoming (Frison and Bradley 1980; Ingbar 1992, 1994) and Lake Ilo in North Dakota (Ahler and Root 1993; Root and Ahler 1994), specialized tool forms and bifaces were at the heart of the technological system. Completed points and final stage preforms are sometimes made of exotic materials even at lithic source areas and workshop sites. Ingbar (1992:187-188) writes, Why are wasteful reduction techniques, especially fluting, not performed at raw-material source sites where production failures would not have been disastrous... the answer to this must be that long-term utility of the core, whether a large biface or flake, must have been equally or more important than the number of projectile points in a hunter’s gear. The wide range of tools that can be created from a flexible form like a large biface or flake may have been more advantageous given uncertainties about the location and purpose of tool needs.

Projective points were apparently only one of several important functional end products of the staged biface technological reduction process. This sequencing of artifact forms included heavy biaxial tools (including early stage cores and preforms), and thick or thin biface reduction flakes which could be used in unmodified form or transformed into a variety of standardized or expedient tool types. Channel flakes from fluting provide a sharp and delicate cutting tool, and fluted or unsuccessful preforms could also be routed to a variety of tool types such as bend break tools, burins, radial break tools, scrapers, gravers, etc. When Folsom point production and fluting is viewed within the broader context of the overall Folsom chipped stone industry, fluting might be seen as a “no lose” strategy rather than as a highly dangerous and wasteful process.

Folsom economy has generally been characterized as specialized or focused on bison hunting (Sellards 1952; Wormington 1957; Frison 1991b; Bonnichsen et al. 1987). To date, all Folsom components which have bone preservation include bison remains, usually as the dominant species in terms of number of animals and almost always in terms of volume or mass yield. Only at the Wasden site, Owl Cave, in Idaho is there evidence for the association between Folsom points and mammoth remains (Miller 1982, 1983); otherwise, mammoth were apparently extinct by Folsom time. Lesser species are also sometimes associated with Folsom material, notably deer, antelope, elk, camel, jackrabbit, wolf, fox, marmot, turtles, and microtines (Walker 1982; Davis and Greiser 1992; Wilmsen and Roberts 1978). Blood residue studies have also shown nonbison species such as antelope were part of the Folsom economy (Hyland and Anderson 1990; Amick 1994).

Several authors have suggested that the dependence of Folsom people on bison is more apparent than real (Kornfeld 1990; Meltzer and Smith 1986), because of differential preservation, visibility, and recovery of bison remains, especially at kill sites, vs. more delicate remains of smaller species. It is generally accepted that Folsom people would have used a variety of plant and animal resources other than bison at least
in some seasons and settings (Hofman 1990b, 1994a; Davis and Greiser 1992).

A variety of bison hunting techniques were employed by Folsom people and we continue to learn more about the variety of hunting strategies of these and other early Plains hunting groups (Frison 1987a, 1993). Minimally, these groups used stalking and small group encounter hunting (e.g., Bamforth 1985; E. Johnson 1987), jumps over steep canyon walls (Dibble and Lorrain 1968), arrowhead cut traps (Frison and Stanford 1982; Bement 1994a, 1994b), and probably sand dune traps as well (cf. Frison 1974; Dawson and Stanford 1975). The number of animals taken ranged from a few individuals to almost 60 at the Lipscomb site (Hofman and Todd 1990, 1995; Todd and Hofman n.d.; Todd et al. 1992). There does not appear to be a direct correlation between the number of animals and the number of projectile points or artifacts recovered (Hofman 1994a) (Table 17). Numerous other factors such as season, number of hunters, length of occupation (opportunity for recovery of gear), number of animals, dispersion of carcasses, access to carcasses, differential preservation, ground cover, and other situational variables were probably of importance in determining the final makeup of the archeological record.

<table>
<thead>
<tr>
<th>Site, Location</th>
<th>#Points</th>
<th>#Bison</th>
<th>Ratio</th>
<th>Season*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agate Basin, WY</td>
<td>3</td>
<td>9</td>
<td>0.3</td>
<td>Late winter/Early spring</td>
</tr>
<tr>
<td>CarterK-M, WY</td>
<td>0</td>
<td>2</td>
<td>0.2</td>
<td>n/a</td>
</tr>
<tr>
<td>Lindenmeier, CO</td>
<td>13</td>
<td>9</td>
<td>1.4</td>
<td>n/a</td>
</tr>
<tr>
<td>(Bison Pt/Area)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folsom, NM</td>
<td>20</td>
<td>26</td>
<td>0.7</td>
<td>Early fall</td>
</tr>
<tr>
<td>Lipscomb, TX</td>
<td>30</td>
<td>56</td>
<td>0.5</td>
<td>Late summer/Early fall</td>
</tr>
<tr>
<td>Lake Thore, TX</td>
<td>14</td>
<td>12</td>
<td>1.2</td>
<td>Early fall</td>
</tr>
<tr>
<td>Cooper, OK</td>
<td>32</td>
<td>357</td>
<td>0.9</td>
<td>Late summer/Early fall</td>
</tr>
</tbody>
</table>

Only finished stone points are included here (not preforms or bone points).
Three kill events are represented at the Cooper site (Bement 1994b).
* Seasonal information is from Todd and Hofman (1992: Table 8), and from Bement (1994b). Folsom groups were highly mobile and are believed to have moved over regions of considerable size during the course of their hunting and foraging activity. Stone tool source studies suggest fairly common movement up to 200-400 km from locations where lithic materials were acquired for tool manufacture (Wilmersen and Roberts 1978; Jodry 1987; Stanford 1991a; Frison 1982; Hesse 1995; Hofman 1991a; Hofman et al. 1991; Amick 1994). Because of the probable low population density and the rarity of recurrently occupied sites, direct acquisition of lithic material for tool manufacture is believed to have been the primary means for obtaining the critically important stone, rather than relying upon uncertain or unpredictable trade.

Information on ideology and ritual is limited. Red ochre was an important element in Folsom life and is represented in some fashion at most Folsom campsites and at several kill sites. Occupation surfaces at Agate Basin, Hanson, and Lindenmeier had evidence of red ochre. Also, an important recent find at the Cooper bison kill site in Oklahoma was a skull from the lowest of three bison bonebeds which had a narrow red zigzag line and other marks (dots) painted on it (Bement 1994a). The skull, from an essentially articulated skeleton, was painted and set on top of the bonebed facing toward the mouth of the gully where two subsequent kill events occurred (Bement 1994a). This is the first such find in the New World Paleoindian record, but it brings to mind painted mammoth skulls and other elements from the Upper Paleolithic sites such as Mezîhirîn in the Ukraine (Soffer 1985). Also, red ochre-stained bone is reported from the Sheeana Clovis site in eastern Wyoming (Frison 1982a), and the important Powars II site represents a red ochre quarry used by Folsom and other Paleoindian people (Frison 1991b; Stafford 1990).

An interesting bone feature is also known from the Lake Theo site bison bonebed. A series of long bones and mandibles were set vertically in a small circular hole and apparently supported a bison skull in a dense bison bonebed (Harrison and Smith 1975). This may have been an offering or a feature similar in purpose to the Cooper site’s painted skull.

Folsom ritual has also been suggested in relation to the production of fluted points (Frison and Bradley 1982; Frison 1991a:56; Bradley 1991:375; Hofman 1989:37). Some Folsom point preforms have been found which were fluted successfully on both sides and then discarded without being completed (Bradley 1991, 1993). This suggests that in some situations it was perhaps the fluting itself rather than the creation of a functional point which was of most significance.

Ornaments are other artifacts potentially reflecting Folsom ideology or decorative art. Beads have been found at several sites including Lindenmeier, Agate Basin, and Shifting Sands. At Shifting Sands in western Texas, a very small bone or ivory bead 1.7 mm in maximum diameter was found in Area 6. This very small bead would not have been used singly but in conjunction with other such beads probably for creating decorations or designs on clothing or other articles. Intensive use of beads is well shown at Upper Paleolithic site of Sungir in the Ukraine where thousands of beads of varying sizes were found as burial associations (Bader 1978; Shimkin 1978). In the New World, such small beads as the ones found at Shifting Sands have not been reported elsewhere in Paleoindian contexts, but this find holds important implications for recovery and recognition of small decorative elements in Folsom technology.

Selected Folsom Sites in the Central Plains

**Lindenmeier Site.** The Lindenmeier site is located in north-central Colorado, north of Fort Collins and less than 3 km from the Wyoming border. The site is on the Colorado Piedmont escarpment within the drainage system of the Cache la Poudre and South Platte rivers. The site's geologic setting and stratigraphy are discussed by Bryan and Ray (1940). It was discovered in 1924 by amateur archeologists who subsequently reported it, following the discoveries at Folsom, New Mexico, to the Smithsonian Institution (Coffin 1937; Cassells 1938; Renaud 1931b, 1932b; Roberts 1935a, 1935b, 1935c, 1936a, 1940, 1941) then worked at the site from 1934 through 1940 conducting extensive, well controlled, and for the most part thoroughly documented excavations. Cotter (1978) also conducted excavations at the site on behalf of the Colorado Museum of Natural History (now the Denver Museum).
As noted by Wilmsen, the Lindenmeier site stands out as exceptional in large part due to the quantity and quality of the fieldwork. More than 1800 m² were excavated by Roberts plus more than 20 test pits, not including the work of Cotter or the Coffins. About 580 field days were spent at the site with an average crew of eight to nine people between 1934 and 1940. Areas I and II which were the primary focus of Wilmsen's analysis included about 1,133 m² which yielded more than 33,000 flakes and tools (not including bone debris or bone artifacts). This is an average of about 30 artifacts per square meter, but the density was highly variable across the excavated areas and there was no fine screen recovery. Dry screening, probably with quarter-inch mesh, was done for the Folsom levels for much of the excavation. At least three distinct artifact-bearing strata of Folsom age were recognized in Area II (Wilmsen and Roberts 1978:54). The formational history and relationships of these units is not well understood but held important implications for artifact density, site occupational history, and assemblage analyses. Because of the large and varied collections, Lindenmeier provides the standard basis for comparison and discussion of Folsom assemblages. The site has been suggested by some authors to represent an aggregation site for Folsom bands (Wilmsen 1974), a possibility which merits further investigation (Hofman 1994a).

**Fowler-Parrish Site.** The Fowler-Parrish site is located near Orchard, Colorado in the South Platte drainage (Agogino and Parrish 1971). At least 17 Folsom points and fragments were collected from the site in an area that apparently contained at least two bison bonebeds. Deflation of the sandy matrix and intensive artifact collecting limited the research potential of the site which apparently represented a bison kill. No information is available on associated camp or processing areas which were probably located nearby.

**Powars Site.** The Powars site is near Greeley and Kersey, Colorado on the South Platte River. It has been largely destroyed by wind deflation and subsequent house construction and agricultural activity. The site was a camp in a sand dune area on the south side of the river and yielded more than 2,000 artifacts including Folsom points and endscrapers. Brief mention of the site is found in Worthington (1957:39) and Roberts (1973a).

**Johnson Site.** This small Folsom assemblage from a site near La Porte, Colorado on the Cache la Poudre River was documented by Galloway and Agogino (1961, Worthington 1957:40). This location is about 24 km from Lindenmeier and the site yielded 10 Folsom points (most from the surface), 22 channel flakes, and endscrapers. Substantial Archaic and late prehistoric material was also represented at this severely deflated site. An area of more than 20 m² was excavated. A stone circle probably of post-Folsom origin is reported, as is evidence for late prehistoric occupation of nearby rockshelters. The site is significant for the reported common utilization of quartzite in the Folsom assemblage. The site has been largely destroyed by road construction.

**Upper Twin Mountain (Jim Chase Site).** This site, SGA1513, is located northeast of Kremmling, Colorado and has been investigated since 1990 by Frison and Kornfeld (Kornfeld et al. 1992; Kornfeld and Frison 1995). The site consists of a bison kill at an elevation of about 2,500 m ASL and represents a Goshen or Goshen/Plainview kill. An area of about 32 m² has been excavated, and a single radiocarbon date on bone is 10,240 ± 70 (G.C. Frison and M. Kornfeld, personal communication, 1994). At least 15 bison are represented and were apparently killed in late fall or early winter (Todd et al. 1996). A Folsom campsite, Lower Twin Mountain (5GA186) is located a short distance away.

**The Crying Woman Site, 5GA1208.** This extensive site includes an area which represents a Folsom campsite along Barger Gulch in Middle Park (Naze 1994). The site is situated near a series of springs in the headwaters of the Colorado River. Controlled surface collections and testing by Naze has produced Folsom points, preforms, channel flakes, a spurred endscraper and other materials. Two preforms and three channel flakes are made from local Kremmling chert, but at least one point from the site is from possibly nonlocal red jasper.

**Middle Park Survey.** The upper Colorado River drainage north, south, and east of Kremmling, Colorado has a relatively high density of Folsom sites and finds (Naze 1986). Naze documented 26 sites and probable sites of Folsom age in about 6,200 km² of the Middle Park drainage basin for a site density of about one site per 237 km². Additional discoveries have been made since Naze’s initial report, but he reported 32 Folsom points, 13 channel flakes, 21 preforms, and other artifacts. About 80% of the lithic material represented by Folsom artifacts was “local” Kremmling chert, but Table Mountain jasper (from the eastern part of the drainage) and exotic cherts such as Flattop chaledony from near Sterling and oolitic chert from the Red Desert area of southern Wyoming are also represented. The region was an important source of quality lithic material, but a variety of site types are represented. These include camps, hunting overlooks, and isolates (Naze 1986:6). In addition, bison kill sites of Folsom or Goshen age are also known in the area (Kornfeld et al. 1992). Some sites occur above the timberline. Continued research in the Middle Park basin promises to provide important new information about Folsom and Goshen activities in the Rocky Mountains region.

**Cattle Guard and San Luis Valley Sites.** Cattle Guard is the most thoroughly investigated of several Folsom sites in the eastern San Luis Valley of south-central Colorado (Jodry 1987, 1992; Jodry and Stanford 1992; Emery and Stanford 1983). Other sites in the vicinity include Linger (5AL91) (Hurst 1943; Dawson and Stanford 1975), Reddin (5SH77), and Zapata (5AL50) (Worthington 1957). The sites, except for Reddin, are located along the eastern margin of the Pleistocene San Luis Lake in the vicinity of Great Sand Dunes Park. Two radiocarbon dates on bone from the Linger site are believed to be too young to represent the age of the Folsom occupation there (Dawson and Stanford 1975). But young bone dates are a common problem at Paleoindian sites on the Western Plains (Wilmsen and Roberts 1978:40; Hofman 1995b; Stafford et al. 1991). Investigations at Linger including excavation (ca. 99 m²) and controlled surface
collections, indicate that kill/butchery and camp areas are represented.

Cattle Guard (5AL101) was discovered in 1977 and test excavations were made in 1981 (Emery and Stanford 1983). Since that time several additional field seasons of intensive excavation have produced one of the most extensive and well-documented Folsom assemblages. This assemblage apparently represents a single occupation surface which is now buried about 25 cm below the present surface. Excavation has documented several spatially discrete activity areas apparently associated with hearths which occur some 20-30 m from the primary bison bonebed (Jodry 1987). The thickness of the occupation zone is about 30 cm with numerous refitted artifacts serving to link the assemblage through and across this unit (Jodry 1992, Jodry and Stanford 1992). A large assemblage of Folsom artifacts and bison remains has been recovered from the site. Spatial analyses are providing important insights to the organization of activities at this Folsom camp and kill/processing site. A series of probable hearth areas have yielded evidence for a variety of activities including tool maintenance. Projectile point bases (discarded), preforms, channel flakes, and production debris occur in each hearth-related artifact cluster. This suggests that fluting Folsom points was done by several different individuals, rather than by a single specialist. A kill area is located 20-30 m from the hearths and camp and may have included about 25-30 bison (Jodry 1992, personal communication 1994). Also, site formational studies conducted at Cattle Guard are of significance to all investigations in sand dune situations. The artifact assemblage from Cattle Guard includes numerous projectile points, point preforms, channel flakes, scrapers, gravers, unifacial tools, utilized flakes, hammerstones/ anvils, chopping tools, abraders, red ochre and an assortment of other artifact types. Lithic material sources include artifacts of Allabates flint, Washington Pass chalcedony, Trout Creek jasper, and Black Forest silicified wood among other materials. Artifacts around hearth areas indicate that several preforms were finished into points near each hearth area.

Black Mountain Site. 5HN55. This high altitude site is in a mountain pass in the San Juan Mountains in Hinsdale County (Jodry et al. 1993). Only preliminary investigations have been conducted, but a campsite and overlook with point production debris and a variety of other tools is indicated.

Nolan Site. The Nolan site in Chase County, Nebraska was discovered and first reported in the 1930s when this sand dune area was severely deflated by wind erosion (Schultz 1932; Barbour and Schultz 1936). Myers (1987) Folsom points from Chase County are primarily from Nolan. Folsom points, preforms, endscrapers, unifacial tools, gravers, and large bifacial thinning flakes are represented in the site collection. Lithic materials include both Niobrara or Smoky Hill jasper and Flattop chalcedony (White River Group, Hoard et al. 1992).

12 Mile Creek Site. Excavation of a late Pleistocene bison bonebed east of Russell Springs, Kansas on the Smoky Hill River in 1895 by paleontologists from the University of Kansas yielded the first evidence from the Central Plains region of an artifact associated with an extinct form of bison (Williston 1902; Rogers and Martin 1984; Hill 1994, 1996; Hill et al. 1993). A single projectile point was found lying beneath and against the dorsal surface of a scapula of a large articulated bison substantiating the contemporaneity of the artifact and the bison remains. Unfortunately, the point was lost soon after discovery and only a sketch and photograph remain. The point was fluted and the banding suggests it may have been made of Allabates flint (Stanford 1983). A series of three radiocarbon dates are now available for the site based on bone from the original excavation (Table 15). These all are in close agreement and well within the range of other Folsom-age dates.

The projectile point from 12 Mile Creek is considered by Haynes (1993-Figure 1), Rogers and Martin (1984), and O'Brien (1984) to be Clovis. Others, including Gunnerson (1987:15), Brown and Simmons (1987), Brown and Logan (1987) consider it to be Folsom.

Restudy of the bison bones from the 12 Mile Creek site has yielded new insights into the formational history of the site and more details about the fauna (Hill 1994, 1996). At least 12 animals are represented in the bonebed, there is limited evidence of butchering, and the season of the kill was probably late winter to early spring.

Midland Complex

The Midland archeological complex was first defined based on discoveries at the Scharbauer site near Midland, Texas. The discovery of a human skull, animal bones, and artifacts in ancient dune deposits of uncertain late Pleistocene age brought considerable notoriety to the site in the 1950s (Wendorf et al. 1955; Wendorf and Krieg 1959). Despite additional study of the type site and other deposits in the region, and study of the stratified Paleoindian assemblages at the Hell Gap site in Wyoming, the relationships between Midland and other Paleoindian complexes, especially Folsom, has remained a topic of debate. The relationships between Midland and Folsom in terms of chronology, technology, cultural groups, and archeological taxonomy remain unresolved.

The single primary difference between Folsom and Midland assemblages is that Midland projectile points are not fluted, though they share most other morphological and technical attributes or characteristics of Folsom points. Other elements of the technology are essentially identical. These include spurred endscrapers, delicate gravers, eyed bone needles, and a pattern for use of the same exotic lithic sources preferred by Folsom people. One problem is that there are few stratified sites which provide a clear indication of the chronological relationship between Folsom and Midland. There are currently no radiocarbon dates for clearly unmixed Midland assemblages. It is often assumed that Midland represents, in part, the later phase of the Folsom technology when fluting was losing "popularity." The abandonment of fluting projectile points by Paleoindians may have occurred at different times and rates in various regions of the Plains, but it is a technique which was
eventually completely lost. The relationship between Midland and Folsom may, then, in part be a chronological or historical one.

It has also been suggested that these projectile point types reflect the activities of two distinct but more or less contemporary groups (Blaine 1968, 1992). Alternatively, technological aspects of projectile point production and decisions about when, and when not, to fluted projectile points may have been influenced by technological considerations, availability of tool stone, time restraints, and so forth (Hofman 1992a). There are many archaeological sites, such as Shifting Sands in Texas (Hofman et al. 1990) and Hell Gap in Wyoming (Irwin 1968), where both Folsom and Midland points (or unfluted Folsom points) are found together, but the integrity of the sites and the possibility of mixing remains from multiple occupations through deflation and other natural processes are generally undocumented.

As it stands at present, there are multiple possible and reasonable interpretations for explaining the relationships between the Midland and Folsom complexes. There is no question but what they are very similar in overall technology, economy, and to a large extent the time and space framework of their distributions. Because of recently improved understanding of the Goshen complex, which is an unfluted point assemblage of Clovis or Folsom age on the Northern Plains, we can no longer simply assume that Midland is necessarily a later development out of Folsom or a continuation of Folsom which simply lacked fluted points. Understanding the interrelationships of these technologies represents one of the more intriguing questions in contemporary Paleoindian research.

No Midland sites have been identified or excavated in the Central Plains, but a number of Midland artifacts have been documented from Kansas, Nebraska, and Colorado as well as further north in Wyoming and North Dakota (Frisco 1991b:Figure 2.38g).

Late Paleoindian or Plano Complexes

As first used by Jennings (1955), the Plano "culture" or complex was a general term used to refer to a number of distinct assemblages recognized by various unfluted, lanceolate projectile points which are known or assumed to be of post-Folsom or late Paleoindian age. The basis of the Plano complex concept, as used by most authors, is that it represents late Paleoindian, ca. 10,200-7500 B.P., groups with an economic focus on bison hunting in the Plains. It incorporates a number of more specific and often temporally or geographically restricted complexes or assemblages found throughout the Great Plains. In a typological sense, it is often used in much the same way the term "Yuma" was used during the 1930s through 1950s (usually as a reference to parallel flaked lanceolate points), until the Yuma terminology was abandoned as too vague and imprecise (Howard 1943; Worthington 1957).

The Plano taxon has been widely accepted as a useful term and has been applied to many late Paleoindian materials which are not assignable to a specific complex or when numerous distinct complexes are considered together as a group (Cassells 1983; O'Brien 1984b; Brown and Simmons 1987; Brown and Logan 1987; Krieger 1964; Lintz and Anderson 1989; Spencer and Jennings 1965; Wedel 1978d). In his later writings, Jennings (1974, 1978) included assemblages with stemmed and notched points in his discussion of Plano. Most other researchers would consider some of these materials Archaic rather than Plano. He also presented a somewhat muddled discussion of the relationships between Plainview, Firstview, Folsom, Cody, and other complexes (Jennings 1978). In this overview, Plano is used to refer to post-Folsom Paleoindian complexes. Examples of Plano projectile point types are shown in Figure 30. Late Paleoindian sites are listed in Table 18 and radiocarbon dates from Late Paleoindian sites in Table 19.

Plainview Complex

The Plainview complex was first recognized based on excavation of an extensive bison kill at Plainview, Texas (Sellards et al. 1947). The projectile points from this bonebed were used
by Krieger to define the Plainview type (in Sellards et al. 1947). The type is most commonly reported in the Southern Plains region (Thurmond 1990; L. Johnson 1989; Baker et al. 1957) but is common in Kansas (Brown and Logan 1987), and occurs in Colorado as well (Lintz and Anderson 1989:116). Lanceolate points originally attributed to the Plainview type are also reported from southwestern Nebraska at the Lime Creek and Red Smoke sites (Davis 1953a, 1952; Wisdom 1957), but this assignment for Lime Creek has been questioned (Knudson 1983). The Red Smoke assemblage from Zone 88 (originally Level 88) yielded a significant series of projectile points which Davis (1953a) attributes to the Plainview type. He suggests that the Meserve-like specimens with beveled and shortened blades are simply reworked Plainview points.

Discussion of the Plainview complex is provided in Hofman (1989:38-40). Plainview points are distinguished by a lanceolate outline with a concave base, lateral edge grinding, and basal thinning. They share attributes with Goshen, Milnesand, Midland, Meserve, Dalton, Clovis, and Folsom points (L. Johnson 1989; Haynes 1991b; Leonhardy and Anderson 1966; Irwin 1968, Frison 1971a, 1993). Available radiocarbon dates from the Plainview site, Lubbock Lake, Lake Theo, Bonfire Shelter, and other Texas sites indicate that Plainview assemblages date from approximately 10,000 to 9,000 years ago (Holliday et al. 1983, 1985; Thurmond 1990:Table 6). In some cases, Plainview has become a catchall category for any unfluted, lanceolate, edge-ground, basally thinned point. The variability in the type assemblage also suggests a relatively broad range of base and blade forms as well as flaking patterns. Haynes (1991b) compared metric attributes of Goshen and Plainview points and showed them to be indistinguishable. One of the Clovis points from the Domebo mammoth site in Oklahoma was compared favorably with the Plainview type (Leonhardy 1966). Knudson’s (1983) technological analysis is of considerable significance in

<table>
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<th>Date</th>
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Table 19. Radiocarbon Dates from Central Plains Late Paleoindian Sites.

Table 18. Late Paleoindian Sites Reported in the Central Plains.

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<td>Scott</td>
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<td>Gordon Creek</td>
<td>Larimer</td>
<td>Plano</td>
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demonstrating the technological system of which Plainview points form a part. Similar technological studies of other late Paleoindian samples are needed.

Plainview Sites in the Central Plains.

**Red Smoke, Nebraska.** The Red Smoke site, 25FT42, has perhaps the best known and documented Plainview assemblage in the Central Plains region (Davis 1951, 1952, 1953a). This deeply stratified and multicomponent site on the north bank of Lime Creek in the Medicine Creek Reservoir area of Frontier County, southwest Nebraska was excavated between 1947 and 1952, with the primary work done between 1949 and 1952 under the direction of E. Mott Davis (Davis 1953a). More than 90 m² were excavated from Zone 88 which was the primary occupation level on the site and which produced the Plainview points and fragments. The occupation surface was approximately 30 cm thick and consisted of many dense concentrations of knapping debris of Niobrara jasper. Some concentrations of bone and a few surface hearths were also reported. The primary activity at the site appears to have been flint working and perhaps retooling of equipment. Many bifaces, cores, flakes, and much reduction debris was found as well as dozens of formal artifacts. The projectile points are compared to the specimens from the Meserve site in Hall County, Nebraska, and primarily to the Plainview type first identified at the Plainview bison kill in west Texas. The Meserve points from Red Smoke are argued by Davis to represent reworked Plainviews. The beveled blade edges on these specimens suggest use as knives, and they show a distinct type of blade reworking that is not common on early Paleoindian points from the Plains but is common on Dalton points on the eastern Plains margin (Myers and Lambert 1983).

Agate Basin Complex

The Agate Basin complex is named for the Agate Basin type site in eastern Wyoming (Roberts 1961) which was also referred to as the Brewer site (Agogino 1972). The complex is most well known from research at the Agate Basin site (Frison and Stanford 1982) and at the Hell Gap site located about 110 km southwest of Agate Basin (Irwin-Williams et al. 1973; Irwin 1968). Additional important sites include the Frazier site near Kersey, Colorado (Cassells 1983; Malde 1988; Worthington 1988). At present no Agate Basin assemblages are reported from Kansas or Nebraska, although Agate Basin projectile points have been found throughout the region (Brown and Logan 1987; Bozelli 1994; Barbour and Schultz 1936), including western Iowa (Anderson and Semken 1980) and Oklahoma (Wyckoff 1985, 1989b).

The age of Agate Basin components overlap with Folsom, Plainview, and Hell Gap dates, and range from about 10,500 to 9,500 years ago (Frison 1991b:Table 2.2). Two radiocarbon dates are available on soil humic acid from a unit immediately overlying the Agate Basin stratum at the Frazier site but have been reported differently and often incorrectly by different authors (cf. Cassells 1983; Greiser 1985:Table 7; Gunnerson 1987; Haynes and Hass 1974; Wheat 1979). The dates are 9650 ± 130 (SMU-31) and 9550 ± 130 (SMU-32) (Haynes and Hass 1974). These provide minimum ages for Agate Basin in the Central Plains region.

The diagnostic features of Agate Basin points include their generally long lanceolate shape, rounded to straight base, and relatively thick biconvex cross section. Discussion of Agate Basin technology is provided in Bradley (1991), Frison and Bradley (1982), and Shelley and Agogino (1983).

Central Plains Agate Basin sites

**Frazier, Colorado.** The Frazier site is located on the Kersey terrace on the south bank of the South Platte River in Weld County, Colorado. This bonebed may represent a processing area and at least 43 animals are represented based on left astragali (Worthington 1988:82). Limited remains of deer and canid are also reported (Greiser 1985:99). Excavations were directed by Marie Worthington between 1965 and 1967 exposing an area of about 288 m². Season of death was apparently winter to early spring (Todd et al. n.d.). The tool assemblage of about 93 specimens includes 10 Agate Basin points and fragments (see Cassells 1983:Figure 5.8; Greiser 1985:Figure 23a,b), endscrapers, side scrapers, bifaces, notches, spurs, beads, and denticulates (Worthington 1988; Irwin and Worthington 1970). A few possible modified bone pieces or bone tools may be represented. Several small concentrations of debitage were also recorded in the bonebed and probably primarily reflect reshaping of tools. Lithic materials include quartzite, jasper, Flattop chalcedony, and a significant percentage of Albite flint.

**Allen Site, Nebraska.** The Allen site, 25FT50, is located in the Medicine Creek Reservoir in Frontier County and was excavated between 1947 and 1949 primarily under the direction of Preston Holder and Joyce Wike (Holder and Wike 1949). Two primary occupation levels were identified and correlate with buried soils separated by about 45 cm of lighter colored sediments with minimal cultural materials. This was referred to as the Intermediate Zone sandwiched between the lower Occupation Level I (15-20 cm thick) and the upper Occupation Level II (12-18 cm thick). All three units were buried below about 6 m of terrace fill on Medicine Creek (Holder and Wike 1949:260-261). Radiocarbon dates and projectile points indicate the occupation levels reflect Paleoindian activity, but the cultural affiliation and precise chronology remain somewhat problematic. Bamforth (1991a:361) suggests that the projectile points from the lower occupation are referable to the Agate Basin type, but that obliquely flaked lanceolate points are also in the site collection and may be from Occupation Level II. Available radiocarbon dates suggest that possible Agate Basin and later components are present, and the site is included here with Agate Basin for convenience until final assessment has been made.

 Occupation Level I yielded 68 artifacts, evidence of nine hearths, and the majority of faunal material from the site (Holder and Wike 1949:261). Level I excavation included 15.37 m² of matrix, compared to 46.1 m² from the Intermediate Zone and 18.37 m² from Occupation Level II. Level II held evidence of 10 hearths and 26 artifacts. The projectile points are lanceolate and at least some have thinned bases. They were
initially compared with the Plainview type (Holder and Wike 1949:262), Wedel (1986:70) compares them with the Angostura type, and Bamforth (1991a:361) suggests that at least two specimens are Agate Basin points and others are obliquely flaked and so share at least this attribute with points in the Frederick/Allen complex discussed below.

Radiocarbon dates include three reported by Libby (1955; and Wedel 1986:71; Worthington 1957:138), which are not very consistent and have large standard deviations. These charcoal dates are 10,493 ± 1500 (C-470) and 8274 ± 500 (C-108a) from Occupation Level I and 5256 ± 350 (C-65) on a combined charcoal sample (Worthington 1957-138) indicates this date is based on soil) from both occupation levels. Reports on the associations and derivation of these dated samples are conflicting (Worthington 1957:138). New dates reported by Bamforth (1991a:360-361) for both occupation levels are more consistent, though still having large deviations. The new Occupation Level I dates are 10,260 ± 360 B.P. (TX-6596) and 10,600 ± 620 (TX-6594) which are comparable to the oldest of the previously run samples and are in general accord with other dates on Agate Basin (Frison 1991a). The Occupation Level II date is 8680 ± 460 (TX-6555), which is late for an Agate Basin date but is in agreement with dates on obliquely flaked lanceolate points from other sites (Frison 1991b) as discussed below (see Bamforth 1991a).

Projectile points await detailed description and comparison, but Bamforth (1991a:361) identifies two Agate Basin points from Occupation Level I. Unprovenienced points include specimens with parallel oblique flaking. Holder and Wike (1949:262) indicate that the points and fragments were about evenly distributed between the upper and lower occupation levels. Numerous bifaces representing biface reduction were recovered from the site and reflect the intensive use of the locally available Niobrara or Republican River jasper. Bamforth (1991a:362) reports that most of the bifaces represent early stage reduction, mostly stage 2 in Callahan's terminology. There were 94 (68.6%) stage 2 bifaces, 34 (24.8%) stage 3 bifaces, and only 9 (6.6%) stage 4 bifaces. Twenty points and fragments, a few drills, 144 worked pieces and flake tools, and 29 trapezoidal scrapers were recovered. This last category includes specimens comparable to Clear Fork gouges from Texas and Oklahoma (Hofman 1978) and Munkers Creek gouges from Archaic sites in eastern Kansas (Witty 1982). Such tools occur in late Paleoindian contexts in Texas at several sites (Turner and Hester 1994; Birmingham and Hester 1976). The Allen site assemblage also includes eyed needles, bone awls, abraders, hammerstones, and a grooved spherical piece of Niobrara chalk which is suggested to have been a bola stone.

Faunal material is primarily from the lower occupation level and includes bison, antelope, deer, coyote, rabbit, mice, prairie dog, and rare beaver and fish. Some reptiles, amphibians, and birds are also represented as are freshwater mussels. Fauna from Occupation Level II was limited essentially to bison. Whether some of this assemblage may represent naturally occurring background fauna is uncertain, but Holder and Wike (1949:261-262) indicate that almost all of the large mammal bone had been modified by breakage, cutting, or other activity.

Hackberry seeds and small gastropods also occur but are not attributed to human activity. Numerous nests of mud dauber wasps were also found and it has been suggested that they were used as food (Wedel 1986:71), and that they reflect the presence of structures at the Allen site. It is certainly possible, however, that the nests were built against nearby rock exposures or cutbanks along the creek. Though no structural remains were found, numerous surface hearths were documented. These ranged from intensively to lightly used and indicate repeated and perhaps intensive occupation. Holder and Wike (1949:262) refer to "windrows of broken and disarticulated bone scattered along the old surface" of Occupation Level I. These may reflect some natural formational features at the site which could result from erosional processes. These "features" were apparently separated from the hearths. The ongoing study and evaluation of the Allen site by Bamforth and his colleagues will aid considerably in improving our understanding of the site and its potential relationship with the Agate Basin and other complexes.

Hell Gap Complex

The Hell Gap complex is named for the Hell Gap site located near Guernsey in eastern Wyoming (Irwin-Williams et al. 1973; Irwin 1968; Sellet and Frison 1994). This is an important stratified campsite in a protected canyon/foothills setting. Several distinct occupation areas and cultural units ranging from Goshen to Lusk are represented. Stratigraphic evidence here and at the Agate Basin site as well as radiocarbon dates indicate that Hell Gap assemblages are slightly younger than Agate Basin ones and generally date between 10,100 and 9600 B.P. (Frison 1991b; Frison and Stanford 1982; Irwin-Williams et al. 1973).

Other reported Hell Gap sites include Sister Hill, a campsite in northern Wyoming (Agogino and Galloway 1965); Casper, a bison kill in a sand dune situation in central Wyoming (Irwin 1974); and Seminole Beach (Miller 1986), a camp and workshop site. Hell Gap points are reported throughout the Central and Southern Plains region (Brown and Logan 1987; Mallouf 1990; Polyak and Williams 1986; Thurmond 1990), but documented assemblages south of Kansas are not known.

Central Plains Hell Gap Sites

Jones-Miller Site, 5YM8. In the Central Plains, the best known Hell Gap site is Jones-Miller (Stanford 1974, 1975, 1978, 1979b, 1984), an extensive bison kill located in eastern Colorado near the Kansas and Nebraska state lines. The site is on a terrace of the Arikaree River, a few miles downstream (east) from the historic Beaver's Island battle site, and was discovered by the late Robert Jones in 1972. Jones-Miller is in many ways one of the more important bison kill sites yet reported from the region (Stanford 1978, 1979b, 1984; Todd and Stanford 1992). The site is an extensive bonebed estimated to contain more than 250 bison representing at least two kill events which occurred during the winter. A radiocarbon date of 10,020 ± 320 (SI-1989) is available for the site. Lithic materials include a significant amount of Niobrara (Republican River) jasper perhaps from sources in the area of the Tim Adrian or Walsh
sites in Kansas. Also Flattop chaledony with its source near Sterling, Colorado was a significant source for the Jones-Miller site assemblage and Albates flint from the Texas Panhandle is also represented. The materials may have been introduced to the site when the group making the kills was moving from different directions. Several hearth areas are present around which various flint knapping and bone processing activities were conducted. There is no evidence for a post corral, but it is possible that deep snow, logs, or brush was an aid in entrapping or containing the bison in this limited area.

An important feature near the center of the bonebed at Jones-Miller was a postmold (22 cm in diameter and 46 cm deep), next to which was found a miniature Hell Gap point, a bird bone probably representing a flute, and remains of a butchered dog. This feature has been interpreted to represent a shaman's "medicine" pole analogous to those reported in early historic time for other Plains groups.

Tim Adrian Site. In northwestern Kansas, O'Brien (1984a) reported the Tim Adrian site which is a lithic quarry/workshop with Hell Gap evidence at a Niobrara jasper source in Norton County. A Hell Gap point and a number of tools were found with an abundance of workshop debris. It is notable that numerous Hell Gap points made from Niobrara jasper have been identified in museums and private collections in western Kansas. On the Saline River in the northeastern Grove County area, a cache of large jasper bifaces (the Walsh cache) which appear to be early stage Hell Gap points is also known (Stanford 1984).

Gordon Creek Site. The Gordon Creek burial (Breternitz et al. 1971; Cassells 1983) is one of the few Paleoindian-age human burials documented in the Plains region (Table 20). This burial, considered by Irwin (1971) as possible Agate Basin age, has been radiocarbon dated to 9700 ± 250 (GX-0530). The remains of a 25-30 year-old female about 152 cm tall (a little under 5 feet) were discovered in this isolated burial in north-central Colorado, northwest of Fort Collins. The body was in a flexed position and was covered with red ochre. A fire on or near the body destroyed some of the evidence but is believed to have been part of the burial process or ritual. A number of artifacts were recovered with the remains, but none were diagnostic. They included three bifaces, a hammerstone, an endscraper, utilized flakes, a smoothed stone, cut bones, and perforated and broken elk teeth. Whether these materials were personal possessions or offerings, or both, is unclear.

<table>
<thead>
<tr>
<th>Table 20. Paleoindian Human Remains and Burials in the Plains.</th>
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<tbody>
<tr>
<td>Site/Location</td>
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<tr>
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<tr>
<td>Anzick, MT?</td>
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<td>Gordon Creek, CO</td>
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<tr>
<td>Browns Valley</td>
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<tr>
<td>Shifting Sands</td>
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<tr>
<td>Scharbauer</td>
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<tr>
<td>Ranier</td>
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</table>


Angostura Complex

Excavation in the Angostura Reservoir of South Dakota at the Long site in 1948 (Hughes 1949) yielded evidence of an early component(s) with lanceolate points originally named Long points. The site is located approximately 55 km east of the Agate Basin site. After continued fieldwork in 1949 and 1950, the point type was renamed Angostura (Wheeler 1954a, 1957). Three primary excavation areas were opened at Ray Long (Wheeler's final report has recently been published, 1995). A variety of tools and hearth areas were recovered. Worthington (1957:139) illustrates a specimen which has generally been assumed to represent a classic Angostura point but which is actually distinct from the specimens from the Long site (Hannus 1986:Figures 10, 11). Worthington (Worthington and Forbis 1965:22-23) later concluded that the specimens from the Long site were not typologically like Angostura but more similar to Agate Basin. She encouraged the abandonment of the type Angostura until a more detailed report on the Long site specimens was available. She further suggested that many specimens previously referred to as Angostura were more appropriately classified as Frederick based on research at the Hell Gap site. About the same time, others (Agogino and Rowner 1964) argued for the distinctiveness of the Agate Basin and Angostura types, and in so doing gave continued reason to distinguish the latter type.

Radiocarbon dates from the Ray Long site do little to clarify the situation. Two dates of 7073 ± 300 (C-604) and 7719 ± 740 (C-454) are on charcoal but not clearly associated with Angostura points (Thoms 1993:19). A third date, 9380 ± 500 (M-370), is a composite charcoal date from a zone which produced Angostura points in place. This latter date is certainly in the right order of magnitude given information on other late Paleoindian site chronology.

Reinvestigation of the Ray Long site between 1985 and 1994 by Hannus (1986) has focused on the stratigraphic, geomorphic, and paleoenvironmental aspects of the site area. This has added substantially to an understanding of the stratigraphic and formational history of the site and the relevance of the three original radiocarbon dates but has not fully clarified the typological problems. The site's stratigraphy is complex and continued investigations should provide clarification of the cultural and geologic layers. Multiple occupational surfaces and hearths are indicated, and a series of four new radiocarbon dates indicate that a pre-Angostura component is probably represented (Hannus 1986:Table 1). The new dates from hearth features in Trench F, just east of Area B excavated by Wheeler, indicate that multiple cultural components are probably represented. The dates, 8950 ± 140 (I-14239), 9540 ± 540 (I-14240), 10,400 ± 360 (I-14245), and 11,000 ± 310 (I-14241), are not yet associated with diagnostic artifacts but are derived from charcoal. The three oldest dates are from features at the base of Trench F at a depth of more than 2 m below the surface. A hearth and Clovis point base were recently discovered below the Angostura level (A. Hannus, personal communication, 1995). The younger date, perhaps of Angostura age, is from
about 1.5 m below surface and compares fairly well with previous dates from the site.

The relationships between the Long site Angostura points need to be critically compared based on technology and metric information with Agate Basin and Frederick point samples. Recent investigation at the Richard Beene site in Texas (Thoms 1993) has finally provided some well-controlled assemblage information on Angostura material from Texas, where the type is commonly reported and even divided into several varieties (Turner and Hester 1993; T. C. Kelly 1982; Thurmond 1990:Table 5, Figure 10), but where discrete assemblages have been essentially unreported. Some of the original Ray Long site diagnostic artifacts have been lost, but casts of some points are still available (Hannus 1986). Based on his recent reinvestigation of the site and available collections, Hannus (1986:96) writes, "Due to the limited number of points available, it is still premature to render a conclusive statement as to whether angostura as a Type is to be considered valid, or whether it should be discontinued to be subsumed under the Agate Basin complex of projectile points as a local variant, or be considered closer in affiliation to the more recent Frederick or Lusk types." One of the largest assemblages of projectile points considered to represent the Angostura type is from the Travis 2 site (33WW15) near Mobridge, South Dakota (Ahler et al. 1977; Toom 1994). This distinctive assemblage from a deeply stratified site may provide some critical insights into the Angostura cultural complex.

Cody Complex

The variety of sites and projectile point types which constitute the Cody complex represent a significant portion of the Paleolithic archeological record in the Plains and Rocky Mountains region. Cody complex is a term suggested by Worthington (1957:136) to designate the range of artifact types including Eden, Scottsbluff, and Cody knives which are believed to be closely associated based on research at the Horner site near Cody, Wyoming (Jepsen 1953; Frison and Todd 1987), the Finley site near Eden, Wyoming (Frison 1991b; Howard 1943; Moss et al. 1951; Satterthwaite 1957), Claypool, Colorado (Dick and Mountain 1960; Wheat 1972; Bradley and Stanford 1987), and elsewhere. The discovery of a Cody knife with the Alberta assemblage from the Hudson-Meng site in northwestern Nebraska, provided support to the argument that the Alberta complex could also be included with Cody (Agenbroad 1978a, 1978b). More recent technological analyses (Bradley and Frison 1987; Bradley and Stanford 1987; Ingbarg and Frison 1987; Huckell 1978; Read 1982; Wheat 1972, 1976, 1979) indicate that the typological relationships are complicated, and there are multiple models of the technological and historical relationships of the types in the literature.

At least 10 projectile point types have been defined which are considered to be part of the generalized Cody complex or technological tradition as envisioned here. These types include Alberta, Scottsbluff I, Scottsbluff II, Eden, Alberta/Cody I, Alberta/Cody II, San Jon, Firstview, and Kersey (see Table 21).

### Table 21: Cody Complex Projectile Point Types and Sources.

<table>
<thead>
<tr>
<th>Type</th>
<th>Sites</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>Hudson-Meng</td>
<td>Agenbroad 1987, Huckell 1978</td>
</tr>
<tr>
<td>Scottsbluff I</td>
<td>Claypool/Horner</td>
<td>Dick &amp; Mountain 1960; Bradley &amp; Frison 1987</td>
</tr>
<tr>
<td>Scottsbluff II</td>
<td>Larson Cache</td>
<td>Ingbarg &amp; Frison 1987</td>
</tr>
<tr>
<td>Scottsbluff III</td>
<td>Finley, Satterthwaite 1978, Wheat 1972</td>
<td></td>
</tr>
<tr>
<td>Eden</td>
<td>Claypool/Finley</td>
<td>Dick &amp; Mountain 1960; Satterthwaite 1957</td>
</tr>
<tr>
<td>Horner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firstview</td>
<td>Olsen-Chubbuck</td>
<td>Wheat 1972</td>
</tr>
<tr>
<td>Kersey</td>
<td>Jurgens</td>
<td>Wheat 1979</td>
</tr>
<tr>
<td>Alberta/Cody I</td>
<td>Horner 1 and II</td>
<td>Bradley &amp; Frison 1987</td>
</tr>
<tr>
<td>Alberta/Cody II</td>
<td>Horner I</td>
<td>Bradley &amp; Frison 1987</td>
</tr>
<tr>
<td>San Jon</td>
<td>San Jon, N.M.</td>
<td>Roberts 1940</td>
</tr>
<tr>
<td>Cody Knives</td>
<td>Horner, Claypool</td>
<td>Bradley &amp; Frison 1987</td>
</tr>
<tr>
<td></td>
<td>Hudson-Meng</td>
<td>Dick &amp; Mountain 1960; Agenbroad 1978b</td>
</tr>
</tbody>
</table>


For purposes of this review, I follow primarily the classification of Bradley and Frison (1987). They include Scottsbluff I and Eden points and Cody knives as part of the traditional Cody cultural complex as defined by Worthington (1957). Bradley and Frison also argue that the variability represented by Firstview and Kersey points can be easily accommodated by the reduction technology and hafting or rehafting of Scottsbluff and Eden points (also Bradley and Stanford 1987). I agree with this grouping as do several other investigators (Stanford and Patten 1984; Fulgham and Stanford 1982; Bradley and Stanford 1987; and cf. Greiser 1985:76). They also refer to this traditional Cody complex as the Scottsbluff/Cody technology. They see the Alberta/Cody point types as intermediate technologically (and chronologically?) between Alberta and Scottsbluff/Cody. Bradley and Frison (1987:229) indicate that a larger generalized Cody complex or technological tradition might be recognized, but they emphasize that the Scottsbluff/Cody and Alberta/Cody types are technologically distinctive and readily recognizable and provide an opportunity to trace the technological development of the Cody complex. For present purposes, I have included all these types, including Alberta, within the Cody complex which might be thought of as a technological tradition and type cluster.

The spatial distribution of point types at the Horner site and the radiocarbon dates available from there also help in untangling the technological and chronological relationships between Cody industries. Horner I, excavated as two discrete areas in 1949, 1950, and 1952 in the northern portion of the site complex, yielded distinctive assemblages. The South excavation (1949, Area 1 of Horner I) and North (1950, 1952, Area 2 of Horner I) excavations had radically different
frequencies of projectile point types. The North (1950, 1952)
Area 2 excavation yielded almost exclusively Eden points (16
of 19 from the Horner I excavations), while the South (1949)
Area 1 excavation had mostly Scottsbluff points (10 of 13 from
Horner I). Furthermore, no Eden or Scottsbluff points were
recovered from the Horner II (1977, 1978) excavation located
35 to 40 m south of the 1949 excavation. In the Horner II
excavation, only Alberta/Cody points were recovered and
radiocarbon dates indicate that this area is as much as 1,000
years older than the Horner I assemblages (Prison and Todd
1987). In addition, Alberta/Cody points were common (19 of
21 from the Horner I areas) in the 1949 excavation at Area 1 of
Horner I where Scottsbluff points were also common. Whether
there is a significant age difference between Areas 1 and 2 of
Horner I remains unclear. The spatial evidence suggests a close
relationship between Alberta/Cody and Scottsbluff types and
technological analyses indicate close links between Alberta/
Cody and Alberta points and between Scottsbluff and Eden
points (Bradley and Prison 1987). Scottsbluff and Eden points
occur together at the Finley (Moss et al. 1951), Carter/Kerr-
McGee (Prison 1984) and Claypool sites (Dick and Mountain
1960).

The Cody complex, then, is not as simple a taxonomic
grouping as it once was, nor is it well understood throughout
the Plains region as a whole. It is apparent, however, that there
is both chronological and technological variability represented
in the Cody cultural complex or technological tradition as
reflected by the diagnostic projectile point types. The
interpretation of this variability is somewhat limited by
inadequate chronological control for most assemblages,
including that from the Horner site (Prison 1987).

Radiocarbon dates from Horner, Finley, Jurgens, Dreier-
Frasca, Hudson-Meng, and Olsen-Chubbuck indicate a time
frame of 10,000 to 8,800 years ago for the Cody complex (Prison
1987:105, Table 4.1). A date from the Mammoth Meadow site
in Montana, 9590 ± 90 (T0-1976), also supports this time frame
(Bonnichsen et al. 1992). On the Southern Plains, radiocarbon
dates for Firstview levels from the Lubbock Lake site indicate a
similar time span (Holliday et al. 1985; E. Johnson 1987).

Cody complex radiocarbon dates for the Central Plains are
listed in Table 22. The earliest date in the region is from Olsen-
Chubbuck and is 10,150 ± 500 B.P. based on bone (Wheat 1972).
This date has generally been considered as too early, but
radiocarbon dates on bone in the region generally date too
recent, not too old. Also, the early dates now available from
Horner (Prison and Todd 1987) and Hudson-Meng (Agenbroad
1978a; Todd and Rapsor 1991), which average about 9700 B.P.,
indicate that the Olsen-Chubbuck dates may not be too old
(within one sigma). If correct, then the relatively contemporary
technological variability in Cody assemblages (Alberta,
Scottsbluff, Alberta/Cody) offers some interesting explanatory
problems. What is the significance of lithic material quality,
variability, social groups, and perhaps even knapping specialists
during Cody times? Dates from other Central Plains Cody
components Frasca, Nelson, Wetzel, Caribou Lake, and Lamb
Spring are younger by 1,000 or more years than the Olsen-

<table>
<thead>
<tr>
<th>Site</th>
<th>Complex Type</th>
<th>Date</th>
<th>§</th>
<th>Lab No.</th>
<th>Reference</th>
</tr>
</thead>
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<tr>
<td>Olsen-Chubbuck</td>
<td>Firstview</td>
<td>10,150</td>
<td>500</td>
<td>A-744</td>
<td>Wheat 1972</td>
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<td>Jurgens 3</td>
<td>Cody</td>
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<td>90</td>
<td>SI-3726</td>
<td>Wheat 1979</td>
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<td>Cody</td>
<td>8460</td>
<td>140</td>
<td>I-5449</td>
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<td>Frasca</td>
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<td>90</td>
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<td>Fulgham &amp; Stanford 1982</td>
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<td>Lamb Springs</td>
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<td>240</td>
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<td>Wetzel</td>
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<td>135</td>
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<td>Nelson</td>
<td>Cody</td>
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<td>80</td>
<td>SI-4988</td>
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<td>Alberta</td>
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<td>160</td>
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<tr>
<td>Lime Creek</td>
<td></td>
<td>9524</td>
<td>450</td>
<td>C-471</td>
<td>Wedel 1986</td>
</tr>
</tbody>
</table>

Chubbuck date. The Lime Creek, Nebraska date is closer (9524
± 450 B.P.), but it is not unquestionably of Scottsbluff age. A
similar divergence is evident in the dates from the Horner I
and Horner II sites (Prison and Todd 1987) and is at least in
part attributable to bone dates that are too young based on

Additional information on the Cody occupation of the Plains
region is documented at the Mammoth Meadows site
(Bonnichsen et al. 1992) where remains of a possible Cody
rectangular structure with stone-lined walls is reported. Within
this feature was found a concentration of red ochre. Ochre was
also found covering the surface of several Cody artifacts.
Evidence of a possible circular stone lined structure is also
reported by Stanford and Patten from the R-6 lithic workshop
and campsite in northeastern New Mexico. A Scottsbluff burial
is reported by Mason and Irwin (1960) from the Renier site in
Wisconsin which consisted of a cremation and associated
projectile points.

The economy of Cody tradition people was focused on
bison, but a variety of other species are represented from sites
such as Mammoth Meadows (Bonnichsen et al. 1992), Medicine
Lodge Creek (Prison 1991b; Walker 1975), and Lime Creek,
Nebraska (Davis 1962). Bison kills range from a few to several
hundred bison and were made throughout the year
(Bonnichsen et al. 1987; Todd 1991). Seasonality of Cody bison
kills is as follows (Todd 1991:Table 11.1): Scottsbluff, late spring-
summer; Olsen-Chubbuck late summer-early fall; Hudson-Meng
fall; Finley, Horner I, and Horner II late fall to early winter; and
Carter/Kerr-McGee early winter. The traditional interpretation
that bison kills occur primarily in the late fall or winter (e.g.
Bamforth 1988, 1991b) simply does not hold for this significant
part of the Paleoindian record.

Several Cody complex sites in the Central Plains region have
received detailed investigation. Numerous other sites are
known or reported based on limited surface finds or severely
mixed components (Greiser 1985).
Central Plains Cody Complex Sites

Scottbluff Site. This is the type site for the Scottbluff point type, but interestingly, only one of the eight artifacts is a complete Scottbluff I type point (Barbour and Schultz 1932; Schultz and Eiseley 1935). Three other points were found, one is most similar to Plainview, one compares to the Scottbluff II type, and the last is a tip fragment. Four tools were also collected from the bonebed. The bonebed was a relatively thick deposit and an MN1 has not been established, nor is it clear whether one or multiple kill events are represented. Season of the kill(s) has been determined based on tooth eruption and wear to have been late spring to summer (Todd et al. 1990).

Claypool Site. This site is located in a dune field in Washington County, Colorado. The primary document on this important surface collection is Dick and Mountain (1960; Malde 1960; see also Womington 1957), but subsequent geological investigations are reported by Stanford and Albanese (1975), and additional artifact analysis is provided in Bradley and Stanford (1987). The site collection was made primarily by Bert Mountain and Perry Anderson with limited excavation in 1953 by the University of Colorado (Dick and Mountain 1960). The site has been interpreted as a camp rather than a kill situation (Dick and Mountain 1960:225). The assemblage is dominated by "square-based" points (Bradley and Stanford 1987) of the Eden and Scottbluff types (about 60), but a small number (N=15) of non-Cody complex points were also found, including Clovis, Folsom, Midland, Plainview, Hell Gap, Agate Basin, and a few Archaic points. Cody knives are also well represented, and there are a variety of scrapers, drills, and other tools. A bonebed was also present at the site but was severely deteriorated and unstudied. The lithic material at Claypool includes a number of pieces which are similar to Madero formation chert, comparable to that which dominates the R-6 workshop/campsite assemblage in northern New Mexico (Stanford and Albanese 1975; Stanford and Patten 1984). Also, the Eden/Scottbluff technology at Claypool is very similar to that from the Horner I site (Bradley and Frison 1987).

Hudson-Meng Site, 25SX115. Hudson-Meng, located northwest of Crawford in Sioux County, Nebraska, is the largest Paleoindian-age bison bonebed known in the New World (Agenbroad 1978a). Hundreds of bison are represented in association with a relatively few Alberta projectile points and tools. Testing at the site began in 1968 and more intensive work was conducted from 1971 through 1975. Remains of about 400 animals (MNI of 396 for humerus and tibia, Agenbroad 1978a:Table 1) were documented and it is estimated that as many as 600 animals may be represented at the site. It is unclear how many kill events may be represented, but the season of death was fall. It is interesting that only 20 projectile points were recovered from the excavated area, a small number given the number of animals present. One Cody knife (Figure 31), three gravers, 14 flake knives, one preform and three scrapers were also found in the bonebed excavations (Agenbroad 1978a:85). More than 600 m² was excavated and there was more than 100 m³ of trenches and tests, and it is notable that it was the fourth year of testing before an artifact was found in situ with the bones (Agenbroad 1978a:5, 9).

Continued research at the Hudson-Meng site since 1991, supported by the U.S. Forest Service to enhance potential site development, has been directed toward a more complete understanding of the site's formation history and processes of bonebed formation and subsequent modifications (Todd and Rapson 1991). The initial puzzle of why skulls were so rare at the site has been resolved through detailed taphonomic study. The dense inner ear, petrous portion of skulls is well represented, but the less durable cranial elements have been lost to deterioration due to their higher than average "weathering profile." When the majority of carcass elements became buried, the crania were generally left exposed and suffered more prolonged weathering by comparison to other flat-lying elements (Todd and Rapson 1991). The puzzle as to how the bison were killed and how many kill episodes may be represented remains, despite continued investigation of the site's geomorphology and paleotopography. A series of new radiocarbon dates generally support the previous dates and indicate that the bonebed dates to about 9700 B.P. The artifacts found in the recent excavations have occurred several centimeters above the bone level.

Lime Creek Site, 14FT41. Lime Creek is one of three important and deeply buried Paleoindian sites in the Medicine Creek drainage (Wedel 1986; Davis 1953a, 1962; Bamforth 1991a; Holder and Wike 1949). Lime Creek represents a camp and lithic workshop which was exposed by creek bank erosion, and the primary cultural level Zone I was buried nearly 14 m below the surface (Davis 1962). Dynamite and bulldozers were used to remove overburden in order to gain access to the cultural levels prior to flooding of the site by Medicine Creek Reservoir.

This location yielded diagnostic Cody complex projectile points and fragments in occupation Zone I. One of these was originally referred to as a Milnesand point (Davis 1962), but the form and distinctive flaking conforms well with points from other Central Plains Cody assemblages such as Claypool. Numerous projectile point preforms originally called "Lime Creek Knives" were recovered from the site, and the Zone I occupation can best be interpreted as a workshop and camp location (Wedel 1986:Plate 4.4). The site is located near Niobrara jasper outcrops, and this was the dominant material represented in lithic artifact assemblage (Davis 1962:41).

Of the more than 200 artifacts reported from the site (excluding lithic debitage), 158 are from Zone I, and these include a variety of scrapers, bifaces, preforms, flake tools, cores, and several ground stone pieces (Davis 1962:Table 1). An area of approximately 133 m² was excavated in Zone I. Fauna from Zone I is dominated by antelope and beaver, but bison is most common in the higher later Paleoindian component of Zone III. Limited bones of bison, deer, elk, prairie dog, gopher, jackrabbit, raccoon, and coyote or dog are also present in Zone I. Beaver may have been emphasized because of their pelts or fat as the site was occupied during winter when fats and warm clothing would have been at a premium. Bison from Zone I are
interpreted as *Bison antiquus*, but the sample is small. Bison remains were apparently the only bones recovered from Zone III. The Zone III bison are also noted to have been larger than those from Zone I (Davis 1962:29); this may simply reflect sexual dimorphism, small samples from Zone I, or seasonal differences in herd composition and site use (cf. Speth 1983).

A radiocarbon date of 9524 ± 450 (C-471) was derived on charred wood from Zone I. Zone III received less intensive study but contained a later Paleoindian component(s) which included a Plainview-like point, a square-based point, and an obliquely flaked lanceolate which is most comparable to Frederick and Allen material. This provides support for evidence from other locations, such as Hell Gap, Wyoming, where Frederick postdates Cody material (Irwin-Williams et al. 1973).

**Olsen-Chubbuck Site.** Perhaps more than any other site, Olsen-Chubbuck has served to characterize the nature of Paleoindian bison hunting in the Great Plains region as detailed in numerous archeology text books and summaries. This is in large part due to the innovative, creative, and detailed analytical approach brought to the site by Joe Ben Wheat (1972). Wheat's research at Olsen-Chubbuck helped demonstrate the critical importance of bonebeds, and not just the artifacts in them, as an interpretive resource which can contribute to an understanding of the archeological record and prehistoric behavior (also Frison 1970, 1974; Frison and Todd 1987; Reher and Frison 1980). Olsen-Chubbuck is located in Cheyenne County, Colorado near the communities of Kit Carson and Firstview. The excavation was conducted between 1958 and 1960 following initial testing by Jerry Chubbuck and Sigurd Olsen. About 80 m² were excavated along an ancient arroyo which had been used to trap the bison as they stampeded across it. About 190 bison were killed in this location during the late summer or early fall (Wilson 1974). The bison were apparently stampeded across the arroyo from northwest to southeast where many were killed or trampled and speared. Interesting patterning is evident in the butchering and sorting of carcass portions along the bonebed.

Sixty artifacts were recovered from the bonebed and immediate vicinity, of which 27 are projectile points and fragments. This is a ratio of only 0.14 points per bison (27/190) which suggests fairly good recovery of weapon tips and perhaps that many animals died from the fall or trampling. Lithic materials represented include Knife River flint from western North Dakota and Alibates flint from the Texas Panhandle. The projectile points from Olsen-Chubbuck were used by Wheat as the basis for defining the Firstview type, which others believe to fall within the technological and morphological range of Edge and Scottsbluff (Bradley and Stanford 1987; Bradley and Frison 1987). The sample compares well with that from Claypool, which Wheat refers to primarily as San Jon points, and to Lime Creek, Nebraska, MacHaffie, Montana, and San Jon, New Mexico. The San Jon points have minimal shoulders often apparently produced only by grinding, whereas the Firstview points lack obvious shoulders. All fall within the “square-based” points discussed by Bradley and Stanford (1987).

**Figure 31. Cody complex artifacts from the Central Plains. a-c: Olsen-Chubbuck site points, CO; d: Cody knife, Hudson-Meng site, NE; e: Cody knife, Claypool site, CO; f: Scottsbluff point, Lime Creek site, NE; g-i: Jurgens site points, CO.**

Other artifacts include a few endscrapers, side scrapers, and flake tools, several of which were manufactured from Alibates flint. A hammer/anvil stone and a piece of limonite were collected and a few bone artifacts are represented including a possible needle preform.

A single radiocarbon date on bone is available for the Olsen-Chubbuck site. This date, 10,150 ± 500 (A-744) is at the early end of the available Cody complex dates. New bone dates are being assayed at present.

**Jurgens Site.** Jurgens is a complex of three activity areas or artifact concentrations located on the Kersey terrace of the South Platte River near the town of Kersey in northeastern Colorado (Wheat 1979). Excavations were conducted by Wheat during 1968 and 1970, revealing three distinct areas associated with bison processing and camp activities. A total of 248 m² was excavated in the main areas at Jurgens with numerous additional corings and tests. The recovered artifacts totaled
represent a distinct type which he terms Kersey and reworked Kersey points. Others have generally included these within the Cody complex and do not see a substantial difference between the Jurgens site specimens and Eden and Scottsbluff point variability. A single radiocarbon date of 9070 ± 90 (SI-3726) is available for Area 3.

**Dreier-Frasca Site.** The Dreier-Frasca or Frasca site is located northwest of Sterling in northeastern Colorado and was investigated in 1979 and 1980 by Fulgham and Stanford (1982). This Scottsbluff bison kill site appears to have been an arroyo trap and yielded evidence of about 60 bison with numerous articulated units. Season of the kill was winter, and a radiocarbon date of 8910 ± 90 (SI-4848) is reported. Two areas of bone concentration are documented, the largest, Area 1, covers about 28 m² and is up to a half meter in thickness. Area 2 is separated by about 100 m and is a smaller thin bonebed covering about 9 m². Nearly 8,000 bones and bone fragments were recovered from Area 1 including numerous articulated units and complete carcasses of six animals. At least 56 bison are represented by the bone in Area 1, plus remains of perhaps five bison fetuses. Direct evidence of butchering is minimal. A large dog or wolf is also represented in the Area 1 fauna. Eight stone artifacts were recovered from Area 1 including seven Cody (Eden and Scottsbluff) points and fragments and a flake knife. Sixteen chert flakes were also recovered in Area 1. Lithic materials include local chert and quartzite and Flattop chaledony probably from Flattop Butte about 35 km northeast of the site.

Area 2 produced about 190 bones with few articulations representing at least four bison. Two flakes but no diagnostic artifacts were recovered. Dentition studies and the fetuses indicate that the kill(s) occurred in winter.

**Lamb Spring Site.** Lamb Spring, located southwest of Denver at Littleton, Colorado, was first excavated by Wedel in 1961 and 1962 who investigated the Eden/Scottsbluff component, excavating about 216 m², and identified a potentially very early lower component. Investigations between 1979 and 1981 were directed by Dennis Stanford and focused on the lower pre-Clovis-age deposits (Rancier et al. 1982; Stanford et al. 1981; Fisher 1992) exposing about 116 m² to a depth as much as 3.5 m. The Cody component at Lamb Spring was apparently a bison kill with the bonebed situated in an old channel deposit near a spring vent. The remains of at least 22 bison are represented. Eight Cody points and fragments were recovered. Two radiocarbon dates on bone produced only one that was accepted by the researchers (Rancier et al. 1982) of 8870 ± 350 B.P. (M-1463), and a second which is somewhat young for Cody (7870 ± 240, SI-45). Overlying the Cody component(s) is evidence for Archaic (McKean complex) occupation.

**Wilber Thomas Rockshelter.** The lowest cultural level at Wilber Thomas Rockshelter, 5W145, in northern Colorado south of Cheyenne, Wyoming yielded a Scottsbluff point base and a flake tool (Breternitz 1971:Figure 6) well below most other cultural material. This find, and a similar occurrence in Deluge Shelter in the Dinosaur National Monument in northwestern Colorado (Leach 1970; Cassells 1983:64), probably indicate the
use of small shelters as bivouacs or temporary camps by Cody complex peoples in the central Rocky Mountains region.

Frederick/Allen Complex

In general, the latest Plains Paleoindian cultural complexes are even less well understood than the earliest ones. The period from 9,500 to 8,000 years ago was a critical one for technological, economic, and environmental change in the Plains region. During this period and soon thereafter, fundamental changes were occurring in the climate and ecology of the region and this is apparently reflected in a changed technology and settlement system during the late portion of the early Holocene. By 7000 B.P., the Central Plains region was a very different place than it had been at 10,000 years ago. The nature of the transition between the Paleoindian and Archaic cultural traditions, and the similarities and differences between these archeologically recognized groupings, remain to be adequately investigated. The latest Plains Paleoindian technological complexes are recognizable by lanceolate unfluted projectile points and other distinctive tools forms.

One of the distinctive markers of this late Paleoindian period is the common occurrence of oblique parallel flaking on lanceolate projectile points (Frison 1991b). According to Frison (1991b:74), "Angostura, Frederick, James Allen, Lusk, and others may be local or regional variants of the terminal Paleoindian manifestation for the Northwestern Plains." To this list in the Central Plains, we need to add Meserve and Dalton. The Allen and Frederick complexes are two of these late Paleoindian complexes which are combined here because of apparent similarity (Irwin 1971). The Jimmy Allen site near Laramie, Wyoming was studied by Mulloy (1959) and provided the basis for the Allen complex (not to be confused with the Allen site on Medicine Creek in Nebraska). The bison kill at the Allen site yielded a minimum radiocarbon date of 7900 ± 400 derived from bone. Thirty points and fragments were recovered with a minimum of 15 bison represented. The 38 tools included six scrapers and two flake tools or knives. The projectile points were well made, having oblique parallel flaking, deeply concave bases, and nearly parallel to slightly convex blade edges. Many were manufactured from high quality quartzite.

Similar points from the Hell Gap site were used to define the Frederick type (Irwin 1968; Irwin-Williams et al. 1973). The Frederick component at Hell Gap included possible evidence for a temporary structure in Area 1 (Irwin 1971). Available radiocarbon dates indicate that the Frederick complex dates between about 8,400 and 8,000 years ago (Frison 1991b). Benedict (1992) reports that most terminal Paleoindian obliquely flaked lanceolate points from the Rocky Mountains in Colorado are made from quartzites, especially Dakota orthoquartzite. The Caribou Lake site (5GA22) in Grand County represents a Paleoindian lithic workshop where this material was procured.

Artifacts from the Betty Green site and Hell Gap site have been used to define the Lusk complex which is here included with Frederick/Allen (Greene 1967) with which it is generally assumed to be related (Frison 1991b). Lusk material may be slightly later than and perhaps derived from Frederick/Allen.

Norton Bonebed, Kansas. The Norton site, 14SC6, was discovered in the late 1970s during quarrying operations in a sand pit on Ladder Creek in Scott County, Kansas (Hofman et al. 1992, 1995; Hill and Hofman 1992, 1995). The site was brought to archeological attention by Charlie Norton in 1992 and preliminary excavations in 1992 and 1993 yielded an assemblage of generally fragmentary bison bone, several hundred flakes, scrapers and cutting tools, and point fragments. A complete projectile point was found with the bones in the bank exposure prior to excavation, and additional point fragments were found during excavation (Figure 32). Two of the projectile points have concave bases and oblique flaking, but the overall form is broader and with more convex edges than typically found on Allen points. These pieces are, however, similar to a point from the Clary Ranch site in Nebraska (see below) which was compared to the Frederick type. The base of a third point appears to represent a square-based or Cody complex artifact, and its potential association with the obliquely flaked points remains unclear.

The sand and gravel quarrying operation which originally exposed the bonebed deposit was terminated once the bones

![Figure 32. Artifacts from the Norton Bonebed, Scott County, Kansas. a-c. Allen Points; d. Cody Point base; e, b. endscrapers; f, g. flake tools.](image-url)
were recognized. Subsequently, more than a decade of erosion has occurred on this vertical bank resulting in an unknown amount of slumpage and site loss. The bones occur on the floor, along the margins, and in the brown silt fill of an old channel which had cut into the underlying Pleistocene-age sand and gravel deposit that was the focus of quarrying activity. Mammoth, horse, turtle and other Pleistocene faunal remains have been found in this sand and gravel. Spoil dirt from quarrying operations has been deposited on top of the site in some areas resulting in a maximum depth below surface for the bonebed of about 5 m in the western excavation area. To the east and north the bonebed is more shallow reflecting both prehistoric and modern topographic factors. The ancient channel or gully apparently drained to the north toward Ladder Creek, but the head wall and most of the western margin of this gully have been removed as a result of quarrying activity. The remains of at least eight bison, and probably many more, have been recovered from the channel fill and margins. It is assumed that the old arroyo was a significant feature used in the trapping of these bison, but substantial postdepositional movement has occurred and much of the bone excavated from the channel fill has been moved or rearranged by water action and slump blocks. The number of kill events is unknown and the season has not been determined. Although faunal remains are dominated by bison, a few elements of antelope are also represented.

Three radiocarbon dates are available for the site, two on humates from a late Holocene soil which caps the old arroyo and one on bison bone. The total humate samples from the 45 cm thick soil are 410 ± 50 (TX-7815) for the topmost portion and 1790 ± 60 (TX-7941) for the bottom of the soil. This provides a minimum age for the end of filling and stabilization of the gully containing the bison bone. The bone collagen date of 9080 ± 60 (CAMS-16032) is based on a humerus found near the location of an Edwards chert endscraper and the original point find.

Lithic artifacts include several unifacial tools in addition to the projectile points. An endscraper of chalcedony (from the local Ogallala Formation) and another of Edwards chert (from central Texas) were found among the bone in the gully fill. Unifacial tools of basalt (from local gravels) and Flattop chalcedony are also represented. The points are made from quartzite, Niobrara jasper, Albates, Flattop chalcedony (the square based specimen), and fossil wood (an impact damaged tip). Lithic debitage is dominated by small retouch flakes made predominantly of Niobrara jasper, but with other lithic types including opaline, Florence, Albates, basalt, quartzite, and Flattop represented. Further investigations are planned for the site and it should be possible to learn more about the seasonality, assemblage, site history, number of episodes of site use, and cultural affiliations.

**Clary Ranch, Nebraska.** Excavation in 1979 at Clary Ranch in Garden County, Nebraska revealed a bison kill/processing site with projectile points comparable to the Frederick and Meserve types (Myers et al. 1981). Clary Ranch (25GD106) was buried by about 2 to 15 m of sediments in a terrace-2 fill on Ash Hollow Creek. The bonebed was in a water-deposited silt and was capped by a high energy deposit containing silstone slabs and then recent alluvium. The bones were in relatively fragile condition, but an area of 50 m² was exposed and about 40% of the bison remains was collected. Nonbison fauna and snails were also collected. In addition to bison, box turtle and canid remains were present. A canid humerus had been grooved and snapped, perhaps in the manufacture of beads. Most of the bison material was highly fragmented, but this may be due in part to natural processes. The number of individuals is about 12 (M.G. Hill, personal communication 1994; Myers et al. 1981; originally reported an MNI of 7 or 8). Tooth eruption and wear data suggest a late spring or early summer kill (Myers et al. 1981).

Two projectile points, more than a dozen flakes, a point tip, and a knife were collected from the site. The two complete points were recovered in the bonebed. The largest is referred to as a Frederick point and is made from Niobrara (Republican River) jasper. The second point has a reworked blade and is referred to as Meserve. This specimen is made from Flattop chalcedony. The specimens are closely comparable to points found at the Norton Bonebed in western Kansas.

**Pryor Complex**

In the Rocky Mountains and foothills adjoining the western Plains the latest cultural complex usually attributed to Paleoindians is recognized by parallel-oblique flaked lanceolate or slightly stemmed projectile points with concave bases and alternate beveling on the blade edges (Frison and Gray 1980; Frison 1991b, 1992). The complex takes its name from Pryor Mountain on the Wyoming-Montana border where research by Husted identified a series of rockshelters with Pryor Stemmed points in the lowest levels (Husted 1969). Research at a number of additional sites indicates a time frame from about 8300 until 7800 for Pryor Stemmed and associated assemblages (Frison 1991b:71; Frison and Grey 1980). In contrast to earlier Paleoindian assemblages, components with Pryor Stemmed points are found in numerous cave sites (Frison 1992). Also, economic orientation was apparently not focused on bison but on other species. Artifacts which may represent the Pryor complex are present in southeastern Wyoming and occur in limited numbers in northern Colorado’s front range (Benedict 1992:348).

**Meserve Complex**

In much of the Central Plains, lanceolate Paleoindian projectile points with beveled blade edges or steeply reworked distal ends are classified as Meserve points. This type takes its name from the Meserve site south of Grand Island in Hall County, Nebraska (Davis 1953a; Meserve and Barbour 1932; Barbour and Schultz 1936; Schultz 1932; Wormington 1957). The remains of at least two bison have been found in association with two projectile points in a soil horizon buried by more than a meter of sediment (Barbour and Schultz 1932a:Figure 168). The site was investigated several times, initially by high school
students in 1923, who donated a bison skull to the museum at Grand Island College where it attracted the interest of F. G. Meserve. Meserve was a biology professor at Grand Island College and later at Northwestern University. In 1923, he returned with a number of helpers and excavated at the site recovering another skull, postcranial material, and the first Meserve point. The point was found in place below the left scapula of bison No. 1 about "two inches back of the glenoid cavity" (Meserve and Barbour 1932:240). Meserve later donated this point and the collections to the Nebraska State Museum (Barbour and Schultz 1932a). Two essentially complete animals were recovered by this work. In 1931, a crew led by C. B. Schultz excavated at the site recovering additional material including a second projectile point, very similar to the first, found in place among ribs and near vertebrae. These were apparently the only artifacts found in the deposit, and it is unclear whether more than two bison were represented.

The Meserve point type is widely recognized (Bell 1958; Thurmond 1990; Turner and Hester 1993; Worthington 1957) but was actually named by Davis (1953a), based on work at the Red Smoke site in the Medicine Creek Reservoir, southwest Nebraska. Red Smoke yielded Plainview or similar points, including some with reworked blades which Davis referred to the Meserve type based on similarity with the points from the Meserve site. Several authors have questioned the validity of Meserve as a distinct point type (Story et al. 1990; Gunnerson 1987:21; Wheat 1972), and many consider it to simply represent Plainview or other types with reworked blades (Goodyear 1982:388). Myers and Lambert (1983) argue that Meserve represents a Western variant or attribute of the Dalton technological complex.

A number of recent syntheses omit the Meserve complex from consideration (e.g., Wedel 1978). General consensus appears to be that Meserve is not a valid cultural-historical or technological complex but simply a modified blade form when projectile point blades are resharpened, especially during use as knives. It should be noted, however, that the points found at the Meserve site were apparently lost during use as projectile and not as knives. The beveled blades on the Meserve site points may reflect previous use as knives or a distinctive technological trait reflecting situational or other factors. Nevertheless, the basal form of so-called Meserve points can generally be easily subsumed within other types such as Plainview or Dalton.

Dalton Complex

On the eastern Plains margin and along streams reaching well out into the Great Plains, projectile points of the Dalton technological complex are well documented (e.g., L. Johnson 1989; Brown and Logan 1987; Galin and Hofman 1984; Turner and Hester 1993; Story et al. 1990; Thurmond 1990; Wetherill 1995; Wyckoff and Bartlett 1995). The Dalton complex is well known from a number of stratified sites in Missouri (Wood and McMillan 1976; Kay 1982; Klipple 1971; Chapman 1975), and from single component Dalton sites in Arkansas (Morse 1971, 1982; Goodyear 1974, 1982). Additional information comes from the stratified and well-dated Packard site in Oklahoma (Wyckoff 1985, 1989b).

The Dalton technological complex has a highly distinctive tool assemblage which includes stemmed, concave based, edge and basally ground projectile point/knives. These are commonly basally thinned or fluted, and the overall form of the base sometimes has prominent corners or ears isolated by concave lateral and basal margins. There is substantial variation in basal form and overall morphology. Blade edges are commonly serrated and often beveled with considerable morphological variation resulting from use, dulling, breakage, and reworking or resharpening of the blade (Morse 1971; Goodyear 1974). In addition to points, Dalton adzes are an important and distinctive tool type, apparently used primarily in wood working activities (Morse and Goodyear 1973). Much of the remainder of the tool complex is comparable to that found in Paleoindian assemblages and includes spurred scrapers, gravers, spokeshaves, and a variety of unifacial flake tools.

The time frame for Dalton is argued by Goodyear (1982) to be from about 10,500 to 9900 B.P. and he suggests that it always predates notched point assemblages. Evidence from the Packard site in eastern Oklahoma, however, shows Dalton assemblages stratified well above Agate Basin and notched point types dating to about 9700 B.P. Story et al. (1990) argue, based on typology and some stratigraphic occurrences, that Dalton developed out of Clovis. The common fluting on Dalton points provides some support for this interpretation.

In eastern Kansas, Dalton points are relatively common in the Kansas River basin (Wetherill 1995; Brown and Logan 1987; Rogers and Martin 1982, 1983). No stratified or single component sites are yet documented west of the Missouri in the Central Plains region. The projectile point from the Laird site northeast of Goodland, Kansas, however, is typologically most similar to Dalton. This very western occurrence of a Dalton-like point is of particular interest. The specimen was found in association with bison bone and appears to be made from fossil wood similar to material that occurs along the front range in central Colorado. Continuing investigations may shed additional insight on the typological affiliation and age of this find. Kornfeld (personal communications 1995) reports late Paleoindian points morphologically similar to Dalton in the Middle Park region of northern Colorado.

Problems in Paleoindian Archeology

Human groups were living in the Great Plains region of the New World by soon after 11,500 years ago, based on the undisputed evidence from a number of Clovis sites (Bonnichsen and Tunnamie 1991; Frison 1991b; Haynes 1987). Clovis people were apparently not the first to inhabit the New World, however, as somewhat older evidence, dating to about 12,500 years ago and represented by a distinctly non-Clovis technology, is present in southern Chile (Dillehay 1989). The initial peopling of the Great Plains region remains problematic in terms of the timing and direction of entry of the first inhabitants. We can no longer assume, as was common two decades ago (e.g., Jennings 1974, 1978; Worthington 1957), that people necessarily
first entered the lower latitudes of North America by way of an "Ice-Free Corridor." This corridor would have opened from the Porcupine River region of southeastern Alberta as the massive continental glaciers melted away and created a late Pleistocene pathway which connected with the Great Plains near Edmonton, Alberta. This corridor would also have been open during previous interglacials. The prospect of alternative migration routes that may have been available, before or while the "Ice-Free Corridor" was open, holds multiple possible scenarios for the peopling of the North American continent (Bryan 1986, 1991). The possibility of a coastal route of colonization along the western margin of North America (Fadmark 1979, 1986) leaves open the very real prospect that we do not know when, or from which direction, the Great Plains region was first inhabited. We must at least acknowledge the reasonable possibility that people first entered the Plains region from the west, south, or east rather than from the north.

Clovis is no longer the earliest uncontested New World cultural complex. The Nenana complex in Alaska and the El Jobo complex in South America both are slightly older (Goebel et al. 1991; Bryan 1986). Clovis may be the oldest complex in the Plains region. The widespread occurrence of distinctive Clovis artifacts and sites (Bonnichsen and Turnmire 1991) also leaves open the possibility that Clovis culture, which was originally defined based on discoveries at the Blackwater Draw site in New Mexico, Miami, Texas, and at Dent, Colorado, may have originated outside the Plains region (e.g., Bonnichsen 1991; Stanford 1991). We can no longer simply assume that Clovis culture originated in the Plains or that these people spread throughout North America by way of the Great Plains. We must admit that relatively little is known about this prehistoric group other than some aspects of their economy and technology, from which overall organization and lifeways are postulated (Bonnichsen and Turnmire 1991; Kelly and Todd 1988). Plains Clovis origins and lifeways are problem areas in need of further empirical evidence and investigation.

Information on Clovis culture in central North America is based primarily upon excavations of mammoth (less commonly bison or mastodon) kill/butchery sites, surface finds of Clovis projectile points, and some artifact caches consisting of stone or stone and bone or ivory tools. Substantial recent developments have been made in study of the mammoth and other bone from Clovis sites (Frison and Todd 1986; Saunders and Daeschler 1994; Kreutzer 1988), and the artifact caches have provided valuable insights to lithic technology (Bradley 1991; Wilke et al. 1991), lithic material use patterns and mobility (Frison 1991a; Hoard et al. 1992), and some clues about possible mortuary practices (Lahren and Bonnichsen 1974; Steele and Powell 1994). Relatively little information is available, however, concerning the few known occupation sites or camps of Clovis people (Haynes 1982; Ferring 1994; Frison 1982a).

There remain significant limitations in our understanding of Clovis culture in the Plains region and elsewhere, and critical gaps in the available information base representing this very early New World culture. A primary area of concern needing further investigation is the potential pre-11,500 year old sites and deposits in the Plains region. The origins of Clovis can be addressed more effectively if sites and deposits dating before 11,500 B.P. are studied in detail. A number of sites in the Central Plains and elsewhere have yielded suggestive evidence of human activity in the region before Clovis time (e.g., Holen 1994; Stanford 1979a; Wyckoff and Carter 1994). We can no longer begin our analyses with the assumption that Clovis culture arrived in the Plains fully developed, or that it developed in isolation, or that it was the earliest human culture in the region.

Similar problems abound in the study of later Paleoindian complexes. As argued by Frison (1993), we can no longer assume a simple unilinear development of Paleoindian complexes from Clovis onward. The cultural and historical relationships among the various recognized Paleoindian complexes remain for the most part poorly defined. The possibility of contemporary distinctive traditions has been suggested (e.g., Pettis 1982) and remains an important possibility (probability) for Paleoindian times, especially if we consider the Plains and Rocky Mountains regions together. Even on the Plains proper, there are numerous overlapping radiocarbon dates representing distinct complexes and sites with multiple point types in close association. These data could reflect mixing, problems of context, co-traditions, variability in the technology of single cultural groups, and numerous other factors.

Other fundamental issues in the study of Central Plains Paleoindian archeology include site recognition and accessibility due to geomorphic processes, technological analyses of assemblages (not just points and formal tools), precise dating, site formational studies, lithic material source studies, investigation of hunting technology, recognition and documentation of structural remains, study of mobility and land use patterns, evaluation of the importance of trade, detailed studies on nonbone resource utilization, information on ideology and symbolism, gender roles, the relationships between Paleoindian and Archaic complexes and many more. Some key issues which are currently evident are listed here, but the order is not intended to imply relative significance.

1. The problem of buried site recognition and documentation and the need for systematic regional studies of quaternary geology and geomorphology are basic to progress at the site, regional, and area scales of Paleoindian investigations (Arzt 1983; Bettis and Benn 1984; E. Johnson 1987; W. C. Johnson and Logan 1990; E. Johnson and Holliday 1990; Holliday 1982, 1986; Mandel 1992, 1995; May and Holen 1993). Alluvial processes, stream channel histories, depositional history of upland loess deposits, study of dune field formation and change, playa lake fluctuations, and general knowledge of landscape evolution are essential for modeling and interpreting buried sites, for finding and recognizing such sites, and for determining where they may and will not occur. Geomorphology must be an integrated part of all effective Paleoindian site and regional studies. The radical changes which have occurred in Great Plains landscapes during the past
8,000 years necessitates geoarchaeological research in order to interpret Paleoindian sites.

2. A further concern is the need for extensive excavations at sites which may be deeply buried and which often have a light density of artifacts. Decades of site studies have shown that our most significant assemblages for many kinds of studies can result only from extensive excavations (Sellers 1952; Prisom 1991b; Hester 1972; E. Johnson 1987; Wilmsen and Roberts 1978). The ephemeral nature of many hunter-gatherer occupation sites, combined with the large area encompassed by dispersed activities (e.g., Binford 1978; O'Connell et al. 1992; Yellen 1977), suggests that most of our archaeological investigations of Paleoindian sites are spatially inadequate. We will probably continually face the problem of the need for extensive site studies and relatively small or inadequate fieldwork budgets. A good understanding of site geomorphology is critical to making the most of available research support. Ferring's (1990, 1992, 1994) research at the Aubrey site in northern Texas, and Haynes' (1982) research at the Murray Springs site in Arizona, are excellent examples of these problems.

3. Regional investigations which reach beyond specific sites are also critical to Paleoindian and other hunter-gatherer studies. It is important to utilize the archeological record at many scales in order to gain a more holistic perspective on the overall activities and land use practices of prehistoric hunter-gatherers. Surface-derived information can complement excavation data toward defining general trends in regional activity, population changes, resource use, and so forth (Amick 1994; Hester and Grady 1977; Hofman 1988, 1991b; Judge 1973; Dawson and Judge 1969). Surveys of diagnostic projectile points at the state and regional levels are also important to defining patterns of activity, changes through time, and identification of data gaps and problem areas (e.g., Brown and Logan 1987; Davis 1988; Hofman 1994b; Melzer 1987; Morrow and Morrow 1994; Myers 1987; Naze 1986; Schneider 1982). Regional studies can also make important contributions to the problems of recognizing site variability and utilizing the tremendous information attainable through study of well-documented avocational collections. Many patterns of landscape and resource use will simply not be visible if we only study a selected handful of "productive" sites.

4. Dating of Paleoindian sites and complexes remains a major problem area in need of further research. Although some complexes seem to be relatively well dated (e.g., Haynes 1993), the precise chronological and historical relationships among many complexes remain obscure. There are many examples of these problems of which the Cody complex is an excellent case. At this time we lack a clear understanding of the chronological limits of the Cody complex and of the precise age limits of the various Cody point types. Obviously a combination of chronostratigraphic and technological research is needed. Also, the relationships among the Plainview, Goshen, Midland, Folsom, and Clovis types remain unresolved. Beyond the issue of dating and chronology with respect to archaeological complexes and types, we have the extremely critical issue of dating techniques and reliability of methods. Dramatic improvements in radiocarbon dating (Haynes et al. 1984; Haynes 1992; Stafford et al. 1987, 1991) have provided a considerable boost to the understanding of Paleoindian chronology and in the identification of "out of sync" dates. The accelerator mass spectrometer (AMS) technique in radiocarbon dating and improvements in dating of bone and soil samples are especially notable advances, but they come with an increased analytical cost. Other dating methods are also important to Paleoindian studies including thermoluminescence, electron spin resonance, and, potentially, archeomagnetism. In all cases, critical assessment of samples and results is needed (e.g., Allerton 1980), and there is a significant need for using multiple lines of dating whenever possible.

Methods of relative dating are also of significance and this includes studies of patination (Frederick et al. 1994), bone weathering, and isotope analyses which may be correlated with other evidence (e.g., Todd 1995).

5. Remaining near the top of the "headaches and problems" list for Paleoindian researchers are the issues of artifact and site typology. Artifact typology in Paleoindian research has been dominated by consideration of projectile points, although systematic typologies for other tool forms have been offered (e.g., Irwin and Worthington 1970). A number of Paleoindian sites and components have yielded a variety of projectile points including specimens which would generally be classified as distinct types. Sites exhibiting such variability include Scottsbluff (Schultz and Eisle 1935), Rex Rodgers (Willey et al. 1978), Domebo (Leonhardt 1966), Clay Ranch (Myers et al. 1981), Norton (Hofman et al. 1995), and others. Discussions concerning the relationships among defined types, such as Goshen, Folsom, and Plainview, also provide evidence that we still have much to learn from technological, stylistic, and functional studies of Paleoindian projectile points and other artifacts.

A key factor for future progress in understanding Paleoindian projectile point typology may be in taking a polythetic typological perspective (Clarke 1968). In such a framework, typological affiliation is determined by the co-occurrence of a number of specified attributes, no one of which is required or sufficient for definition of (or inclusion of an artifact in) the type. Such an approach changes the initial level of comparison and classification from the type to the attribute, and so enhances the potential to recognize, define patterning in, and accommodate unusual, "nontypical," or "nontyped" specimens within the analytical framework. Some key attributes, fluting in Folsom points for example, may occur in a majority of examples of the type but are still not required for inclusion nor sufficient for definition of the type. Folsom points may have two, one, or no flutes, and other points including Clovis, Dalton, and Cumberland may be fluted and not be Folsoms. By conducting analysis of assemblages and regional samples based first on attributes, and only secondarily on types, we may define patterns and relationships which would not otherwise be recognized or obvious. Such study of variability
is key to the study of change. The need for analytical comparisons which are not limited to previously defined types is evident to anyone who has studied large numbers of projectile points. Avocational collections of Paleoindian projectile points in the Plains region almost always include specimens (sometimes a large percentage) which do not fit easily within defined types but that, nevertheless, exhibit distinctive Paleoindian attributes. For example, fluted “Hell Gap” points or an “Agate Basin” points with concave bases. Documentation of such variability is important but would commonly be masked if analysis began at the type rather than attribute level.

Another problem area is the typology of nonprojectile point artifacts. Endscrapers, gravers, bifaces, flake tools, grinding stones, hammerstones, and so forth have not been sufficiently investigated as to functional, technological, and stylistic variability within and between assemblages. Certainly the same forms can be and were used in multiple ways, and the same function can be extracted from tools having different technological histories or styles. A variety of situational factors (independent of archeologically ascribed site type or artifact type) will influence tool form and function, maintenance and recycling, loss and discard rates, and redundancy in these features.

Site typologies have perhaps done as much to limit archeological interpretations as to enhance them in the context of Paleoindian studies. Although a variety of site types have been defined or alluded to in the literature, the commonly recognized (expected) Paleoindian site types include kills, camps, butchering/processing sites, workshops, and hunting overlooks. Unfortunately, rather than enhancing the study of past behavior and variability, these site types have often been used with minimal definition as if all archeologists knew or agreed upon what characterized each type, and as if there was minimal or only insignificant variation within each site type. It is commonly assumed that, other than overall size, there is only minimal or unimportant differences within the types: campsites, kill sites, workshops, etc. Partially as a result of this perspective, we have an inaccurate and incomplete understanding of site variability and assemblage variability. Variation among campsite assemblages and among kill site assemblages from Plains Paleoindian sites is extreme and poorly understood, and definition of site types has largely been on a post-hoc accommodative level. One of many unfortunate results of this situation are the common assumptions that campsites and kill sites will necessarily be separated in space, and that campsite assemblages will always differ radically from kill site assemblages. Recent evidence suggests that these may well be unjustifiable assumptions for Plains Paleoindian sites. More research needs to be directed toward documentation and evaluation of assemblage variability, independent of prior site type expectations.

5. Taxonomic consideration of archeological complexes is closely related to, and really just another version of, the typological problems mentioned above. Archeological unit concepts currently employed in Paleoindian studies are a mishmash of ideas derived from the Midwest Taxonomic System (Willey and Phillips 1958) and numerous other sources (e.g., Beardsley et al. 1956; Worthington 1957). The terms “complex,” “assemblage,” “industry,” “phase,” “culture,” “technocomplex,” and others are found throughout the literature on Plains Paleoindian. These terms sometimes appear with specific definitions, but more commonly are used interchangeably without clarification and are often characterized primarily by one or several point types. The Cody “complex” as discussed above is an example of the wide range of interrelated archeological unit concepts which occur in reference to potentially related segments of the Paleoindian record. Other taxonomic issues revolve around the interrelationships of identified complexes. The Goshen cultural complex is an example of the inherent problems in precisely defining the relationships between “new” and existing archeological units. Resolution of many such issues will require more site studies, better dating, improved understanding of typology, clear definition of analytic tools, and so forth.

7. Historically, one important component of success in Paleoindian research has been active cooperation of avocationalists. Artifact collectors and avocational archeologists have identified and reported a significant number of the more important Paleoindian archeological sites and collections now known and studied. Developing and maintaining an effective relationship between professionals and amateurs is a key to making the most of available research time and resources. If archeologists were dependent solely upon their own brief surveys for knowledge of archeological site occurrences and for evaluation of sites and localities, our current information would be reduced tremendously. It stands to reason that if we exclude or disallow avocational input in our modern surveys, excavations, and regional studies, then we do so by ignoring a wealth of often high quality information that can dramatically enhance understanding of the archeological record and improve decision making in the mitigation or research process.

During the past 25 years, the number of practicing archeologists in the Plains region has increased dramatically. This is true for the academic, governmental, and private sectors. It is unclear, however, whether the active avocational archeology community, judging by membership in state and local archeological societies, has grown in stride. It is evident that the current and prior generations of archeologist have included numerous individuals who undervalue or disclaim the significance of avocational cooperation for doing effective and high quality archeological research. The benefits brought to archeology by avocationalists cannot, however, be ignored as many key studies have relied heavily upon their work (Hester 1972; Hofman 1992b; Naze 1986; Judge 1973; Frison 1987b). Part of the background investigation for all cultural resource management and research projects should include interviews with avocational archeologists and documentation of existing knowledge and collections. This step can provide for informed decision making in archeological endeavors where funding, time, and resources are almost always inadequate.

8. Were there Paleoindian co-traditions? Pettipas (1982) has provided an interesting discussion of possible co-traditions
during late Paleoindian time. This is a possibility which is receiving increased attention as complexes become better dated and evidence for chronological overlap continues to be found. Again, the cases of the Goshen and Cody complexes are excellent examples of why we can no longer easily accept a single linear progression of Paleoindian cultures for the Plains as a whole or for lesser regions.

9. The relationships between Paleoindian and Archaic complexes remains a key issue which has received only limited systematic attention. Similarities in technology, economy, and organization have been alluded to in many studies (Forbis 1992; Meltzer and Smith 1986; Simms 1988). Were changes in demography and ecology enough to account for the commonly offered differences between Paleoindian and Archaic archeological records?

10. Elements of technology, symbols, and ideology have been hinted at by a variety of finds including ochre quarries, engraved stones, possible burials, flint knapping activities associated with fluting, ornaments or items of personal adornment, unusual arrangements of features and artifacts, and odd sized (too large or too small) artifacts. The Paleoindian mind may be a terrain lacking a road map or direct access, but clues pertaining to organization of groups, domestic use of space, spatial arrangement of activities at campsites and across the landscape, the division of labor, sharing among family groups, value systems, and planning ability are all things for which clues can be found in the archeological record. The perception of Paleoindians only as hunters who ate meat is inappropriate and incomplete. In order to do more with the archeological record, we need a better understanding of what it is and what we want to learn from it.

Mesolithic Archeological Record

Archaic sites on the Plains are often perceived as relatively unexciting and redundant lithic scatters, sometimes with associated hearths or roasting pits. A stereotypic description of Plains Archaic lifeways might be as follows.

They ate grass seeds, tubers, and rodents, wore yucca sandals and deer hides, and hunted bison when they could be found. They occupied the margins of the high plains, except for seasonal forays in good years. Theirs' was a diffuse economy making use of diverse resources in limited regions. Yearly rounds of activity resulted in recurrent use of specific sites, ornaments are rare but simple flexed burials occasionally are found.

Such bleak hand-to-mouth portrayals of middle Holocene, Middle Period, Mesolithic or "Archaic" hunter-gatherers in the Plains region have been recurrent in the archeological literature (e.g., Mulloy 1958; Wedel 1965:72). The newest views of the Archaic, as witnessed by recent research, often diverge dramatically from this traditional view. Many basic issues remain unresolved including aspects of group organization, mobility, economic variability, technology, and causes of change. Now, however, the Archaic is recognized as key in many ways to understanding Plains archeology. It is no longer beneficial or realistic to view the Archaic only as a discrete and simple archeological construct to be studied independently of what came before or after. An enhanced understanding of the preceding and following periods will ultimately derive from the improved understanding of the diversity within the Archaic itself, not as discrete and separate entity but as part of the continuum of human occupation in the Plains region since the Pleistocene. Archaic studies are no longer limited to economy and technology, but art, ideology, land use patterns, and social organization are increasingly the topics of concern (e.g., Francis et al. 1993; Ingbar 1985; Larson 1990; Keyser and Fagan 1993; Metcalfe and Black 1991).

What is the "Archaic"? Is it an appropriate term in its implications and usages, and how do we improve our understanding of the diversity of Holocene hunter-gatherers on the Plains regardless of the references we use to represent them? The Webster's definition of archaic is more or less apropos of Ritchie's (1952) initial usage, "that which comes before—remote period," but our perception of chronology and preceramic archeology has changed dramatically since the 1950s. The term "Archaic" is pervasive in archeological usage but is perhaps an unfortunate term as a referent to the many, diverse, creative, and largely successful hunting and gathering societies who lived in the Plains and Rocky Mountains during the Holocene. Public perceptions of 'Archaic lifeway' or 'Archaic people' in archeological usage could mistakenly be taken to indicate that these hunter-gatherers were less than fully modern in abilities, technology, or ideology. For this reason, I prefer the term "Mesolithic" over "Archaic." There are plenty of alternatives which lack such embedded connotations about the lifeways and abilities of these prehistoric people.

The term "Archaic" (or Mesolithic) is used in the sense of a cultural-social-technological stage, of prehistoric people who were adept at living entirely on wild resources in a highly demanding variety of settings and conditions. Forbis' (1992) preference for Mesolithic as a referent for the archeology of post-Paleoindian occupation in the Plains and pre-late prehistoric or (Neolithic) cultures has a certain appeal, if for no other reason than it avoids some of the connotations of "archaism" in reference to these Holocene hunter-gatherers. His argument against the use of Archaic in the Northern Plains is based on his belief that the term does not reflect the same kind of adaptation or cultural stage as it does in the Eastern Woodlands. This position merits consideration.

Willey and Phillips (1958:107,120-121) have provided the most commonly used definition of the Archaic, one which is at the core of most recent definitions and which is built on the initial usage of Ritchie and the expanded applications of Webb for midden sites in Kentucky, Tennessee, and Alabama (e.g., Webb 1946).

Forbis recognizes incongruence between the Northern Plains post-Paleoindian archeological record and Willey and Phillips' Archaic definition, as he interprets it. Hunter-gatherers...
who relied at least in part on bison as a key component of their economy simply do not fit the traditional view of "Archaic" as representing broad-spectrum localized foragers.

Willey and Phillips (1958:107) define the Archaic as the stage of migratory hunting and gathering cultures continuing into environmental conditions approximating those of the present...there is now a dependence on smaller and perhaps more varied fauna. There is also an apparent increase in gathering...sites begin to yield large numbers of stone implements and utensils that are assumed to be connected with the preparation of wild vegetable foods.

Willey and Phillips, however, also recognized some potential problems in the application of their definition of the Archaic stage concept to the archeological record of the Plains.

Classification of Archaic stage cultures is even more difficult in the Plains than in the East, owing to...a long persistence of ancient hunting traditions .... Practically all Plains Archaic cultures show a mixed Lithic-Archaic typology, and in some cases the specific Archaic relationships are with the later "typical" Archaic cultures in the East. Nevertheless, the general configuration of these cultures is closer to our concept of Lithic. For example, Signal Butte I and II in western Nebraska...A bison-hunting economy is indicated, and there can be little doubt that the culture reflects a strong continuity from the ancient Lithic stage cultures of the area.

The same general observations apply to the Frontier complex found at the Medicine Creek (Allen) site in south-central Nebraska...we have here a significant instance of temporal overlap of Lithic and Archaic stages in the same area. (Willey and Phillips 1958:120-121)

Willey and Phillips continue their discussion of problems in application of the Archaic stage concept in the Plains region with other examples, but these comments illustrate the nature of the problem. Their discussion (1958:80) is limited not only by the nature of the available evidence at the time but also by assumptions concerning the Lithic stage, which was thought to be essentially (primarily) big game hunters throughout North America, and by their attempt to provide a relatively simple and dramatic contrast with the diversified economies of Archaic hunter-gatherers. This position has been seriously questioned (e.g., Bamforth 1991a; Kornfeld 1988; Meltzer and Smith 1986; Meltzer 1988), and evidence for economic diversity during the Paleoindian (Lithic) period on the Plains has continued to increase (e.g., E. Johnson 1987; Davis and Greiser 1992; Frison 1991b; Bamforth 1991a; Greiser 1985). In fact, the distinctiveness of the Lithic and Archaic stages as defined by Willey and Phillips have become less distinctive rather than reaffirmed, especially between 8,000 and 6,000 years ago, as the result of continued research.

Archeological unit concepts for prehistoric Plains hunter-gatherers are useful tools to aid discussion and comparison, but we must be mindful that such concepts do not constrain or predetermine the results of our comparative studies (or dictate what is or can be compared). Ultimately, understanding the social and economic operation of past cultural groups will not come from classification of archeological assemblages but from gaining an understanding of the operation of past cultural systems through documentation of variability and through comparative studies (e.g., Simms 1988). Our taxonomies should not limit the interpretation of the archeological record or compel us to construe it inappropriately into preconceived frameworks.

These issues are, I believe, at the heart of Forbes' concern with the concept of Archaic in the Northern Plains region. It is also a concern which is appropriately echoed for the Central Plains region.

It has been common, at least since Willey and Phillips' discussion, for archeologists to recognize at least two kinds of Archaic in the Plains region. This perspective has resulted from an awareness of apparent continuity between some late Pleistocene and Holocene Plains hunter-gatherers in terms of technology and economy, and from an awareness of relatively dramatic environmental changes which resulted in extinctions, extirpations, and a continuing reorganization of available resources. It is interesting, however, that the diversity of Plains Archaic has been summarized quite differently by different researchers. These differences probably reflect the fact that the Plains Archaic can be, or at least appears to be, radically different depending upon which sites, which site types, which time periods, and which regions are the topics of discussion. The following examples serve to indicate that the Plains Archaic has been perceived and presented in quite contrasting forms.

"the Middle Prehistoric period comprised small-game hunting and generalized gathering, with little use of bison, is now regarded as applicable primarily to the Big Horn and Wyoming Basins...Elsewhere in the northwestern Plains...relatively simple subsistence groups [were] relying heavily on bison..." (Wedel 1978:196)

The Western Plains Archaic...continues to emphasize the earlier Paleo-Indian pattern of big-game hunting, while the Eastern Plains Archaic, known from sites in and along the river valleys, manifests an eastern United States Archaic-like pattern of deer hunting, fishing, and nut and seed collection. (Johnson and Wood 1980:38)

In the extreme western Plains, the Archaic peoples carried out a true foraging existence similar to the Desert Culture to the south, where people depended heavily on seeds, nuts, roots, and other
such food... Some suggest that the Archaic peoples of the more eastern prairie were still predominantly big game hunters because the climate there was still favorable for the herds... Archaic existence was usually not much different from the lifeway of the big game hunting peoples. (Zimmerman 1985:59-60).

Relationships between eastern and western Plains hunter-gatherers during the Holocene, or between Plains and Mountain-Foothills groups are key issues in Central Plains archaeology. Are there two kinds of subsistence patterns or types of Holocene hunter-gatherers using the Plains during the Holocene? Those that focus on bison hunting and those that are more general foragers? If so, should both be considered under the same broad taxonomic classification? Or, are these economic options simply alternatives used during different seasons or different years by the same groups? This is again at the heart of Forbis' frustration with the term “Archaic” in reference to Holocene bison hunters on the Plains. During the middle Holocene, 8,000 to 4,000 years ago, bison hunting and utilization is well documented at a number of sites on the eastern and western Plains. These include sites in Iowa, Minnesota, Nebraska, Colorado, Montana, Wyoming, and elsewhere (Anderson and Semken 1980; Davis and Wilson 1978; Forbis 1985; Frison 1991b; Frison et al. 1976; Grange 1980; Kivett 1965; Metcalf 1974a:125; Miller 1985; Morris et al. 1985; Reher et al. 1985; Shy 1971). Hunting of mountain sheep, mule deer, and other species is also evident at Holocene sites on the western Plains margin and in the Rocky Mountains but not to the total exclusion of bison (e.g., Metcalf and Black 1991; Gooding 1981).

These recognized differences between east and west, Mountain-Foothills and Plains, when viewed from a chronological perspective which incorporates paleoenvironmental change, point to diversity in the archeological record of Holocene hunter-gatherers which remains unexplained or poorly understood. One of the reasons for this is the scale of analyses within which many archeological investigations have been conducted. They have commonly been site specific or delimited by “natural areas.” How do we set the limits on the proper and delimited size of regions for investigating questions about the economy, organization, land use, technology, and variability within specific Holocene hunter-gatherer systems or cultural traditions? This can not be done a priori, although contemporary hunter-gatherer land use studies provide an important framework for comparison (Binford 1983, 1991; Hitchcock 1982; Hall et al. 1985; R. L. Kelly 1983; O’Connell et al. 1992).

Metcalf (1985:187) and others have suggested that our understanding of the McKeans archeological record, and by implication other complexes, has been limited in part due to parochial perspectives. If we interpret McKeans subsistence and technology on the bases of single sites or small regions, we will very likely miss significant elements of and variability within the system. Further, if we define specific hunter-gatherer complexes primarily on the basis of specific economic orientations (e.g., big game hunters vs. broad spectrum foragers, Mountain-Foothills vs. Plains hunters), then we may simply reaffirm the distinct prehistoric cultural systems which may not have existed. The seasonal, yearly, and long-term variability of technologies, economies, and organizations within specific cultural systems or traditions have generally not been the focus of research, and as a result such variability is poorly understood.

If we consider the distribution and variability in the McKeans and Early Side-Notched (Logan Creek) technocomplexes, for example, it is evident that the records can be and have been explained in a variety of ways. If we find McKeans artifacts with bison remains, such as at Signal Butte, Cordero Mine, or Dipper Gap, does this mean that they were bison hunting specialists to the exclusion of other economic pursuits? Apparently not, if we accept the evidence from Mummy Cave and Dead Indian Creek (Frison and Walker 1984; McCracken 1978). Variability in McKeans technology, settlement, economy, and organization can be expected to occur as a result of seasonal, yearly, and long-term variation in resource availability, competition, elevation, ecological diversity, information exchange, and local or regional variation in all these. Some sites have structural remains, some have bonebeds, some have hearths, roasting pits, overlooks, or rockshelters. This is certainly true for the McKeans and Early Side-Notched materials in the Plains and Rocky Mountains region and we should expect it of other technocomplexes as well. We do not expect that all McKeans sites should have bison remains or pit houses, but in certain settings and seasons we can predict that occupations will be associated with such features. The range of movement, size of economic territories, composition of social groups, and duration of site occupations should all be expected to vary widely through seasons and generations.

There are, however, grounds for making predictions about the nature of such variability, and there are effective ways to use the archeological record to evaluate or test and further develop these models. We need explicit holistic models for evaluation of Mesoidan occupation in the Plains-Mountain region which have detailed and realistic test implications to be assessed in further study of the archeological record.

Osborn (1993) has presented an important model concerning seasonal variation in land use and hunting patterns for hunter-gatherers and farmers in the Southwest, in relation to elevation, ungulate ecology, nutritional requirements, and foraging theory. This model for winter hunting of large ungulates, when they are forced down from the highest elevations by deep snow and up from dryer or harsher open environments to protected “moisture islands” or areas of reliable and productive forage, provides a theoretically sound reason for people to occupy mid-elevation mountain sites during the winter. If the protein, fat, and hides of large ungulates were critical resources, then some mountain settings in winter would have provided the greatest ungulate density and highly predictable behavior of these key economic species. Technologically sophisticated Mesoidan groups may have sought these winter wildlife refugia as key components in a
potentially wide-ranging diversified economic and settlement system. Widespread discoveries of middle elevation structures used during the winter by Mesoiidians make sense within this framework, not because they were tied to specific localities and had to eke out a living there through all seasons, but because they identified these locations as productive and predictable resource patches important to their foraging and hunting way of life. We might expect hunter-gatherers with such knowledge of ecology and prey behavior to make equally predictable or patterned use of other key species in other habitats in other seasons. Limber pine nuts, plums, sego lilies, and bison were among the resources which were apparently incorporated into the seasonal schedule of foraging. Brush shelters, tipis, rockshelters, and pithouses might be used during the course of a single year by a single human group. We must remain as flexible in our classifications of the archeological record as prehistoric people had to be to live by foraging in the Plains-Mountain region during the Holocene.

The widespread occurrence of early and middle Holocene hunter-gatherer houses, from Illinois and Texas through the Rockies to Nevada, is no longer surprising or especially remarkable in and of itself (Larson and Francis 1996; Lintz et al. 1995; Brown and Vierra 1983). Much remains to be learned, however, concerning the position of these structural sites within the overall economy, ideology, and lifeways of the peoples who constructed and used them. It will become increasingly feasible to predict the kinds of settings in which Mesoiidian pit house structures should occur. This is important not so we can congratulate ourselves for guessing correctly but in order to identify counter instances and further evaluate and refine models of Mesoiidian lifeways and assemblage relationships. Why do some upland hunting-processing camps have pit houses while others do not? The answer is probably complex but certainly tied to season of use. The summer to early fall activity at the Helen Lookingbill site (at over 2,600 m), for example, was apparently conducted without need of permanent shelters (Frison 1983; Larson 1991; Rapson 1994). But, why was the site not used in winter? Site attributes such as exposure, snow depth, and alternative resources were also important in selection of occupation sites.

This widespread occurrence of permanent seasonal or semipermanent structures during the middle Holocene is one of the single most important archeological facts to impact our perception and understanding of Mesoiidian archeology in the Plains-Mountain region. Pit houses and other elements of technology and economy serve to link Mesoiidians with both earlier and later archeological complexes. Bison hunting continued during Mesoiidian time and was particularly important in some regions, during some periods, and some seasons. This change then was not absolute but one of emphasis. Certainly Paleoiidian groups, especially evident in the Mountain-Foothills region, often or periodically utilized smaller animal species and plants. Grinding stones, usually implicated as circumstantial evidence for plant food processing, become more common in the archeological record through the middle Holocene. Some of these stones, however, possess evidence that they were used for grinding pigments (e.g., Grange 1980) as was common during Paleoiidian times. Also, Frison (1991b:333) indicates that grinding stones for processing pine nuts and perhaps other vegetal foods were in common use by late Paleoiidian time in the Mountain-Foothills region.

Storage and food processing technology also developed or changed significantly during the Mesoiidian period. Some elements of food storage and processing which are first developed during this period become central or key components of late prehistoric adaptations (cf., Wolley and Osborn 1991). One Mesoiidian development was the making of pemmican for storage and transport (Reeves 1990; Fawcett 1985), but this apparently happened relatively late. It is only after about 4000 B.P. that features representing intensive fat production from bone are found in the archeological record. Such fat was an essential ingredient for pemmican. What were the factors which selected for this intensive and distinctive method of utilizing bison resources? Was it tied to seasonal sedentism in areas with few fat and protein sources? What was the role of competition, demographic change, environmental change, and bison herd availability? Is there a concomitant change in settlement systems and other elements of technology?

Tracking hunter-gatherers across the landscape is enhanced by seasonal determinations of site occupations, as has been possible for some bison kill and pit house occupations. Linking multiple Mesoiidian sites, however, will require use of lithic assemblages and study of artifact function, style, and technology in relation to lithic resource types and availability (Ingbar 1985; Keyser and Fagan 1993; Larson 1990; Francis 1991). Knowledge of the natural distribution of lithic materials and the ability to source them accurately is an important first step in the study of group mobility and organization through lithic studies.

Are the similarities within the range of Paleoiidian or Mesoiidian assemblages always greater than the differences between Paleoiidian and Mesoiidian assemblages? The answer is, not surprisingly, no. Simms (1988) and others (Frison 1992; Forbis 1992; Kornfeld 1988; Michlise 1986; and Bamforth 1991a) have argued for elements of continuity between Paleoiidian and Mesoiidian. If we approach the study of the hunter-gatherer archeological record in terms of its diversity as reflected in artifacts, structures, site patterning, and resource use, and monitor changes in this diversity through time which resulted from the operation of numerous selective forces, including environmental change, demographic growth, competition, and effectiveness of social and information systems, we will open the exciting possibility of learning about what the past was like and how changes came about rather than simply classifying sites and assemblages into static archeological formulations.

The Mesoiidian or Archaic period in the Central Plains and Foothills-Mountain region must be understood if we are to
understand the archeological records which preceded and developed from it. The Mesoindian period holds important keys to understanding hunting and gathering peoples who occupied the Plains-Mountain region from the first settlement of the New World until the historic period. The primary factors influencing the human groups who lived in the Central Plains region during the Holocene from 8,000 to about 1,500 years ago include the highly seasonal climate, changing climatic conditions, reduced effective moisture and productivity of the Plains region compared to the late Pleistocene, and increased regional human population (measured in terms of site frequency or artifact frequency by period). It is profitable to contrast the Archaic and the Paleoindian archeological records in the Central Plains not in terms of radical differences but in terms of changing emphasis in economy, technology, organization, and land use strategies.

Summary of Central Plains Mesoindian Archeology

A number of Archaic archeological complexes have been recognized in the Central Plains region. The primary taxonomic units defined by archeologists are summarized here with selected information provided for key sites. Location of selected Mesoindian sites is shown in Figure 33.

Logan Creek Complex

The Logan Creek complex was first recognized through research at the Logan Creek site, 25BT3, in Burt County, northeastern Nebraska (Kvett 1958, 1962; Witty 1957, Mandel 1995; Thies and Witty 1992; Grange 1980:45-47; Anderson et al. 1980:263; Bozell 1994). This complex is characterized by side-notched projectile points, usually with straight to concave bases which are often ground. Point length ranges from 3 to 5 cm, but reworking of blades is common. Unnotched lanceolate points of similar form also occur at several sites. Side-notched points with tips reworked to form hafted endscrapers are also considered diagnostic (Thies and Witty 1992:Figure 2). These artifacts appear to be projectile points which were reworked into hafted scrapers, perhaps after the tips had broken. Whether the scrapers were ever reworked back into points is unclear and would probably depend on need and length of the specimen. Grinding stones and a variety of other stone tools are documented. Some grinding stones have evidence of red ochre (Grange 1980:45), so they do not all necessarily reflect plant food processing. Lithic materials often include some exotic materials from distant sources (e.g., Anderson et al. 1980:Table 9.9). Available radiocarbon dates indicate a time from about 6,000 to 7,500 years ago. Faunal remains are dominated by bison in all reported sites, but a variety of smaller animals are well represented, most notably dog (or other canids), deer, antelope, rabbit, fish, birds, and mussels. Bison is the primary fauna at sites where bones have been studied. Sites referred to the Logan Creek complex have been reported from western Iowa through western Nebraska and Kansas.

Early Holocene side-notched projectile points occur in sites and complexes throughout the western Plains and portions of the Rocky Mountains. Early side-notched or Early Plains Archaic evidence comes from locations such as Hawkin (Frison et al.

1976), Ladder Creek (Larson 1990), Mummy Cave (Wedel et al. 1968; McCracken 1978), Medicine Lodge Creek (Frison 1976, 1991b), Helen Lookingbill (Frison 1983; Larson 1991), and elsewhere in Wyoming and Colorado (Cassells 1983; Lischka et al. 1983; Lintz and Anderson 1989).

On the Northern Plains the Gowen (or Mummy Cave) complex, represented by sites such as the Gowen site near Saskatoon (E.G. Walker 1988) and the lowest level at Head-Smashed-In bison jump (Reeves 1978), is characterized by side-notched projectile points dating before 5,500 years ago and is approximately contemporary with Logan Creek (Forbis 1992). To the far west in Idaho and into Montana, the Bitterroot complex and notably the Bitterroot point type has been recognized as comparable to Logan Creek (Frison 1991b; Forbis 1992; Lahren 1976).

Central Plains Logan Creek Sites

Several excavated sites in western Iowa have components referable to the Logan Creek complex. These include Cherokee Sewer (Cultural Horizons I and II), Simonsen, Hill, Turin, Lungren, Pisgah, and Ocheydan (Anderson et al. 1980). These sites include bison kills, camps, and burials. Zone 7 at the Simonsen site represents a bison kill which yielded three projectile points. This stratum is about 5 m below the surface (Agogino and Frankforter 1960; Frankforter and Agogino 1960), and a single radiocarbon date of 6840 ± 520 b.p. is reported. This is currently the earliest date which might be attributed to the Logan Creek complex. Campsites are represented by the Hill and Lungren sites near Glenwood on Pony Creek. At the Hill site (Anderson et al. 1980:262; Frankforter 1959) the primary cultural level was about 5.7 m below the surface and contained a hearth, five side-notched points, an unnotched point, notched and unnotched endscrapers, and remains of bison, deer, turtle, and bird bone. A radiocarbon date of 7250 ± 400 b.p. is reported. Lungren (Brown 1967) is another camp which was minimally investigated and had a single side-notched point and a radiocarbon date of 6280 ± 120 b.p. (Reeves 1973:1238). Turin, near the town of the same name, yielded evidence of four burials about 6 m deep in a loess deposit (Anderson et al. 1980). An adult male, an adolescent, a child and an infant are represented. The adolescent was buried with shell beads and red ochre in a flexed position. A side-notched projectile point was found with the burials or in the same stratum. Radiocarbon dates on bone indicate a minimum age of 4720 ± 250 b.p. and bison bone from below the burials is dated to 6080 ± 300 b.p. The Lansing burial in a loess deposit in northeastern Kansas has also yielded radiocarbon dates which are of comparable age (Table 23). Logan Creek artifacts are shown in Figure 34.

Cherokee Sewer Site. One of the more important and well-documented Logan Creek sites is the stratified Cherokee Sewer site (Anderson and Semken 1980). Cultural levels I and II yielded side-notched projectile points in association with bison remains in what are interpreted to represent processing and camp areas associated with nearby kills. The relatively narrow side-notched points from Cultural Level I are associated with radiocarbon dates of 5950 ± 80 b.p. and 6300 ± 90 b.p. The broader side-notched points in Cultural level II are dated to 7350 ± 100 and 7480 ± 100 b.p. and a number of unnotched points occur in this level as well. Endscrapers are common especially in Cultural Level II, and a variety of other chipped stone, bone, and ground stone artifacts are reported. These Archaic levels are from 3 to 7 m below the surface. The paleoecological record from Cherokee Sewer makes it one of the more important middle Holocene records in the region (Anderson and Semken 1980).

Logan Creek Site. The Logan Creek site is located south of Oakland in Burt County, Nebraska and was investigated during the late 1950s and early 1960s by Rivett with support from the National Science Foundation. This stratified site had eight distinct horizons designated A through H from top to bottom which were initially interpreted as units contained in an alluvial terrace. A series of radiocarbon dates were derived from charcoal ranging from about 6,600 to 7,300 years ago, but these were not in stratigraphic order. The extensive excavations at this deep buried site have never been fully reported (Bozell 1994:97), but evidence of hearths, pits, and several possible postmolds were found. Faunal remains were dominated by bison bone (Snyder and Bozell 1983), but a variety of other species are represented including deer and fish. The faunal assemblage has never been adequately studied and reported. This important tool assemblage has not been fully documented, but the projectile points are triangular with side notches (usually deep) and slightly to deeply concave bases. Notched endscrapers made from recycled or broken points are also common (Thies and Witty 1992), as are other scrapers, bifaces, drills, and ground stone artifacts. Bone and antler tools as well as a fishhook were recovered.

Reinvestigation of the site context and stratigraphy in 1992 provided important new perspectives on the site's depositional history and age. Six new radiocarbon dates and a revised interpretation of the site formation add to an understanding of Logan Creek (Bozell 1994; Mandel 1995). The site is located on an alluvial fan on the eastern edge of the Logan Creek valley and formed as a result of sediments washing down slope and accumulating in the valley floor. The new radiocarbon dates are in good stratigraphic order and indicate that the upper six Archaic components date from 7,350 to 6,020 years ago.

Spring Creek Site. Archeological salvage work in Frontier County, Nebraska, along Red Willow Creek in 1961 were focused in part on the Spring Creek site, 25PT31 (Grange 1980). Spring Creek was initially recorded during a 1948 survey on the second terrace above Red Willow and Spring creeks near the confluence of the latter. The deeply buried Archaic component was exposed during borrow pit excavation and dam construction and was heavily impacted prior to archeological work and eventually destroyed by borrow operations (Grange 1980:12, 21-47). The Archaic component was about 3 to 4 m below the surface and only a portion of the original occupation area could be studied. Use of heavy equipment to remove overburden enabled the small field crew to excavate a significant sample of the site. A grid of 5 foot squares was used for horizontal reference in Area
| Site/Location | Complex | Date | δ  | Lab# | Mat. | Ref. | Signal Butte | Logan Creek | Logan Cr | 258Ts | 25FT31 | Spring Creek | Logon Cr | 25FT60 Walker | Gilmere | Kansas | Læsung 14LVS15 | 7825 | 105 | GX-588 | bn | 12 |
|--------------|---------|------|----|------|------|------|------------|------------|---------|-------|--------|----------|----------|------------|---------|----------------|--------|-------|----------------|------|-------|--------|----|     |
| Hungry Whistler | Mt Alb. | 5300 | 130 | I-4416 | ch | 1 | McKeen | 4550 | 220 | L-3559 |        |          |          |          |          |          |          |        | 12 |
| 5BL77 | Mt Alb. | 5520 | 120 | I-3404 | ch | 1 | McKeen | 4710 | 250 | L-385D |        |          |          |          |          |          |          |        | 12 |
| 5BL70 | Mt Alb. | 5730 | 120 | I-3817 | ch | 1 |          |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5BL73 Albion | Mt Alb. | 5800 | 125 | I-3267 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Fourth of July | Mt Alb. | 5650 | 145 | I-3023 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5BL120 | Mt Alb. | 5730 | 150 | I-3023 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Parnigian | Mt Alb. | 5800 | 120 | I-6544 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5BL170 | Mt Alb. | 6045 | 110 | I-5545 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Yamony | 5EA799 |      |     |       |     |     |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Vail Pass | MT Alb. | 5055 | 100 | I-3988 | ch | 3 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5ST85 | MT Alb. | 6750 | 120 | WU-1752 | ch | 2 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Granby |      | 8985 | 115 | UGA-1148 | ch | 2 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Hill Horn | MT Alb. | 4500 | 120 | WU-1750 | ch | 2 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Pontiac Pit |      | 4710 | 120 | Beta-8382 | ch | 6 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Cherry Gulch |      | 5730 | 220 | UGA-1230 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Sj63 |      | 4300 | 75 | UGA-1069 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Helmer Ranch | Magic Mtn | 5780 | 180 | W-227 | ch | 2 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Magic Mtn | LoCash | 4930 | 250 | W/70-71 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Hutton-Pinchkam | Dipper Gap | 4310 | 200 | Beta-3565 | ch | 5 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Phoeni Shelter | McLean | 4180 | 90 | UGA-435 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5LR161 | McLean | 3570 | 85 | UGA-435 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Spring Gulch | McLean | 3260 | 135 | Beta-3870 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5LR252 | McLean | 3095 | 75 | UGA-671 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Pack Rat Fltr | 5LR170 | 3855 | 350 | UGA-1048 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Kinney Spring | McLean | 3780 | 105 | UGA-1047 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5LR144 | McLean | 3110 | 130 | Beta-2288 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Blue Lake V | McLean | 3215 | 90 | I-8281 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5LR141C | McLean | 3570 | 70 | UGA-736 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Lindemeyer | Archac | 6015 | 65 | UGA-737 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Willowbrook | Sj6 | 2215 | 75 | UGA-737 | ch | 1 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5JF10 |       | 2140 | 250 | Beta-3840 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Kewlakw | Archac | 2770 | 60 | Beta-1298 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| Knockdown Ranch | Archac | 2770 | 60 | Beta-1298 | ch | 4 |          |          |          |          |          |          |          |          |          |          |        | 12 |
| 5AH5 Witkin Butl | Archac | 3190 | 80 | Beta-3339 | ch | 10 |          |          |          |          |          |          |          |          |          |          |        | 12 |

2 which was the largest excavation. The total area excavated was approximately 160 m² and the matrix was not screened. Several features were documented including bone concentrations, charred bone and rock concentrations, shallow basins, shallow pits, and a cluster of three ground stone artifacts with red pigment staining. One bone concentration also included pieces with red stained surfaces. A single radiocarbon date based on charcoal pieces combined from six features resulted in an age of 5680 ± 160 B.P. (M-1364).

Of the 276 stone and bone artifacts recovered were 21 projectile points and fragments including side-notched and unnotched forms comparable to those from Logan Creek (Grange 1980:Figure 8). Endscrapers (unnotched), bifaces, a variety of flake tools, and flake debris were also found. Reported bone artifacts include some probable and some questionable pieces which merit reevaluation given modern awareness of taphonomic processes which can affect bone breakage and surface modifications. A tubular bird bone head was also recovered as was a single human tooth.

Faunal remains were dominated by bison, represented by 454 of 541 reported pieces and an MNI of 12 (Grange 1980:Table 9; Appendix 1. Tables 1-3). There may have been as many as 18 bison based on Grange's tabulation in Table 2 which indicates 18 right mandibles. Other species of importance include dog or wolf (NISP = 55, MNI = 5), rabbit (MNI = 2), and gopher (MNI = 3), but the later could represent natural background fauna. Other species, each having an MNI of 1, include swift fox, deer, antelope, beaver, prairie dog, vole, duck, goose, and a small bird. Remains of shell fish is also reported from the features. Grange (1980:45) suggests that, "the excavated part of the camp at 25FT31 represents the debris left by a group of between five and ten people for a period of two to four months."

Mount Albion Complex

Research by Benedict and associates since the mid 1960s has focused on several problems of high altitude archeology in the Indian Peaks area of the Rocky Mountains Front Range in north-central Colorado along the continental divide. One target of this research has been the investigation of middle Holocene climatic change on human habitation in the region. Research at the Hungry Whistler and SBL70 sites was part of this research to study the impact of the Altithermal on human use of the region through the Holocene, and these sites served as the focus for definition of the Mount Albion complex (Benedict and Olson 1978). A number of additional sites and surface collections are documented which contribute to the definition of this high-altitude seasonal game drive complex. Sites are between 2,300 and 3,700 m ASL. Game drive sites were often reused due to preferred or suitable terrain in mountain passes which were funneled routes of animal travel and probably movements of human groups as well. Species, which were the focus of such hunting efforts (along drives), are not well documented from the archeological investigations but are assumed to have included mountain sheep and possibly bison.

Deer and elk are also common in the area.

The technology of Mount Albion sites is characterized by corner-notched, corner-removed, or side-notched dart points which exhibit convex bases and are generally heavily ground on the base and stem. Blade forms vary widely reflecting common reworking and heavy use and recycling of points as cutting and scraping tools. Lithic materials are most commonly quartzite, quartz, and argillite. A variety of unifacial cutting and scraping tools and bifacial implements and preforms are reported and many of these were apparently intensively utilized and recycled. Grinding stones are documented which may reflect vegetal food processing, perhaps in conjunction with preparation of winter stores, and red "pigment stones" are common.

Mount Albion Complex Sites.

Hungry Whistler. Excavation at SBL67 included a total of 73 m² using natural levels and 2.5 cm excavation levels with excavation fill screened by .5 m quadrants of each unit. The site has a complex formation history and is in a dynamic periglacial landscape. Detailed study of stratigraphy, lichenometry, geomorphology, freeze-thaw processes, and radiocarbon dating have provided important clues about changing snow, moisture, and frost intensity during the
Holocene (Benedict 1978:31). Several hearths were encountered, with variously dispersed charcoal and these provided samples for five radiocarbon dates primarily between 5000 and 6000 B.P. A number of stone cairns occur in the site area and three of these were excavated and studied in detail. They were stratigraphically associated with the Mount Albion component and had flakes, charcoal, a Mount Albion point, core, and pieces of red ochre in close association.

Site 5BL70. Site 5BL70 is located a distance of about 150 m east of the Hungry Whistler site on the same ridge (Olson 1978).

Magic Mountain Complex

Research at the Magic Mountain site, located in the hogback ridges about 15 km west of Denver in the Rocky Mountains foothills, provided one of the earliest documented well-stratified Holocene archeological records in Colorado (Irwin-Williams and Irwin 1966). Zones F-D, the deepest cultural levels at this open campsite, yielded a radiocarbon date (Zone E) of about 5000 B.P. and a series of notched dart point forms. These materials were designated the Magic Mountain complex and believed to represent a local mountain adaptation. Benedict (Benedict and Olson 1978:127-128) suggests that these materials represent mixed assemblages rather than a single cultural complex. The large corner-notched points are comparable to the Mount Albion complex defined by Benedict. Some materials from the lower levels of the LoDaisKa Rockshelter, about 10 km south of Magic Mountain, are also attributed to the Mount Albion complex (Benedict and Olson 1978).

McKean Complex

The McKean complex was defined based on research at the McKean site at Keyhole Reservoir in northeastern Wyoming where Mulloy (1954; Wheeler 1952; 1954) defined assemblages with distinctive projectile point forms dating to the Middle Prehistoric Period (Mulloy 1958). The Middle Period, or Plains Archaic was very poorly known at the time and research at McKean helped establish a regional chronology for the middle Holocene. The presence of human remains at the McKean site also brought attention to the site. Recent summaries of the McKean complex have been provided by Greiser (1985:91-97), Sundstrom (1989:48-56), Frison (1991b:88-101), Forbis (1992), and a series of key papers in Kornfeld and Todd (1985).

The McKean complex includes a variety of distinctive projectile point types including McKean Lanceolate, straight-stemmed Duncan points, and slightly expanding stemmed Hanna points, and the large triangular side-notched Mallory point type (Greiser 1985:Figure 35; Wheeler 1985; Frison 1991b:Figure 2.52; Lobbell 1974; Benedict and Olson 1973). Bases are usually deeply concave and the Mallory points usually have a basal notch. Greiser (1985:91) suggests that the Hanna type may be the most recent and date slightly later than the others in the McKean technocomplex. These types occur in collections from the Oklahoma Panhandle, western Kansas, eastern Colorado, and western Nebraska. It is not clear how far east these types occur. Key excavated sites with McKean components in the Central Plains include Signal Butte in western Nebraska, Dipper Gap, Wilber Thomas, Hutto-Finkham, Magic Mountain, and LoDaisKa in Colorado. Campsites on butte tops, terraces, and in shelters are represented, but kill sites are not yet reported in the area although these occur to the northwest (Brumley 1975, 1978; Fawcett 1985; Lobbell 1973; Reher et al. 1985; Miller 1985; Morris et al. 1985). Examples of McKean artifacts are shown in Figure 35.

In the Colorado Plateau and Great Basin area similar projectile points are generally classified as Pinto and the relationships of those groups using McKean- and Pinto points is a topic of some interest (Metcalf and Black 1991; Green 1975; Gooding and Shields 1985). Mallory points are represented at sites studied in the North Park Colorado inventory (Lischka et al. 1983), the Albion Boardinghouse site (Benedict 1975), and elsewhere in Colorado (Linz and Anderson 1989). These points are generally comparable to the San Rafael Side-Notched in the Colorado Plateau area (e.g., Gooding and Shields 1985).

Whether McKean technology developed in the Rocky Mountains region with McKean lanceolate derived from terminal Paleoindian Foothills-Mountain complexes, such as Lusk and Pryor, remains undemonstrated. The chronologically intermediate early side-notched complexes may reflect multiple technological traditions or a period of economic and technological realignment. It has also been suggested that the early side-notched, and possibly the McKean tradition as well, is the result of eastern immigrants onto the Plains (Forbis 1992). The nature of any direct relationships between projectile point types and distinctive cultural groups remains an open issue. For the most part it has not been possible to identify specific projectile point types which occur exclusively with specific historically known tribal groups on the Plains, with perhaps a few broadly defined exceptions (cf. Reher and Frison 1980; Fawcett 1980).

In the Northern Plains, the Oxbow complex is approximately coeval with McKean, with the earliest Oxbow dates a few centuries earlier than McKean (Forbis 1992; Morlan 1993, 1994). By 5,000 years ago, McKean and Oxbow assemblages occurred with bison and antelope remains forming important economic components (Forbis 1992). Oxbow projectile points are triangular with deeply concave bases and side notches which often result in a prominent basal "ears."

Economy of the McKean people in the Central Plains region apparently focused on bison, at least during some seasons and periods, and bison bone is common in some assemblages (see papers in Kornfeld and Todd 1985; Frison 1991b; Forbis 1992). In the Rocky Mountains and foothills, mountain sheep and mule deer were also important economic species. Several sites include evidence of antelope utilization or procurement and antelope is occasionally the dominant species (Keyser and Davis 1985; Forbis 1992). Some sites include a wide range of species including numerous small mammals, shellfish, antelope, and deer. Plant foods were probably also of importance but have not been adequately preserved, recovered, or studied, so it is
difficult to evaluate the seasonal or long-term significance of these varied resources in the Middle Archaic diets of the region (Keyser 1986; Kornfeld 1985, 1996). The presence of grinding stones at several sites (e.g. Breternitz 1971) also suggests that plant food processing may have played an important role in some seasons or years, but grinding stones were not necessarily always used for plant food processing (Forbis 1992). Technological developments including roasting pits and stone boiling and probably pemmican making, which included bone grease extraction, were well in place by the end of McKeen times (Fawcett 1985; Reeves 1990; Forbis 1992).

We should expect some seasonal variability in the economy and habitation and activity site types for McKeen in the Central Plains and Mountains. Bison hunting was apparently of some significance in some locations at least during some years, but there may have been significant variability in the availability of bison within specific regions on both a seasonal and long-term basis. Rockshelters, such as Wilber Thomas Shelter, LoDaiska, and Mummy Cave, probably served as important winter occupation sites but also would have been used as short-term camps during logistical forays of task groups. The occurrence of butte-top occupation sites, such as Dipper Gap and Signal Butte, suggest warm season (at least not midwinter) occupation during which ungulate hunting was a primary activity. Butte-top sites provided rapid information gathering (overlooks) and were perhaps also important because of reduced flying insect populations and for communication or signaling. The Dipper Gap site is also close to the Flattop chalcedony lithic source which may have made it a likely gearing-up camp for seasonal bison hunting.

Evidence from several sites suggests that middle Holocene Plains hunter-gatherers were not primarily broad spectrum gatherer/gatherers during all seasons. It is also probable that successful bison or antelope hunting would not occur without purposeful gearing up or maintenance of specialized technologies, but this may have been done with seasonal emphasis rather than as a full-time specialization.

Open air sites in unprotected settings which lack pit houses, such as Hutton-Pinkham, were most likely occupied during the milder seasons when a wide range of fruits, tubers, and seeds would have been available which could have served either as primary or supplemental food sources (Latady and Dueholm 1985). Stone circle sites are relatively common on the open Plains and were in use at least by McKeen times (Forbis 1992:58; Frison 1991b: 92; Stuart 1990), probably a reflection of relatively mobile seasonal camps.

Pit houses are documented at an increasing number of sites (Larson and Francis 1996) in the Plains and the Mountain-Foothills region, and are generally assumed to reflect winter or cold season occupations (e.g., Metcalf and Black 1991). They occur from the Plains (e.g., Shields 1980; Lintz et al. 1995) to middle elevations (e.g., Goodyear 1981). The model proposed by Osborn (1995) for winter season ungulate (mule deer, sheep, bison) hunting in upland settings in the Southwest provides an important model for consideration for the Central Plains and Rocky Mountains region. The relationships of these various site types, open camps, rockshelters, butte tops, and pit houses, in open plains, foothills, and mountain settings remain unresolved or debated. Seasonal and long-term variability in resource availability are assumed to have had a direct influence on the economy; mobility, and land use patterns of middle Holocene people.

Central Plains McKeen Complex Sites

Dipper Gap Site. The Dipper Gap site (S1G101) is located about 37 km north of Stoneham, Colorado on a butte top south of “Dipper” valley (Metcalf 1974). Dipper valley was named for its numerous springs, which were probably attractive to prehistoric people, and the Dipper Gap site is named for a gap in the butte forming the southern margin of this valley. This is a short grass region but with a wide variety of plant and animal resources available in the immediate locale (Metcalf 1974:Tables
The Flattop Butte chalcedony source can be seen in the distance about 19 km east of Dipper Gap, so the location was well situated for exploitation of a variety of resources. Bison remains, however, dominate the fauna from the site.

The principal occupation area was designated Locality I and occurred in a large jagged crack about 29 x 5 m in size which had formed in the caprock of the butte. The 1972 excavation exposed an area of about 95 m² in the crack or Locality I and excavation was primarily within the top 1 m of deposit and rarely extended more than 1.5 m below the surface. Previous excavations had occurred at the site (J. J. Wood 1967), and the 1972 work began by cleaning out these old units. Excavations were controlled by 2 m squares with 20 cm levels, and fill was screened through .25 inch mesh. Locality II on the butte top, was excavated in 1 m units, and the small trench (1 x 4 m) was excavated in Locality III under a small overhang (Metcalf 1974:Figure 3).

A number of features were documented, and charcoal from three of these in the crack area excavation was submitted for radiocarbon dating. The dates (3180 ± 90, UGa-456, Feature 16; 3410 ± 90 B.P., UGa-453, Feature 5; 3520 ± 85 B.P., UGa-455, Feature 10) indicate a range for the McKeans occupation at Dipper Gap from 3,100 to 3,600 years ago (uncorrected; Metcalf 1974:46; Morris et al. 1985:Table 3.1). Zone D at Dipper Gap contains the McKeans and Mountain complex middle Holocene deposits. The features included 21 hearths, several of which were superimposed over other hearths indicating redundant use of the site by McKeans people. Hearths of several types were recognized including basins with fire-cracked rock and shallow charcoal concentrations which appear to have been surface fires.

The chipped-stone artifact assemblage from Dipper Gap includes 708 items representing nine categories, plus 70.059 pieces of chipped stone debitage from the controlled excavation. The collection from the crack includes 73 projectile points and fragments, 79 bifaces, 50 endscrapers, 52 side scrapers, 47 retouched flakes, 23 drills and perforators, 13 spokeshaves, a composite tool, and 29 core/choppers. Lithic materials are dominated by Flattop chalcedony (97% of the debitage and 84% of the tools). Other cherts and quartzites are also represented. Ground stone artifacts from the crack include 23 handstones and fragments, 21 grinding slabs and pieces, and three abraders. Numerous pieces of hematite and limonite were also recovered, especially in the lowest levels. Bone artifacts include three awls, three scraping tools, one bird-bone head, and six incised discs (most of the latter were from near a feature in Locality II on top of the butte). This range of artifacts suggests a variety of maintenance, processing, and extractive activities which probably involved a significant cross section if not the total social group. Hunting, hide processing, vegetal food processing, and manufacture of tools, equipment, containers, garments, etc., are all indicated.

Faunal remains are dominated by bison, with a minimum of seven animals represented, and butchering marks common. Additional species include rabbit, ground squirrel, marmot, dog or coyote, antelope, deer, turtle, and duck. Evidence for butchering also occurs on some canid elements. Metcalf (1974:174) offers this speculative model of how the Dipper Gap site might fit into the overall settlement system of middle Holocene foragers in the region.

During the spring and early summer, the Plains are better watered than at other times of the year. One possible pattern of seasonal migration could be: fall banding together for communal hunts, winters spent in sheltered sites nearby, spring and early summer spent foraging on the Plains, summers spent in the high mountains, and a return to the foothills and Plains for fall hunting.

As noted by Metcalf, this speculative model can serve as a target for further evaluation.

Signal Butte Site. The Signal Butte site is located on a prominent mesa about 34 km southeast of Scottsbluff, in Scottsbluff County, Nebraska overlooking Kiowa Creek, and south of the North Platte river. The site was brought to the attention of William Duncan Strong in 1931, who visited the site that summer and followed that with intensive excavations during June and July of 1932 (Strong 1935:224-239). The lowest cultural horizon was designated Level I and occurred above alluvial gravels which capped the Butte. This level was covered with as much as 8 feet of loess which contained at least two distinct later components separated from Level I by 1.5 feet of sterile deposits. Excavations were conducted using 5 foot squares and natural levels with all fill screened (mesh size not indicated). The butte top is approximately the size of three tennis courts, of which approximately half of the archeological deposit was excavated by Strong (1935; Forbes 1985). The total excavation was at least 20 (east-west) by 65 (north-south) feet (Strong 1935) or about 117 m². Over much of this area, Level I was at a depth of 1-2 m.

The historical significance of the Signal Butte site extends well beyond the specific cultural complexes represented by the stratified deposits (Strong 1935; Forbes 1985; Wheeler 1989). Signal Butte has served as a pivotal site, bolstered by subsequent investigations at sites such as Ash Hollow Cave (Champe 1946) and Mummy Cave (Wedel et al. 1968), in demonstrating a long occupation sequence in the Plams region contrary to popular anthropological notions during the early decades of this century (e.g., Kroeber 1939).

The Signal Butte assemblage is one of the larger McKeans assemblages documented, with 1,119 chipped stone artifacts reported by Strong (1935), who also noted a mass of retouch pieces, flakes, and cores from the site which he considered a workshop as well as habitation site. This includes 674 points with types now recognized as McKeans lanceolate, Hanna, Duncan, and Mallory points well represented (Mallory points being the least common). Other tool forms include 445 bifacial ovoid "side scrapers" (bifacial preforms), 491 endscrapers, 217 unifacial side scrapers, 277 blade knives, 124 drills and gravers, and a variety of other artifacts including spokeshaves (Strong 1935:234). Bone and antler artifacts from Level I totaled 72 specimens including 15 knapping tools, 36 awls, five large bone
scrapers, 12 incised bone fragments, four bird bone beads, and numerous worked or split bone pieces. A possible shell (freshwater mussel) pendent with two closely spaced notches on one edge is interpreted as a pendant. The bone assemblage from the site is dominated by bison, but antelope and birds are also represented. Features included common hearths, some with stones, and small "pot-shaped" storage pits. Other artifacts include common pieces of ground hematite and limonite, hammerstones, grooved abraders, a possible grooved axe, and numerous grinding stones and fragments.

The variety of evidence from Signal Butte argues for a habitation site or intensively and repeatedly utilized hunting and processing camp. Forbes (1985:27-29) offers some comments on how the site may have fit into the McKean subsistence-settlement system. The prominent and relatively inaccessible nature of the butte makes it a poor candidate for occupation in severe weather and it probably was not a winter occupation site. There is no wood or water at the butte, so most critical resources would have had to be carried up to the butte top. The butte offers several potentially attractive features including protection from predators, usually a steady breeze or wind which would reduce insect pests, and excellent visibility. From the Signal Butte many thousands of km can be viewed and monitored for game. Also, the Wildcat Hills with their steep cliffs are located south of the butte. Hunters could have monitored the locations and movements of bison, antelope, elk, and other species from the butte and planned and organized their hunting efforts based on quality information. This latter aspect of occupying Signal Butte, the greatly increased potential for information gathering, was probably a key reason for intensive and redundant occupation of the site. Individuals who remained at the camp and were not hunting could continue to monitor the movements of prey species and enhance the overall success of hunting in the area.

Wilber Thomas Shelter. Wilber Thomas shelter (SWL45) is located southwest of Carr, in northwestern Weld County, Colorado (Breternitz et al. 1971). The site was investigated by Nelson in 1968 and by students from the University of Colorado under the direction of David Breternitz during 1969. Excavation units were primarily 2 m² and all fill was screened through .25 inch mesh. The materials from both periods of excavation have been documented and come from a total excavation of about 43 m², which represents no more than a quarter of the total shelter area and includes some excavations in front of the drip line as well. The shelter has a southwest facing exposure. Maximum depth of the excavations was just over 1 m at which point bedrock was encountered. Twenty-eight features were documented during the 1969 excavation including rock-lined and unlined hearths, rock-lined pits, concentrations of fire-cracked rock, and shallow basins. No radiocarbon dates are available as samples submitted were inadequate for dating.

The base of a Scottsbluff point and a flake tool were found just above bedrock, about 1.3 m below the surface. Mountain complex (comparable to the Logan Creek complex) notched points were recovered from levels 3 and 4, 0.6-1.25 m below the surface, and McKean and Duncan-Hanna points were found in levels 2 and 3, from 0.3 to 0.8 m below the surface. Woodland and late prehistoric artifacts were recovered from levels 1 through 3. Several grinding stones (manos) were found in the McKean levels, but no grinding basins were recovered. Chipped stone artifacts include 10 McKean or Duncan-Hanna projectile points, endscrapers, scrapers, gravers, bifaces, perforators, and a chopper.

Hutton-Pinkham Site. The Hutton-Pinkham site is located in southeastern Yuma County, Colorado just a few kilometers from the Kansas border (Larson et al. 1992). The site is contained within the Pleistocene and Holocene alluvium of Bonny Creek near its confluence with the South Fork of the Republican River. Although one or more late Pleistocene levels contains faunal remains and possible artifacts, the primary evidence from Hutton-Pinkham dates to the middle Holocene, with a single radiocarbon date of 4310 ± 200 b.p. (Beta-35336) on carbonaceous soil from a hearth. This is considered a minimum age for the hearth. The primary occupation occurs at a depth of 2.2 to 2.6 m below the surface in a buried soil. Excavation in 1977 included nine 2 m² units which focused on the buried soil. Excavations in 1988 and 1989 were concerned with stratigraphic evaluation of the site, collection of paleoecological samples for pollen and soil analyses, and a reassessment of the cultural component. During this latter work several profiles were cleaned and studied, and eight additional units were excavated.

Artifacts include 29 chipped stone tools, ground stone, fire-cracked rock, charcoal, worked and unworked bone, and a single hearth (Larson et al. 1992). Two projectile points fall within the McKean technocomplex and additional tools include eight endscrapers, six cores, two gravers, one drill, three biface preforms, three biface tools, one sidescraper, and two flake tools. Debitage included 597 pieces of chipped stone mostly representing small tertiary flakes. Lithic material types represented by the artifacts include stone from the Hartville Uplift, Dakota and Morrison formations, and fossilized wood. The latter material is argued to be of local origin due to some gravel cortex. The overall small size and poor quality of the artifacts is, however, attributed to limited availability of raw materials. Ground stone artifacts include eight pieces: two manos, four slab fragments, and two hammerstones. Two bone awls and two tubular bone beads were also recovered. Unmodified bone includes predominantly pieces of bison, deer, antelope, rabbit, squirrel, and various birds are represented. The majority of bone, from at least some units, was burned. Investigation and further analysis of sites such as Hutton-Pinkham, especially interdisciplinary work such as initiated at this site, including study of soils, pollen, and invertebrates, will add significantly to our understanding of the middle Holocene occupation of the Central Plains region.

Albion Boardinghouse Site. The Albion Boardinghouse site (SBL73) is located in western Boulder County at an elevation of 3,260 m, below timberline in the North Boulder Creek drainage (Benedict 1975). The lithic and faunal assemblage from the site indicate that it was a camp associated with high elevation hunting, butchering, and tool repair and maintenance.
The distinctive projectile point assemblage consists primarily of Mallory points, also well represented at sites like Scoggin in Wyoming (Lobdell 1974). Spring Gulch (Kainer 1974) in Colorado, and Signal Butte in Nebraska (Strong 1935). The site assemblage includes 23 Mallory points and fragments and three other notched points. The predominance of point bases suggests retooling activities were common. Also, three preforms, numerous biface fragments, two endscrapers, and 2,278 flakes were collected. The flakes indicate that relatively more tool maintenance than tool manufacture occurred at the site. A fragmentary grinding stone and milling slab were also documented. Many of the artifacts and flakes were burned. Bone occurred as small unidentifiable fragments in the upper charcoal-rich level. The two available radiocarbon dates are divergent and bracket McKean dates from elsewhere. The ages are 2420 ± 220 B.P. and 5730 ± 145 B.P., and it is difficult to resolve which if either can appropriately be associated with the Mallory assemblage. The Albion Boardinghouse site provides some support for Osborne’s (1993) model of seasonal high elevation hunting by foragers who utilized the diverse environments of the central Rocky Mountains and Plains.

**McKean Sites in Northeastern Colorado.** Additional sites with McKean components located in northeastern Colorado have been reported by Morris et al. (1985) and include several that have yielded radiocarbon dates based on charcoal and some sites known only through surface collections. Although these sites have not been published in detail, they provide significant supportive information concerning the distribution of McKean complex assemblages in the Central Plains region. In addition to Dipper Gap, radiocarbon-dated McKean components are reported from Phoebe Rock Shelter (5LR161), Spring Gulch (5LR252) (Kainer 1974), Pack Rat Rock Shelter (5LR170), and Kinney Spring (5LR144c). Collectively, these sites provide some information pertaining to the variety of fauna in McKean assemblages, and to the co-occurrence of various McKean technocomplex projectile point types. Ten additional sites, lacking radiocarbon dates but with McKean complex points, have been documented in the foothills and short grass plains of Larimer and Weld counties. Most of these sites are located on south or southeast facing slopes overlooking springs or creeks (Morris et al. 1985:17).

**Key McKean Sites on the Northern and Northwestern Plains.** A number of McKean sites outside the immediate area of concern to this overview have yielded key evidence concerning technology, economy, age, distribution, and variability in the McKean archeological record. Research with assemblages from the Lightning Spring and Red Fox sites (Keyser and Davis 1985; Keyser and Fagan 1993) has provided important insights into McKean lithic technology and biface reduction systems, following up on research by Green (1975). Several sites with biface caches are also documented (e.g., Davis 1976), and the distribution of components based on projectile point occurrences is fairly well defined (Trattebas 1986; Keyser and Fagan 1993; Kornfeld and Todd 1985). Bison kills are documented in Wyoming at Cordero Mine (Rehre et al. 1985; Nevin and Hill 1995) and Scoggin (Lobdell 1973, 1974), and in Alberta at Head-Smashed-In and Cactus Flower (Brunley 1975; Reeves 1978). Structural evidence in the form of pit houses are documented at McKean and Dead Indian Creek in Wyoming (Frison 1991b; Frison and Walker 1984; Kornfeld and Frison 1985). The Koterman site located in the Angostura area of southwestern South Dakota was investigated with several other middle Holocene sites by Wheeler (1985:8) and has yielded two radiocarbon dates attributed to McKean. These dates 4291 ± 350 B.P. and 3631 ± 350 B.P. may represent early McKean ages.

**Deluge Shelter.** Located in Dinosaur National Monument in the Green River Basin near the Utah-Colorado border, Deluge Shelter is a multicomponent site with an important middle Archaic deposit (Leach 1970). Three radiocarbon dates from Level 12 (Leach 1970:225) have been attributed to the McKean complex, and although they have been inconsistently reported (Metcalf 1974:36; Barnes 1985), the range is between 3200 and 3900 B.P. A Scottsbluff point was found below the McKean level, and Fremont materials occur in the upper deposits. Fauna is dominated by mule deer and rabbit with elk, beaver, and muskrat also represented (Leach 1970:224).

**Apex Complex.**

The Apex complex was also based on work at Magic Mountain and is characterized by the presence of McKean technocomplex points and is dated to the period between 3000 and 5000 B.P. (Irwin-Williams and Irwin 1966). This complex compares favorably with Complex C and Complex D at LoDaiska Shelter (Irwin and Irwin 1959). A variety of stemmed and notched dart points occur with the McKean, Duncan, Hanna, and Mallory points in this complex, and these other forms may represent local variants (Greiser 1985:94). The Apex complex is of importance because it represents part of an early attempt to organize and classify the Holocene archeological record in the eastern Colorado area. The relatively well-dated and stratified sequence at Magic Mountain has provided an important key used to decipher the chronological position of other assemblages in the central and eastern Colorado area. The Apex complex, or a significant part of the three components attributed to this complex (which includes potentially mixed assemblages), can be considered a regional expression of McKean. Artifacts of other groups or non-McKean materials are apparently represented as well. An evaluation is needed as to the potential relationships with sites in the Plains region. One must consider the possibility that some of the differences between Apex and McKean are primarily seasonal or functional rather than cultural.

**Munkers Creek Phase.**

Discussions of the Munkers Creek phase are found in Witty (1982a), Schmis (1976, 1978), Reynolds (1982a), and Thies and Witty (1992). This phase dates to approximately 5500 to 5000 B.P. and was defined by Witty (1982a:202-205, 218-228). Components of this phase are located in northeastern and east-central Kansas. Excavated and reported sites include William Young in the Council Grove Lake area in Morris County (Witty
Cow-Killer (Area 741) in the Melvern Lake area, Osage County (Reynolds 1982a), and the Coffey site on Tuttle Creek Lake in Pottawatomie County (Schmids 1978). It should be noted that the Coffey site components originally assigned to the Munkers Creek phase were later used by Schmids in defining the Black Vermillion phase. The primary documented sites are located in alluvial terrace settings on primary rivers and tributaries. Age of the Munkers Creek phase is based on a series of radiocarbon dates from the William Young and Coffey sites and these indicate that the phase dates to the mid-Holocene Hypsithermal.

Economy of the Munkers Creek people was apparently based on hunting and foraging, with deer and small mammals the primary animal species utilized. Bison are also represented in the fauna at some sites. Distinctive artifacts include Munkers Creek gouges, some of which are made from Munkers Creek knives (Figure 36). Munkers Creek knives are typically large, often sickle-shaped pieces which exhibit gloss on the surfaces of the concave edge. This polish apparently resulted from cutting wild grasses or similar plants (Witty 1982a:152-157).

Other important artifact types include chipped double-bitied axes and lanceolate dart points of the Munkers Creek type which have poorly defined shoulders. Interesting ceramic figurines or fired clay heads were found at the William Young site. No other ceramic technology is known except for a ceramic bead from the Coffey site, and this is the earliest evidence for ceramic technology documented for the region. A number of sites in eastern Kansas are assigned to this phase by Witty (1982a:202-205), but more research is needed as the variety of site types, settlement systems, economy and other issues.

Munkers Creek Sites in Kansas.

William Young Site. The William Young site (14MO304) was tested in 1961 with primary excavations conducted in 1962 and 1964. The site is located on Munkers Creek at Council Grove Lake. Three primary stratigraphic and cultural levels were recognized and it is the lowest, Zone III (ranging from 2 to 5 feet below the surface) which is of primary interest here. A series of sequential occupation surfaces are apparently represented which include hearths, pits, postmolds, charcoal concentrations, debitage concentrations, and mud dauber nests. A rich lithic assemblage includes a large and diverse collection of debitage suggesting a full range of lithic extraction, reduction, and maintenance activities (Reynolds 1982b). A good source of Permian Flint Hills Florence chert is available within a few hundred meters of the site. A considerable amount of early and intermediate stage biface reduction occurred at the site.

The Zone III excavation included 3,800 feet² (about 3810 x 10 foot units) which was conducted in 6 inch levels. The lack of screening is assumed to account for the underrepresentation of very small flakes in the debitage assemblage (Reynolds 1982b:240). The Zone III occupations and collections occurred through a vertical thickness of about 5 feet (Witty 1982a:13). Features included 15 hearths, some small with few stones but others large with numerous burned limestone rocks, six generally shallow pits, four postmolds, and numerous concentrations of charcoal and lithicdebitage.

Among the more remarkable artifacts from the William Young site are two fired clay human “effigy” heads. Both ceramic items are triangular in outline and flat in section and measure about 5 cm in length. The elements of the faces are executed with punctuations and minimal molding. These represent the earliest known ceramic objects (made by use of controlled fire) in the Plains region and perhaps in the entire United States.

A number of distinctive chipped stone artifact types occur at William Young which are characteristic of the Munkers Creek phase. These include Munkers Creek axes which are thick chert bifaces with a sharp cutting edge on one end opposite a blunt or squared poll end, and broad shallow side notches for hafting the handle near the poll end. Munkers Creek knives are also distinctive and are bifacial implements 10 to 15 cm long with a rounded or blunt point on one end and a squared base which often exhibits a cortex remnant. These knives were made from biface blanks rather than from large flakes and have parallel or asymmetrical blade edges. The overall form is usually crescent shaped or with one concave edge and the opposite one convex.

Figure 36. Munkers Creek complex artifacts from the William Young site, Kansas. a. Munkers Creek knife; b-d. Munkers Creek projectile points; e-f. Munkers Creek gouges; g-b. Munkers Creek ceramic figurines; i-j. Munkers Creek axes at 50% reduced scale (redrawn from Witty 1982).
or straight. The concave edge is typically highly polished (e.g., sickle gloss) apparently reflecting the function of these tools in cutting grasses. The type of grass being cut and the purpose to which it was put remain unclear. Grass seeds may have been collected as a food resource, stems may have served as thatch or padding, and there are other possibilities such as the creation of mastic from grass resin. The presence of some grinding stones may suggest vegetal food (grass seed) processing, but at least one of these artifacts was used in association with pigment grinding or preparation (Witty 1982a:179). Munkers Creek knives are a distinctive middle Holocene artifact type and have been recorded, also made of Florence chert, as distant as Caddo County in west-central Oklahoma.

Munkers Creek gouges are another distinctive element in the Munkers Creek phase. These bifacial tools appear to be recycled from broken bifaces, late stage preforms, or broken Munkers Creek knives and are characterized by a steep unifacial bevel on the broad end. These artifacts compare closely to bifacial varieties of the Clear Fork Gouge found commonly in the Southern Plains (Ray 1941; Hester et al. 1973; Hofman 1977, 1978; Hughes 1980; Turner and Hester 1993). These tools exhibit nibbling and crushing on the working edge which suggests heavy-duty work on wood or other resistant material. These gouges are from 6 to 9 cm long and compare in thickness with the Munkers Creek knives, 10 to 17 mm.

Munkers Creek points are also distinctive with a slight stem and lanceolate blade. The shoulders are generally weak and slope toward the base which is straight, or slightly concave or convex. The stem is parallel sided or slightly expanding. Variety 2 points are generally smaller with very slight shoulders and may represent points with substantially reworked blades. A few side-notched or expanding stemmed points are also in the assemblage.

Faunal material is fairly diverse with 10 species of mammals as well as box turtles represented. Notable by its absence in the fauna is bison. Both antelope and deer are represented along with small species including large canid, beaver, rabbit, cottontail, squirrel, muskrat, badger, and fox (Witty 1982a:Table 31).

The thickness of the Zone III deposits at William Young was as much as 5 feet, so some consideration was given to the problem of artifacts associations and assemblage definition based on what is obviously a deposit which accured over an extended period (Witty 1982a:Figure 17). Notably, the hearths and "immobile" features of Zone III range from 2.2 to 7 feet below the surface. During the period of Munkers Creek phase occupation, it is argued that there was rapid aggradation of the terrace surface. Refitting of a number of artifacts demonstrated that there has also been some homogenization of the deposits, probably by a variety of biogenic and physiogenic processes (Butzer 1982; Hofman 1986a), with segments of the same artifact vertically displaced more than a foot in at least some cases. This is an explainable and "typical" amount of vertical movement in terrace deposits of this age (Hofman 1986a).

Cow-Killer Site. The Cow-Killer site (14OS347) is located on the Marais de Cygnes just below the Melvern Lake Dam, about 45 miles east of the William Young site, and was discovered during excavations related to construction activities. Excavations under the direction of John Reynolds were conducted during 1974 and 1975. The work in 1975 was primarily concerned with the early ceramic Greenwood phase component at the site. In 1974, excavation focused on Area 741 which was excavated using 5 x 5 foot horizontal units and 6 inch or 3 inch levels. An area of 350 foot² (ca. 17.5 x 20 feet) was excavated, and the matrix was not screened. Area 741 was the deepest portion of the site and produced Munkers Creek materials including points, knives, and gouges (Reynolds 1982a: Plate 10). Stone hearths, shallow pits, and postmolds were documented as were concentrations of debitage and burned floral material (Reynolds 1982a: Figure 8). A grinding stone and several pieces of hematite were also recovered. Faunal material included more than 1,000 specimens of which about 90 were identifiable to species. Deer elements were most common, followed by bison and beaver. Turtle carapace segments and fish vertebrae were also recovered. The full extent of the site remains unknown due to destruction during construction activities that first exposed the site.

Cowley Site. The Cowley site (14PO1) is located on the Big Blue River near the northern end of Tuttle Creek Reservoir about 40 km north of Manhattan (Schmids 1978, 1982a). The primary buried Archaic cultural levels in Locality I, levels III-5, III-7, and III-8, occur 2.4 to 3 m below the surface. These components have been attributed to the Munkers Creek phase (Witty 1982, Reynolds 1982a) and subsequently to the Black Vermillion phase primarily because of the diversity of projectile point types represented at the Cowley site as compared to the William Young site (Schmids 1978, 1981). The majority of radiocarbon dates frame these occupations between 5000 and 5500 B.P. (Table 29). Excavations were conducted from 1972 through 1975 and covered an area of about 148 m² for level III-5 and somewhat less for levels III-7 and III-8 (about 132 and 120 m², respectively). Methodology included use of 1 x 1 m excavation units, 10 cm levels, screening, and flotation. As a result of the extensive excavation and diligent recovery, the Cowley site investigations serve as a key for comparison and interpretation of middle Holocene sites in the region (e.g., Wedel 1986).

Features include shallow basin pits, burned rock concentrations, hearths, and at least one postmold. Charred botanical remains were recovered through flotation and include evidence of smartweed (Polygonum), hackberry, bulrush (Scirpus), and grape. A variety of plant species which might be expected were not recovered. The diverse faunal and floral inventory provides an important complement to that derived from most other Archaic sites in the region. The contribution of naturally occurring or "background fauna" to this inventory has not been adequately assessed.

The lithic assemblage includes a variety of projectile points including Munkers Creek and basal and corner-notched points, gouges, axes, Munkers Creek knives, and ground stone artifacts. An apparent ceramic bead was also recovered. Reported were 27,754 artifacts and ecofacts (Schmids 1978:Table 2) dominated
by pieces of unworked bone (11,022), flake debris (10,726), charred seeds (4,299), unworked stone (704), burned earth or daub (226), and charcoal fragments (551). The remaining specimens include 205 chipped stone tools, 49 ground stone tools, 11 bone tools, 12 ornamental artifacts, and 39 cores. The chipped stone inventory includes 18 projectile points mostly with straight to expanding stems and basal or corner notches. Bifacial drills (N=3), preforms (N=26), and bifacial knives (N=51) are also described. Ten of the knives are comparable to the Munkers Creek knives from the William Young site and generally exhibit high polish or gloss on a concave edge. The remaining knives are ovate and variable. Three chipped stone axes, two bifacial gouges, two bifacial choppers, and 19 biface fragments are reported with the remaining chipped stone tools consisting of 31 scrapers and 36 retouched flakes. The majority of the chipped stone artifacts and debris are Flint Hills Permian cherts available in the locality. The 49 ground stone artifacts and fragments include grinding slabs (N=7), manos (15), hammerstones (10), a spheroid, a ground stone grooved axe, and ground stone fragments. Bone tools include three antler flakers, three bone tubes, two punches, one awl and two pieces of modified bone. The tubular fired clay bead made of untempered clay represents an unusual element in Archaic assemblages and complements the occurrence of fired clay beads from the William Young site (Witty 1982a). Pieces of hematite and limonite were recovered from the three levels at Coffey, and a quartzite cobble was covered with ochre and traces of ochre were found on a few tools. In the three levels, 19 hearths, and one postmold were identified.

A variety of activity sets were identified and compared between the three primary levels. There was notable variation in the relative proportion of tools related to activities such as hunting, heavy cutting, hide working, woodworking, chert working, and seed grinding. Whether this variation is due to seasonal differences, random variation, or sampling is unclear. It is evident that the site served as a multiple diverse activity base camp rather than a special purpose or limited activity site, although there is no evidence of permanent structures. Schmitt suggests that the most likely seasons of use would have been summer through winter when the site was less vulnerable to flooding. The apparent lack of structural evidence, however, suggests that winter occupation would have been temporary rather than permanent.

A variety of animal resources were apparently used with bison, deer, small mammals, reptiles and amphibians, birds, and fish represented. Mammals include bison, deer, raccoon, dog or coyote, skunk, squirrel, mole, cottontail, gopher, and woodrat. Birds include ducks, geese, and hawk. Several turtles were also found. A large number of fish are represented in each of the three levels, dominated by catfish, with gar, drum, catfish, sucker, and minnow present. Overall, a diffuse economy is indicated, but with catfish forming a significant portion of the diet. The size of the catfish varies considerably with more than 160 individuals. The size variation may indicate use of nets or poisons which would result in a relatively nonselective capture. Such techniques may have been effectively employed in shallow backwater areas. Use of plant resources included seeds and berries with Chenopecus a dominant plant food as shown by the more than 4,000 charred seeds. This is a disturbance plant which would also occur commonly along the margins of backwater lakes. Schmitt argues for a dryer climate and more xeric floral community in the region around Coffey during the middle Holocene, based on the floral and faunal evidence from the site.

Other Munkers Creek Phase Sites. Witty (1982a:204-205) provides a brief discussion of several additional Munkers Creek sites in eastern Kansas. These include Elliott (14GE303), Roniger (14CS375), Hyde in the upper end of Melvern Lake, three sites in the John Redmond Lake area (14LY328, 14LY329, and 14CF1310), and four sites in the Council Grove Lake area (including 14MO360, 14MO361, 14MO320). Evidence from these sites is based primarily upon surface collections which contain some combination of diagnostic Munkers Creek artifacts such as gouges, knives, axes, or points.

Sedalia Phase

The late Archaic Sedalia phase was known initially from surface-collected sites in west-central Missouri along the Lamine River in the vicinity of Sedalia between the Missouri and Osage rivers (Seelen 1961; Turner 1965). This distribution is expanded considerably by Chapman (1975), but Reid (1984:72) and Kay (1983) suggests that the complex as a distinctive assemblage type is more limited. The most definitive research to date has been at the Phillips Springs site and Rodgers Shelter in the Truman Reservoir area in the middle Osage River drainage (Kay 1983). The Phillips Springs site assemblage is particularly noteworthy because of the numerous preserved remains of native cultigens, especially squash and gourds (Chomko 1978; Kay 1982, 1983; Kay et al. 1980). This abundance of evidence for domesticates in the late Archaic of west-central Missouri holds important implications for this time period in eastern Nebraska and Kansas. A suite of radiocarbon dates from Phillips Spring, Rodgers Shelter, and several other sites indicate the time frame for the Sedalia phase to be from about 2600 to 4300 B.P. (Kay 1983). Sedalia components in Unit E at Phillips Spring include hearths, midden deposits, burned rock concentrations, and storage pits. The site is interpreted as a relatively permanent encampment or base camp occupied from spring through fall. Additional components include that at Rodgers Shelter Horizon 3 where three primary flexed Sedalia phase burials are documented at what is interpreted as a short-term hunting-butchering camp (Kay 1983). An important mortuary site is the Holbert Bridge Mound where a secondary bundle burial with associated Afton points was contained in a rock and earth mound. Upland sites between the Osage and Missouri rivers are common, but most consist on lithic scatters (Kay 1983). The Geiger site is an example of an upland site with several discrete midden concentrations which could represent prior house locations (Kay 1983:51).

The characteristic projectile point-knives are Sedalia Lanceolate and the less frequent Etley Stemmed and Stone Square Stemmed, Smith, Afton and occasionally other types.
Other artifacts include gouges, drills, ground stone axes, chipped adzes "Sedalia Diggers," ground stone manos and metates, hammerstones, and choppers. The complex is apparently contemporary with the Nebo Hill phase in the Kansas City area.

Chelsea Phase

In the southern Flint Hills of Kansas, the Chelsea phase has been dated to about 4100-4900 B.P. (Grosser 1977). The phase was first defined by Grosser based on research at the Snyder site and additional information is available on a component at the Milbourne site (Root 1981). Both sites are located in the Walnut River Valley in Butler County. The Chelsea phase is later than Munkers Creek but predates the El Dorado phase, which is recognized over a broader geographical area. A Chelsea phase radiocarbon date from Snyder is 4830 ± 105 B.P. (N-1275). Diagnostic artifacts include short shallow side-notched and long shallow corner-notched dart point/knives. There is evidence of bison, deer, antelope, rabbit, and other small vertebrates in the diet. Food plants are unknown, but grinding stones do occur. Grosser (1977) attributes the change from Chelsea to El Dorado phase as being a result of more generalized foraging or utilization of a larger variety of resources.

El Dorado Phase

The El Dorado phase has been defined based on research at the Snyder site (Grosser 1973, 1977) on Walnut Creek in Butler County and the Williamson site in the John Redmond Lake area in Coffey County. This is one of the east-central Kansas sites (Schmitz 1980b, 1987a), and some less intensively studied components at other east-central Kansas sites (Schmitz 1987b:169-170; Witty 1982a:225-226). The complex is believed to date between about 4100 and 3500 B.P. based on radiocarbon dates from four sites: Williamson, Snyder, 14LY305 and 14MY309 (Table 27). Components are documented throughout the eastern third of Kansas in tall and mixed grass prairie and savanna country. Two burial mounds in north-central Kansas, Matter Mound and Range Mound in Jewell and Mitchell counties, respectively, have been attributed to the phase (Schmitz 1987b; Thies and Witty 1992). These stone mound complexes are poorly documented but provide important clues to mortuary complexity during the Late Archaic in the Central Plains. Secondary burials, a few primary burials, and cremations are represented at these mound sites in north-central Kansas. Ornamental artifacts, including numerous shell items are reported from Matter Mound where the remains of at least 23 individuals were documented (Pinnegan 1981). Several individuals and some shell beads were also found at Range Mound. These round rock mound features are about 10 and 20 m in diameter, respectively, and about 1 m in height. Two primary flexed human burials, both females, and a dog burial were documented at the Williamson site. Both burials were associated with possible rock features or concentrations which may have been part of the grave covering. Artifacts diagnostic of the El Dorado phase include Table Rock stemmed, Sedalia lanceolate and especially Dustin side-notched projectile points. Tubular bone beads are also documented.

Economic pursuits are best reported from the Williamson site where the artifact inventory suggests emphasis on hunting and butchering, hide-working, and chipped stone tool manufacture with minimal evidence for plant food processing (Schmitz 1987b:Table 4). The Williamson site is interpreted as having been used during the fall as a "residential extractive camp." Faunal remains indicate that bison was an important component of the diet with deer, antelope, beaver, and a variety of lesser species filling out the recovered bones. Plant food remains were not found at the site. Remains of shellfish processing is seen at the El Dorado phase component at the Faulconer site (Bradley 1973), indicating that such lesser species seasonally contributed to the subsistence of these Archaic people. The presence of bison in the faunal assemblage helps document the post-Hyposothermal range of this species.

El Dorado Phase Sites in Kansas

Williamson Site. The Williamson site (14CF330) is located on Eagle Creek near its confluence with the Grand or Neosho River in the John Redmond Lake area in east-central Kansas (Schmitz 1980b, 1987b). Excavation was conducted using a grid of 10 x 10 foot units and 6 inch levels and covered an area of about 1200 feet. Stratigraphic Unit II was the primary cultural stratum and was from 1.2 to 1.5 m in thickness. Vertical distribution of artifacts suggests at least two distinct occupational periods. The lowermost of these yielded charcoal which provided two radiocarbon dates of 3500 and 3600 B.P. (Table 29). Features included burned rock concentrations and two burials. The individuals were both females between 20 and 40 years old buried in flexed positions, one seated and one on her back. One was buried with a projectile point and one with a biface knife. A dog burial was also documented at the site. Unit II yielded 123 chipped stone tools, eight ground stone tools, three bone tools, 18 cores, four pieces of limonite, and 326 pieces of animal bone. Projectile points are primarily stemmed with side notches and convex bases and referred to as Dustin. Other types include lanceolate points and Table Rock stemmed. Fauna from Unit II includes a variety of species with bison and deer well represented and badger, beaver, rabbit, canid, turtle, bird, and fish also in evidence.

William Young Site. William Young is primarily known as a Munker's Creek phase occupation, but Zone II (from .5 to 2.0 feet below the surface) at the site yielded an assemblage assigned by Witty to the El Dorado phase (1982a:113). William Young is located in Council Grove Lake in the Flint Hills of east-central Kansas. This component has projectile points of the Table Rock and Motley types, some grinding equipment, bone tools, bison bone remains, and three hearths. The presence of one or more structures may be implicated by fragments of mud dauber wasp nests.

Matter and Range Mounds. Two mound sites in the vicinity of Glen Elder and Waconda Lake in north-central Kansas have yielded limited but tantalizing information pertaining to late
Archaic mortuary practices in the region (Finnegan 1981; Schmits 1987b; Thies and Witty 1992:159). The Matter Mound site, 14JW303, and Range Mound, 14ML307, have yielded preliminary information on probable El Dorado phase burial practices. The sites are known primarily through bank erosion and the results of vandalism. The presence of Table Rock and Dustin or Lamoka point types suggest affiliation with the El Dorado phase (Reynolds 1977; Schmits 1987b; Thies and Witty 1992). The Range Mound contained burned rock and was about 20 m in diameter and 1 m in height. Disarticulated and fragmented remains of several adults are represented (Finnegan 1981), and artifacts include several points and 25 marine and freshwater shell beads. Matter Mound was some 10 to 13 m in diameter and about 1 m high. Remains of at least 23 individuals were present including primary, secondary, and cremation interments. Artifacts include Dustin points, numerous beads, and geometrically shaped shell artifacts (Thies and Witty 1992; Reynolds 1977). Whether the variation in mortuary treatments indicates status differentiation or situational factors relating to the time, location, and season of death remain unknown (Schmits 1987b; Hoffman 1986b).

**Faulconer Site.** This dated site in the Walnut River valley gains significance through the faunal study and radiocarbon dated stratigraphic sequence (Bradley 1975). The diverse fauna from Zone B, radiocarbon dated to 3100 ± 167 B.P. (N-1552), includes coyote, prairie dog, pocket gopher, deer, fox, and turkey. Additional species from the site include jack rabbit, cottontail, and box turtle. Mussels are also abundant below Zone A and are dominated by Ambliema (Crenondonta) with some Quadrula and Ligumia represented. The vertebrate fauna is assumed to have been culturally introduced, but the rodents could represent background fauna. Grosser (1977) suggests that Faulconer Zone B may belong to the Walnut phase, but Leaf (1979) suggests an El Dorado phase connection based on projectile points.

**Snyder Site.** Excavations at the Snyder site, 14BU9, by the University of Kansas during the 1968 through 1971 seasons (Grosser 1970, 1973, 1977) yielded substantial information on Holocene occupations assigned primarily to the Walnut and El Dorado phases. The site is situated on a terrace above the Walnut River near the El Dorado Reservoir area in the southern Flint Hills. Most of the cultural materials of significance are derived from Zone C which is from 90 to 150 cm thick and contains El Dorado, Walnut, and Chelsea phase components. The El Dorado phase component occurred between 80 and 140 cm below the surface, underlying the Walnut phase materials and above the limited Chelsea phase assemblage. Zone C excavations were in 2 m squares (usually divided into four 1 m quadrants) and 15 cm levels, with tools and bones plotted individually. Some of the deposit was dry screened through 1/4 inch mesh and selected samples were waterscreened as well. Total excavated area at Snyder was extensive, but much of the excavation did not extend below Zone B. About 280 m² were excavated through Zone C (estimated from Grosser 1977:Figure 4).

Daub provided clues to the location of a probable structure in addition to hearths, pits, burned limestone concentrations, and a burial in the El Dorado component (Grosser 1977:124-129). Most of the pits were shallow and contained burned limestone, but one containing refuse may have originally been a storage facility. In addition, four postmolds were documented, though there were no structural patterns evident. Feature 22 appears to represent a structure of indeterminate form or size which is indicated by daub with grass impressions, fired earth, and mud dauber's nests. A second area of burned earth, charcoal, daub, and mud dauber's nests suggest a possible second structure.

A burial was encountered at the Snyder site during stratigraphic testing (Klepingar 1972). The individual was an adult female estimated to have been 24-29 years old and about 4 feet 11 inches in height. She had been placed in a flexed position with a few possible associations including a bifacial fragment and large notched projectile point. Sediment from within the burial deposit contained hackberry and chenopod (lambsquarter) seeds. The deposit with the burial is estimated to be more than 3,900 years old.
Radiocarbon dates from Snyder include four for the El Dorado phase. These are 3240 ± 85 B.P. (N-1277), 3650 ± 140 B.P. (N-770), 3910 ± 155 B.P. (N-771), and 3980 ± 100 B.P. (N-1278), suggesting a time frame from about 3,200 to 4,000 years ago for the El Dorado occupations (Grosser 1977:Table 34).

Faunal remains from Snyder include a substantial species list of vertebrates, with bison being the single most important animal in terms of weight or mass contribution. A few lesser species, however, occur in higher frequency. The El Dorado phase fauna includes white-tailed deer, bison, antelope, cottontail, beaver, badger, raccoon, muskrat, river otter, ferret, coyote, jack rabbit, prairie dog, gopher, mouse, moles, and voles in the mammal list. Turtle, rattlesnake, toad, owl, catfish, and mussels are also represented. Plant remains identified to species from the El Dorado phase include hackberry, pigweed, and lamb's-quarter (Grosser 1977:Table 33). In addition, black walnut was found in the earlier Chelsea component at the site.

The El Dorado phase lithic assemblage from Snyder includes 189 artifacts with projectile points (N=33, 25%), knives (49, 37%), choppers (16, 12%), grinding stones (30, 22%), and miscellaneous tool fragments (55) dominating the assemblage. Scrapers, hammerstones, and drills are rare. The later Walnut phase occupation at the site shows a marked increase in scrapers and rare choppers and grinding stones (Grosser 1977:Table 22). A few bone beads and bone tools are documented and chipped stone axes and large bifaces are also common in the assemblage. Projectile points are large, broad bladed, and stemmed or notched. A variety of tools are present, including Dustin, Table Rock, and corner-removed and corner-notched forms.

Coffey Site. The Coffey site in the northern part of Tuttle Creek Lake on the Big Blue River in Pottawatomie County, Kansas is primarily known for its buried components (Schmcts 1978a, 1980a), but an extensive surface collection yielded numerous Dustin and Table Rock projectile points which are derived from an El Dorado phase occupation (Schmcts 1987b:169). The density of material and size of the surface scatter suggest intensive or repeated use of the site by El Dorado phase people.

Nebo Hill Phase

The Nebo Hill phase (Reed 1980, 1983, 1984; Reeder 1980) represents a distinctive late Archaic occupation in the Kansas City area which dates to approximately 3000 to 4500 B.P. The phase is particularly important to the issue of agricultural development in the region because it represents an early period of tropical cultigen usage, notably squash, by hunter-gatherers in the region. Other native cultigens are also indicated at some Nebo Hill components (Adair 1988). Nebo Hill is a key cultural complex in the study of processes leading to an agricultural economic lifeway in the Central Plains region.

Nebo Hill people are interpreted by Reed (1980, 1983, 1984; Reeder 1980) to have had a cyclical pattern of mobility and organizational flexibility. The growing seasons were spent in nucleated settlements on upland divides or high terraces overlooking major streams. During winters the social groups dispersed and lived in protected lowland settings along lesser streams and tributaries. The material culture of these people is distinctive and includes large, though often resharpened, lanceolate projectile point/knives, bifacial gouges, bifacial hoes ("diggers"), adzes, ground stone axes, grinding stones, and fiber-tempered pottery (Figure 37). Other than fragmentary ceramic vessels which may have been used for storage, there is little evidence of systematic intensive storage. The complex is believed to be a precursor of Woodland developments in the region, which were due to a series of demographic and economic changes. Although settlement of Nebo Hill people is believed to have been seasonally permanent, evidence for structural remains is limited. Possible structure areas are identified at the Nebo Hill site (Reed 1984:Figure 23) and a possible pole structure is reported from site 14MM27 in Miami County, Kansas (Blakeslee and Rohn 1982). Limited information pertaining to mortality practices indicates that ridgetop cemeteries were used.

Nebo Hill Sites

Nebo Hill Site. The type site, 23CL11, is located on a high river bluff at the north edge of Kansas City, Missouri (Shippee 1948). Surface collections from this and several nearby sites in Clay and Jackson counties, Missouri were used by Shippee to define the Nebo Hill complex. The variety and distribution of Nebo Hill sites is discussed by Reid (1983, 1984). Sites occur in southwestern Iowa, northwestern Missouri, and northeastern Kansas, and Reid (1983:19-20) suggests that geologic and geomorphic factors may be controlling the limited east-west distribution of recognized and reported sites which include, camps, lithic quarries, burials, and limited activity sites. Few Kansas sites have been studied in detail, but a site is reported in Miami County (14MM27) in the Hilldale Reservoir on the Marais des Cygnes (Blakeslee and Rohn 1982). The upper Osage River Basin is as far south as well-documented Nebo Hill components are reported.

Walnut Phase

The Walnut phase, ca. 3000-2000 B.P., is represented by sites in the Flint Hills province (Grosser 1970, 1977). There is a Walnut phase component at Snyder in the uppermost part of Zone C, 40-80 cm below the surface. The component yielded 107 stone tools dominated by projectile points (N=17, 20%), knives (41, 49%), scrapers (22, 26%), and miscellaneous fragments (N=23). Other rare tools forms include choppers and a hammerstone. Fauna includes bison, white-tailed deer, mole, and voles. Two Walnut phase radiocarbon dates from Snyder are 1970 ± 110 B.P. (N-769) and 2060 ± 80 B.P. (N-1276). Other components include a dated occupation at the Coffey site (Schmcts 1978b, 1981) and other Butler County sites. Small projectile points named "Walnut Valley Corner Notched" (Grosser 1977) may represent an early arrow point type in the Plains region. No evidence of pottery is reported and subsistence data is limited to faunal remains. Bison, deer, and small mammals are represented. Similar early dates for arrow
points are known from further south in Oklahoma (Taylor 1987; Hartley 1974).

Colvin Phase

This poorly known complex was created based on work at the Colvin site in the Wolf Creek Reservoir area of the Neosho River valley in Coffey County, east-central Kansas (Rohn et al. 1977). No radiocarbon dates are available but the phase is estimated to date between 3500 and 2500 B.P. based on typology of the projectile points. Concentrations of fire-reddened limestone and sandstone apparently reflect cooking or food processing activities. As the distinctiveness of this phase has not been well documented, use of this archaeological construct should be dependent upon further study and more complete information concerning the original materials.

Stigenwalt Complex

The Stigenwalt complex was named by Thies (1990) following investigation of the Stigenwalt site, 14LT351, in Labette County and on Big Hill Creek near Big Hill Lake in the Verdigris River valley. The investigations were conducted in 1986 and 1987 along both sides of Big Hill Creek where a new man-made channel had exposed deeply buried paleosols and cultural materials. An extensive deposit containing burned rock and artifacts extended for some 60 m along the creek margins. Numerous features containing burned rock were defined and three of these yielded charcoal used for radiocarbon dating. In addition, two radiocarbon ages were determined on soil humates from an overlying and somewhat younger paleosol.

The rock feature dates range from about 7,300 to 9,000 years ago (7410 ± 70 B.P., TX-5994; 7590 ± 100 B.P., TX-6050; 8130 ± 130 B.P., TX-6048; and 8810 ± 250 B.P., TX-6049) (Thies 1990:109). The projectile points found in association with these features and dates vary considerably in form and have been compared to a variety of named types. Thies (1990:116) describes them as follows: "one point has a lanceolate shape, one is basally notched, four are either side notched or corner notched, and ten are stemmed, or corner removed...10 of the 16...are stemmed...[and]...can be characterized... as being corner-removed specimens with straight stems." Other artifacts include a grooved ground stone axe, bifaces, unifacial tools, flake tools, cores, debitage, grinding stones and slab metates. Bone artifacts include two awls and a bird bone bead. Nine pieces of human skeletal material were found in association with one rock concentration and represent at least two individuals, one adult and young adult. There is no information on burial form and no indication of burning. One of the elements was found in a second rock feature and whether this represents part of the above individuals or a third individual is unknown.

Plant remains include numerous pieces of onion or garlic (Allium) which were apparently collected and roasted at the site. Faunal remains include deer, coyote, mink, beaver, badger, raccoon, squirrel, jackrabbit, cottontail, gopher, vole, mice, hawk, prairie chicken, owl, snakes, and frogs. The MNI for all species is low with two deer, three cottontails, and two coyotes represented.

Overall, the stratigraphic and paleoecological information from Stigenwalt site is as significant as the archeological remains. The site will serve as a key reference point in the development of an early Holocene archeological and paleoecological record in southeastern Kansas.

Frontier Complex

Salvage excavations in Medicine Creek Reservoir at the Allen site led to definition of the Frontier complex which was attributed to the Plains Archaic period (Holder and Wike 1949:260-266). Initial radiocarbon dates from the site were less than satisfactory (Libby 1955) and included two ages from the lower occupation level, about 8300 and 10,500 B.P. with large sigmas and a mixed sample from both occupation levels of about 5200 (Table 29). Recent reanalysis of the collections from Allen by Bamforth (1991a) includes new radiocarbon dates based on charcoal which show the two occupation levels at Allen to be of Paleoindian age. The lower level dates to more than 10,000 years ago and the upper level (Occupation Level II) has one date of about 8700 B.P. The Allen site is discussed above with the Paleoindian complexes. The lower level yielded two points classified by Bamforth (1991a:361) as Agate Basin, and parallel-oblique flaked points from the site may belong with the younger component. Wedel (1986:70), suggests the points from Occupation Level I are concave based and "reminiscent of the Angostura type." Important, distinctive artifacts including "trapezoidal scrapers" were found at Allen, and these compare closely to Munkers Creek gouges in Kansas Archaic assemblages (Witty 1982a).

Other Archaic Evidence

In western Kansas, relatively little early to middle Holocene archeological evidence has been reported. One documented site from Logan County, 14LO6, was reported by Schock (1965) which was a limited activity camp on the Smoky Hill River. Limited testing yielded evidence of a campfire, three fragmentary dart points, and large (bison?) bone fragments. Numerous other accounts of preceramic occupations in Kansas occur (e.g., Rogers 1984), and inspection of numerous collections made by avocational archaeologists indicate a wide range of Archaic materials in western Kansas including projectile points of the Logan Creek, McKeen, Mallory, and later types. Holocene hunter-gatherer sites in Nebraska are becoming better known, but most remain incompletely studied (Carlson 1994). The Dry Lake and Gering sites are among those needing more complete study (Breternitz and Wood 1965; Carlson 1994; Carlson and Steinacher 1978; Thies and Witty 1992).

Awareness of the complexity of Archaic or Mesoindian lifeways is increasing and the importance of Mesoindian archeology to the understanding of cultural variation before and after this period is acknowledged. The commonly deeply buried position of many middle Holocene sites is now widely recognized, and as a result archeologists are increasingly better
equipped to identify and investigate such sites which have usually gone unrecognized on typical pedestrian surveys.

Holocene Hunter-Gatherer Variability in Evolutionary Perspective

Many of the comments included at the close of the Paleoindian section are appropriate here as well. Research problems include the need for documentation of local and regional geomorphology in order to explain patterning in site distributions and site formation. Holocene land surface changes have a dramatic impact in many regions on recognition of settlement patterns (site distributions), site burial, and visibility. Surface stability is a key factor in assemblage formation and study of site formational histories. There have been relatively few extensive excavations of Mesoindian sites in the Central Plains region. This may be the result of, or the cause for, limited concern with intrasite spatial studies or discussion of domestic space use at Mesoindian sites.

Interdisciplinary research focused on a wide range of evidence is needed at a diverse range of Mesoindian sites in a variety of settings. Archeologists, however, must work to investigate and define the paleoecology of study areas without being limited to site-specific inquiry or studies limited only to those materials found at archeological sites (e.g., Butzer 1982; Pearsall 1989). The relationships among recognized archeological complexes, precise dating of assemblages, lithic technological studies, investigation of trade, lithic source studies, evaluation of demographic changes, documentation of technological changes and developments, variation within and between groups in economy and organization, the relationships and processes in the Paleoindian-Mesoindian and the Mesoindian-Woodland transitions, the utility of foraging models for understanding economies and economic changes, and the relationships between mobility, storage, housing, organization and technology are some of the broad areas of interest in need of further investigation.

Beyond these general concerns, several important research issues are specifically evident when we consider Mesoindian archeology in the Central Plains. Between 8,000 and 2,500 years ago substantial and far-reaching changes occurred in hunter-gatherer lifeways in the Plains region. This was a period of climatic and ecological variation and one of cultural, economic, and technological variation as well. We should expect that the adaptations represented by Holocene hunter-gatherers span the range of variation from that found in standard stereotypical views of both Paleoindian and Woodland prehistoric societies. Archaic or Mesoindian lifeways do not represent a single economic or social condition, but a highly diverse range of cultural groups who occupied a wide range of settings and were dynamic in their adaptations during a period of significant environmental changes.

Views on Mesoindian lifeways have changed substantially in the past 15 years, due to numerous field investigations which have documented pit houses, micro-scale economic evidence, technological diversity, and which included improved identification and documentation of sites and assemblages through geomorphic and site formation studies. Of equal importance, however, is the improved understanding and awareness of hunter-gatherer variability and diversity on a global scale, and the use of sound ecological models as a framework for comparison and evaluation of forager behavior (Bettinger 1991; Binford 1980, 1983; Kelly 1995; Smith and Winterhalder 1992). Critical to development of realistic interpretations concerning Paleoindian-Mesoindian and Mesoindian-Woodland relationships is the use of analytical approaches which include diversity and variation as key components in the study of culture change. If comparative studies and explanations are limited to typological assessments, then the potential to learn about diversity and the processes of change will be seriously impaired.

Economies of Mesoindian groups ranged from those which were, at least seasonally dependant upon hunting and other large game to those geared toward intensive use of lower ranked (smaller and requiring more collection/processing time) plant and animal resources. The use of domesticated varieties of squash was well established during the middle Holocene by Mesoindian groups in the Midwest and southeast (Smith 1992). Current evidence for Mesoindian domesticates, other than dogs, is limited in the Plains and Rocky Mountains regions. More systematic sampling and recovery of paleobotanical remains from archeological excavations should help clarify the significance of wild, domesticatable, and domesticated plant foods in the Mesoindian economy. It is now generally accepted that native cultigens may well have been in relatively wide use before Woodland times. It was not the knowledge of cultigens alone which sparked the developments witnessed in the Woodland and late prehistoric periods, but some combination of factors probably including demographics, social organizational changes, environmental change, and technology, which were part of this long-term process.

The hunting technology during the Mesoindian period is assumed to have been dominated by the use of spear throwers, snares, traps, throwing sticks, and nets. The timing and impact of bow and arrow usage remains poorly understood, but the history of its development and use in the New World may have been different on the Plains than in other regions. Individual, cooperative, and communal hunting seem all to have been practiced on the Plains since very early times. The development of communal hunting as a central part of the economies and social organizations of Plains groups is an important research issue, but we cannot simply assume that a large number of bison necessarily implies communal (multigroup) activity (Hofman 1994a). The economic needs, bone technology, shelter, clothing, and food, which were often derived from bison by Plains hunter-gatherers, are needs which could also have been met through use of other resources. The flexibility of bison and nonbison resource use in the economy and technology of Plains societies would directly impact the organization, mobility, land use patterns, and interactions of groups. Investigation of these factors in Mesoindian archeology must be conducted with the realization that the same group may engage in distinctly different economic patterns from season to season, year to year,
or through the lifetime of individuals. It is also important to recognize that some significant resources may be minimally represented at some sites or in some archeological contexts. In some situations, people may have relied heavily upon bison resources such as meat, fat, and robes which leave little evidence in the archeological record. If stored bison products are being supplemented with local small game, our view of the economy may be significantly skewed.

The documentation of structural remains at numerous Mesolithic sites in the Plains and Rocky Mountains region in recent years (e.g., Larson and Francis 1996) has helped open new insights and perspectives on Holocene hunter-gatherer lifeways. Substantial winter structures imply a seasonal collector and logistical mobility strategy for some (Metcalfe and Black 1991), and this may have been linked in some cases to predictable high density resource areas (Osborn 1993). It is clear that not all Plains Mesolithic lived in highly mobile, minimal technology, foraging groups subsisting heavily on plant resources.

Ceramic technology is something generally associated with Woodland and later occupations in the Plains. The discovery of small fired ceramic (clay) decorated humanoid heads in the Munkers Creek component at the William Young site (Witty 1982a) offers evidence that ceramics were being used, at least for special purposes, well before the Woodland period. There remains, however, no evidence for use or development of ceramic vessels in the Plains region prior to the introduction of Woodland ceramics, which stylistically and technologically appear to be derived from the Woodland cultures of the midcontinent. Mesolithic vessels for transport, storage, and cooking remains largely unknown in the Plains. Baskets and bags were highly functional and more durable in situations of frequent or seasonally frequent mobility.

Storage technology has not received detailed study, but the development of pemmican as a stored food source is again important (Reeves 1990). It is suggested that a fundamental change in mobility, technological organization, and resource use occurred with the beginning of pemmican usage by Plains bison hunters. Evidence of below-ground storage and bulk processing activities focused on storable or transportable resources is likely to be found in the archeological record. Pit features are relatively common on some Mesolithic occupation sites, but effectively distinguishing storage, trash, and processing features has not been a priority concern. It is likely that much of the storage, processing, and transport technologies which were critical or became critical in Woodland and late prehistoric times were developed during Mesolithic times.

Information pertaining to ideology, ritual, social organization, art, trade, and division of labor can potentially be gained from the archeological record. Progress along these avenues has been limited in part by the minimal focus most studies have placed on these aspects of prehistoric Mesolithic life (Kornfeld 1991). Theoretically, such information is no more out of reach or abstract than information on many aspects of economy or technology which are more commonly the focus of archeological effort. Burials, use of domestic space, spatial arrangements of activities, elaborations in material culture, attributes of style, use of plants and designs, exotic materials, and child care and training are all things which may leave their patterns in the archeological record.

Our uses of the archeological record will be limited in part by the questions we ask of it, but asking appropriate questions will depend in large part on an understanding of what the archeological record does and does not represent. The archeological record is generally less well suited to doing primitive ethnography than to the study of long-term cultural change (Jochim 1991). But regardless of the scale of analysis or goals of research, it is important to recognize that significance of the archeological record is generally derived from the questions which are asked of it and how it is studied, rather than from some inherent quality that makes some materials or sites more important than others.
5 Woodland Complexes in the Central Great Plains, by Mary J. Adair

Throughout the Central Plains, beginning around 500 B.C., prehistoric cultural groups experienced varying degrees of technological, social, and perhaps political changes. The material consequences of these changes resulted in the recognition among archeologists of a new adaptation to the Central Great Plains. Labeled the Woodland period, this term not only provided a distinction from the earlier Archaic, but also suggested the existence of a formative stage for later agricultural village period occupations. Archeologically, the changes are noted by the appearance of ceramics, corner-notched points adapted for either the atlatl or the bow and arrow, elaborate burial practices, the appearance of introduced and indigenous crop plants, and the arrangement of human groups within a hamlet or household structure. While these characteristics do not appear in all of the Central Great Plains Woodland complexes at the same time or intensity, they are often used to characterize the entire period, which is temporally placed from 500 B.C. to A.D. 1000 (Cassells 1983; Benn 1990; Johnson n.d.; Wedel 1961a, 1986).

On the basis of temporal arrangements and cultural similarities, researchers have suggested that the Woodland period of the Great Plains originated from contact with populations to the east, specifically the Mississippi and Illinois River valleys (Johnson 1979; Wedel 1961a; Willey 1966). This assumed eastern etiology resulted in the prefix “Plains” being added to the term Woodland to distinguish cultural complexes of the east from those on the Plains. However, as more archeological investigations are being conducted on Plains Archaic complexes, the recognition of indigenous cultural innovations as being responsible for the development of the Woodland period has been suggested on several occasions (Johnson n.d.; Reid 1983; Schmitter 1981). As Johnson states “even the traditional Plains Woodland diagnostics have become blurred as we have gained an understanding of later Plains Archaic developments” (Johnson n.d.:2).

For example, ceramic vessels, which are widespread in association with Woodland complexes, first appear in limited quantities in Late Archaic Nebo Hill, Munkers Creek and Black Vermillion complexes of eastern Kansas and western Missouri (Reid 1983; Witty 1982a; Schmitter 1981). The association of both indigenous and tropical cultigens with Plains Woodland contexts is evident from the archeobotanical record, and while such a record is not evident in the preceding Archaic period, the prevailing arguments suggest that the extensive use of certain weedy annuals (i.e., Chenopodium berlandieri) during the Archaic period is an indication of the process of use and cultivation of these plants which resulted in their eventual domestication. The fact that cultivated cucurbits have been recovered from Archaic contexts in proximity to the Plains (Chomko and Crawford 1978; Kay 1986; King 1985) further heightens the possibility of an association of cultigens with Plains Archaic populations. Increasing sedentism during the Woodland period, suggestive of social and demographic changes, is likewise evident during the Archaic period with the recognition of temporary structures at Late Archaic sites (Blakeslee 1979). Some of the smaller corner-notched points commonly associated with the Woodland period also are recovered from Archaic sites, suggesting overlapping technologies. In short, similarities in certain technologies and adaptive strategies between the Late Archaic and Plains Woodland complexes argue for continuity and suggest that the origin of the Plains Woodland period lies in part with the preceding Archaic.

In the western part of the Central Plains, commonly referred to as the Central High Plains, the distinction between the Archaic and Woodland is even less obvious, perhaps as the eastern influence became more attenuated (Gunner 1987-85). Butler (1986, 1988) summarizes the Woodland as very different from contemporary complexes to the east, arguing that the “classic” view of Woodland does not apply to the High Plains. While ceramics and small projectile points indicative of the bow and arrow are present, elaborate burial practices are absent and settlements do not conform to a hamlet setting. Sites tend to be in shelters or open air locations away from major drainages. The archeobotanical record is limited, and suggests in particular that horticultural crops were never economically important. This is based on too few samples, however, and does not address the potential for the importance of wild plants. Also, as will be discussed in greater detail below, the recognition of the economic importance of specific plant cannot be measured solely by the quantity of remains recovered. While the evidence for horticulture in the High Plains is restricted to the appearance of maize, its presence does indicate a transition from a strictly hunting and gathering lifeway to one in which the growing of or trading for plant foods provided a part of the diet. Equally important is the recognition of the variety or type of maize recovered from the archeological contexts, as this information is useful in addressing the direction from which maize entered the Central Great Plains.

Currently there are 17 Plains Woodland cultural phases or complexes recognized in the Central Great Plains. Temporally, the eastern phases (i.e., those located in the prairies or prairie-bordered regions) can be divided into a tripartite classification scheme of Early (500 B.C.-A.D.1), Middle (A.D. 1-A.D.500), and Late (A.D. 500-A.D.1000). Recognized complexes include the Early Woodland Bowlin Bridge phase, the three phases of the Middle Woodland Kansas City Hopewell, and the transitional Middle Woodland to Late Woodland Boyer phase. The Valley focus and Cuesta phase are also included in a Middle Woodland cultural context. Late Plains Woodland complexes, which date from ca. A.D. 500-1000, include Schultz, Hertha, Keith, Grasshopper Falls, Wakarusa, Deer Creek, Greenwood, Parker, Loseke Creek, Sterns Creek, South Platte, and Ash Hollow.
Several of these complexes share characteristics with earlier Middle Woodland complexes and are perhaps more appropriately defined within the context of an Early Ceramic period. As noted earlier, the culture sequence in the High Plains is defined according to this nomenclature. Spatial distributions for each of these complexes is featured in Figure 38. Key sites and radiocarbon dates (Table 24) are also presented for each of these phases.

In presenting these various cultural complexes, it is important to note that different taxonomic systems have been used in designating recognized manifestations of the Plains Woodland. The literature contains descriptions of complexes assigned to either the Midwest Taxonomic System (McKern 1939) or the Cultural-Historical Integration System (Willey and Phillips 1958). The latter is the more recent and widely used system. Many times, however, a specific cultural expression designated as a "phase" does not properly describe the observed, and sometimes extensive, temporal and spatial parameters. It has been suggested, therefore, that the term "variant" be adopted since it appears to be better suited for the organization of various Plains Woodland taxa (Krause 1969; Lehner 1971; Johnson n.d.). Plains Woodland complexes, however, are distributed throughout both the eastern prairies and western plains and therefore display variations in the adaptation to the environment, as well as influences from adjacent cultural groups. Consequently, not all Plains Woodland complexes have been organized in the same manner. For example, the tripartite division of the Woodland period, which works well for the eastern prairie-bordered groups, is not applicable for the Woodland groups on the High Plains (Butler 1988).

For the eastern Woodland cultures, Benn (1983, 1990) has suggested the concept of the Mid-America Woodland tradition (MWT) to highlight cultural continuities within the Middle and Late Woodland periods, within the time frame of 200 B.C. to A.D. 1000, and between the eastern prairies and the western prairie peninsula. Variants assigned to this tradition include the Middle Woodland taxa of Valley, Sonota, and Rowe; the early Late Woodland Boyer phase; and the Late Woodland Loseke Creek complex. Haas (1983) extended the tradition to include several complexes of the central and western portion of the Plains by adding all of the Kansas City Hopewell phases, and the later Plains Woodland complexes such as Keith, Parker, Sterns Creek, Grasshopper Falls, Greenwood, Hertha, and any other Woodland complex defined in Kansas. The division into regional complexes is often based on subtle variations in ceramic decoration or temper and temporal ranges which lack adequate chronometric ages. Although major gaps persist in our ability to organize all Woodland taxa into a single system, there remain underlying similarities which serve to distinguish all complexes as "Woodland." The taxonomic nomenclature used in this chapter does not conform entirely to any of the defined systems, but rather attempts to use whatever designation was originally applied for a specific complex. Therefore, the eastern prairie complexes will be arranged into the early, middle, late sequence while the western cultures, as well as complexes located between the two areas, will be presented as part of the broader Central Great Plains Woodland adaptation.

As will be discussed below for the various Woodland complexes, there is a notable difference in the cultural expression of these groups as one moves from the eastern prairies to the western plains, with greater artifact variety and concentration found in the eastern complexes. Some of this variation is often explained as an adaptation to different, and perhaps richer, environments and the proximity of the eastern prairie or prairie-bordered cultures to the Eastern Woodlands. While the association of Plains Woodland complexes to Eastern Woodland complexes is a repeated research focus, there is an inherent danger in assuming that cultural complexity or cultural expression is directly related to the environment, or any constraints the environment might impose.

In Plains archeological research, however, this assumption has often dictated excavation techniques and cultural reconstruction. This is particularly true for the development of agriculture during the Woodland period. Drawing on modern day scenarios, it is often stated that dry corn farming during the prehistoric past was not possible west of the 100th meridian, since rainfall amounts are too infrequent and insufficient to sustain a crop today. Consequently, the western Woodland complexes are described as exhibiting a heavier reliance on hunting, particularly big game hunting. Identified faunal remains, especially from several Keith complex sites, have indicated instead a more varied strategy (see discussion below) while a lack of flotation, phytolith, or pollen studies makes a discussion of plant resource use impossible. Variations in adaptation between the eastern prairies and the western plains may be very real situations, but the research into this must be concluded from recovered data rather than from assumptions of environmental and technological constraints and modern day analogies.
Table 24. Central Great Plains Woodland Complexes, Major Sites and Radiocarbon Dates.

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</table>
Woodland as a Formative Period

The concept of the Woodland as a formative period for the following agriculturally oriented village period focuses on the increased use of wild and agricultural plants as well as the presence of wattle and daub structures. Greater attention in this chapter will therefore be given to the identified plants and their morphological characteristics, their context within the site, the recovery methods utilized during excavation, and the distribution of the species throughout the Woodland period. House structures and their manner of manufacture are also highlighted.

A summation of the archeobotanical record for the Plains Woodland complexes discussed in the text is presented in Table 25. Also included is the repository(ies) for archeobotanical remains discussed in text. Attention is given to the mode of recovery of the botanical remains, and includes techniques such as hand collected, water-screened, or flotation methods. Variation in the latter mode is further defined by the identification of the specific flotation technique. For example, the “Apple Creek” flotation method, originally designed in the late 1960s (Strouve 1968), called for a screen-bottomed wash tub to be agitated as two archeologists stood knee-deep in a creek. The heavy fraction matrix was trapped in the bottom screen while a cheesecloth-covered tea strainer was used to catch the light fraction. Although revolutionary for the 1960s, this was a time consuming and physically tiring recovery method. Consequently, large amounts of soil could not be processed during a regular field season. In addition, personal recollections of its use in the Plains did not include the use of cheesecloth over the tea strainer, thereby reducing the potential recovery of small seeds. The more mechanized SMAP barrel, developed for the Shell Mound Archaeological Project, enabled significantly larger amounts of soil to be floated (Watson 1976) over less time and with less physical energy. Again, personal recollections of its use on the El Dorado project enabled approximately 12% of the 120 sq. m of excavated area at the Two Deer site to be floated. Although the barrel method remains as the most common flotation method currently used in the Plains, several major problems, in particular, heavy clay content, continue to affect our ability to retrieve the small sized charcoal remains.

Major advances have been made in the field of paleoethnobotany throughout North America within the last few decades. Most have focused on the origins of agriculture and have encompassed changes in both methods of recovery and middle range theory. Included are (1) the concept of agriculture as a dynamic evolutionary process, requiring significant changes over a considerable amount of time in both human behavior and plant physiology; (2) the view of agriculture as a complex form of plant management, requiring a close interaction and development with other aspects of the society; (3) the recognition that indigenous weedy plants were of equal, or perhaps even greater, importance than the tropical cultigens in prehistoric subsistence strategies; and (4) the ability to go beyond the reconstruction of past subsistence strategies by asking why and how things changed over time. Within the Great Plains however, we have not fully embraced these advances. Historically, the assumption existed for many years, and may continue to exist in some measure, that Plains subsistence was dominated by the exploitation of the bison. Recent studies (Bozell 1995), however, indicate that the use of the bison in the Central Plains varied considerably through time and space.

During the Woodland period of A.D. 1-1000, bison use increased from east to west, with deer and various smaller mammals dominating the faunal assemblages in the east. Historically, agriculture has been viewed as late coming and partially if not totally abandoned after the introduction of the horse. While the importance of agriculture to the northern protohistoric and historic Plains tribes was well documented at an early time (Will and Hyde 1917; Wilson 1917; Gilmore 1913, 1919), the long time depth of this subsistence strategy was not recognized. Further, the contemporary view of agricultural development as a process involving social, residential, and technological cultural arrangements, was inconsistent with the belief that fully domesticated crops were merely introduced onto the Plains. Consequently, little attention has been given to the role of plants in the diet of Plains people and we have not fully addressed the dynamics involved in the development or regional diversity of Plains agriculture. While there is no reason to argue that the Plains was another universal location for the development of agriculture, there is every reason to argue that the environmental and cultural diversity of the Plains offered prehistoric inhabitants a variety of plants which could be, and probably were, used for food, fuel, shelter, and clothing. Within the context of well developed and well adjusted plant gathering strategies, cultivation was merely an extension. Although certain domesticated plants were probably introduced into the Plains, their initial acceptance was based on the existence of subsistence and social strategies capable of maintaining their use. The following intensification of certain plant use was more than likely determined by the cultures of which they were a part, rather than by any external influence.

Another misconception of Plains subsistence that is also entrenched in the literature is the tendency to equate horticulture and agriculture with the plant trio of corn, beans, and squash. Extensive research in the Southwest and the Eastern Woodlands is providing convincing evidence that the three tropical cultigens arrived in North America at separate times and were of varying importance to the indigenous populations (Smith 1992; Adams 1994). Of even greater significance, however, is the overwhelming evidence that indigenous weedy annuals, such as goosefoot (Chenopodium berlandieri), marshelder (Iva annua), sunflower (Helianthus annuus), and little barley (Hordeum pusillum) were important subsistence resources in the Eastern Woodlands before the development of maize agriculture. Current data from Plains sites suggest that corn and squash may have been present by Middle Woodland times but were added to cultivated marshelder, an indigenous plant recognized as a domesticate
Table 25. Archeobotanical Remains from Central Great Plains Woodland Sites:

<table>
<thead>
<tr>
<th>Site</th>
<th>Complex</th>
<th>Archeobotanical Remains</th>
<th>Mode of Recovery</th>
<th>Repository</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trefz, 23JA159</td>
<td>Early Woodland</td>
<td>goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), black walnut (Juglans nigra), hawkweed (Carya sp.), marshelder (Iva annua var. macrocarpa), black walnut (Juglans nigra), hickory (Carya sp.), marshelder (Iva annua var. macrocarpa)</td>
<td>barrel flotation</td>
<td>KUMA</td>
<td>Adair, 1980, 1990</td>
</tr>
<tr>
<td>23JA36</td>
<td>Early Woodland</td>
<td>pigweed (Amaranthus sp.), hickory (Carya sp.)</td>
<td>barrel flotation</td>
<td>KUMA</td>
<td>Ziegler 1981b</td>
</tr>
<tr>
<td>23JA40</td>
<td>Early Woodland</td>
<td>knotweed (Polygonum sp.), spurge (Euphorbia sp.)</td>
<td>barrel flotation</td>
<td>KUMA</td>
<td>Ziegler 1981a</td>
</tr>
<tr>
<td>Young, 23PL4</td>
<td>KC Hopewell</td>
<td>goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), knotweed (Polygonum sp.), marshelder (Iva annua), grape (Vitis sp.), spurge (Euphorbia sp.), sunflower (Helianthus annuus), plum (Prunus sp.), blackberry (Rubus sp.), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana)</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Adair 1977</td>
</tr>
<tr>
<td>Trowbridge, 14WY11</td>
<td>KC Hopewell</td>
<td>pigweed (Amaranthus sp.), marshelder (Iva annua var. macrocarpa), grape (Vitis sp.), ragweed (Ambrosia trifida), pawpaw (Diospyros virginiana), persimmon (Asimina triloba), squash (Cucurbita pepo), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana), oak (Quercus sp.)</td>
<td>hand collected</td>
<td>KUMA</td>
<td>E. Johnson 1975, Adair 1988</td>
</tr>
<tr>
<td>Quarry Creek, 14LV401</td>
<td>KC Hopewell</td>
<td>goatfoot (Chenopodium sp.), maize (Zea mays), grape (Vitis sp.), plum (Prunus sp.), purslane (Portulaca sp.), bulrush (Scirpus sp.), dock (Rumex sp.), grass (graminacea), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana), hackberry (Celtis occidentalis)</td>
<td>flotation</td>
<td>KUMA</td>
<td>Adair 1994</td>
</tr>
<tr>
<td>McPherson, 14LV357</td>
<td>KC Hopewell</td>
<td>knotweed (Polygonum sp.), maize (Zea mays), Panic grass (Panicum sp.), grape (Vitis sp.), hickory (Carya sp.), hazelnut (Corylus americana), black walnut (Juglans nigra), oak (Quercus sp.)</td>
<td>flotation</td>
<td>KUMA</td>
<td>Adair 1994</td>
</tr>
<tr>
<td>Yeo, 23CL199</td>
<td>KC Hopewell</td>
<td>goosefoot (Chenopodium sp.), knotweed (Polygonum sp.), marshelder (Iva annua var. macrocarpa), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana)</td>
<td>flotation</td>
<td>KSU</td>
<td>King 1982</td>
</tr>
<tr>
<td>Ovst, 25G02</td>
<td>KC Hopewell</td>
<td>sedge (Carex sp.), bulrush (Scirpus sp.), marshelder (Iva annua var. macrocarpa), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana)</td>
<td>flotation</td>
<td>KUMA</td>
<td>King 1982</td>
</tr>
<tr>
<td>Elliott, 14GE312</td>
<td>Mid.Woodland</td>
<td>sunflower (Helianthus annuus), plum (Prunus sp.), maize (Zea mays), squash (Cucurbita sp.), hickory (Carya sp.)</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Brogan 1981</td>
</tr>
<tr>
<td>14LF304</td>
<td>Cuesta</td>
<td>grape (Vitis sp.), maize (Zea mays), squash (Cucurbita sp.), hickory (Carya sp.), hazelnut (Corylus americana), black walnut (Juglans nigra), &quot;small seeds&quot;</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Adair 1991</td>
</tr>
<tr>
<td>14LT316</td>
<td>Cuesta</td>
<td>hickory (Carya sp.), maize (Zea mays), squash (Cucurbita sp.), hickory (Carya sp.), hazelnut (Corylus americana)</td>
<td>limited flotation</td>
<td>WSU</td>
<td>Blakeslee and Rohn 1982</td>
</tr>
<tr>
<td>14MY305</td>
<td>Cuesta</td>
<td>acorn (Quercus sp.)</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Reynolds 1984a</td>
</tr>
<tr>
<td>Silies, 14MM13</td>
<td>Greenwood</td>
<td>goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), blackberry (Rubus sp.), vetch (Vicia sp.), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut (Corylus americana)</td>
<td>water screened</td>
<td>KUMA</td>
<td>Adair 1991</td>
</tr>
<tr>
<td>Cow-Killer, 14OS347</td>
<td>Greenwood</td>
<td>goosefoot (Chenopodium sp.), violet (Viola sp.), spurge (Euphorbia sp.), grape (Vitis sp.), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), marshelder (Iva annua var. macrocarpa)</td>
<td>water screened</td>
<td>KUMA</td>
<td>Adair 1991</td>
</tr>
<tr>
<td>14JN349</td>
<td>Grasshopper Falls</td>
<td>maize (Zea mays)</td>
<td>flotation</td>
<td>KUMA</td>
<td>Adair 1991</td>
</tr>
<tr>
<td>Senn hill, 14AT2</td>
<td>Grasshopper F</td>
<td>black walnut (Juglans nigra), hickory (Carya sp.), pigweed (Chenopodium sp.), pigweed (Amaranthus sp.), bulrush (Scirpus sp.), purslane (Portulaca sp.), black walnut (Juglans nigra), &quot;small seeds&quot;</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Williams 1986</td>
</tr>
<tr>
<td>Richland, 14SH101</td>
<td>Deer Creek</td>
<td>goosefoot (Chenopodium sp.), black walnut (Juglans nigra)</td>
<td>flotation</td>
<td>KUMA</td>
<td>Adair 1987</td>
</tr>
<tr>
<td>14M509</td>
<td>Grasshopper F</td>
<td>maize (Zea mays)</td>
<td>flotation</td>
<td>KUMA</td>
<td>Williams 1986</td>
</tr>
<tr>
<td>25S012</td>
<td>Deer Creek</td>
<td>goosefoot (Chenopodium sp.), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), black walnut (Juglans nigra),</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Williams 1986</td>
</tr>
<tr>
<td>25T12</td>
<td>South Plate</td>
<td>goosefoot (Chenopodium sp.), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), black walnut (Juglans nigra),</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Williams 1986</td>
</tr>
<tr>
<td>5JF142</td>
<td>South Plate</td>
<td>goosefoot (Chenopodium sp.), maize (Zea mays), black walnut (Juglans nigra), hickory (Carya sp.), black walnut (Juglans nigra),</td>
<td>hand collected</td>
<td>KUMA</td>
<td>Williams 1986</td>
</tr>
</tbody>
</table>

References:
- Adair, 1980, 1990
- Ziegler, 1981b
- Ziegler, 1981a
- Adair, 1977
- E. Johnson, 1975
- Adair, 1988
- Wagner et al., 1989
- King, 1982
- Adair, n.d.
- Brogan, 1981
- Adair, n.d.
- Blakeslee and Rohn, 1982
- Reynolds, 1984a
- Adair, 1991
- Williams, 1986
- Adair, 1990
- Williams, 1986
- Adair, 1987
- Blakeslee and Rohn, 1982
- Adair n.d.
- Kivett, 1953
- Irwin and Irwin, 1959
during the Early Woodland period (Adair 1990). While corn became a dominant crop in Village period complexes, it was only one of several cultigens used by both Plains Woodland and Plains Village populations. To determine the pathway of importance for both tropical and indigenous cultigens, each domesticate should be evaluated according to context, quantity, and frequency from its first appearance in an archaeological context.

With a current emphasis on agricultural origins dominating paleoethnobotanical research in geographical areas adjacent to the Plains, there is certainly a tendency to orient Plains research in the same direction. Although important, elucidating agricultural crops tends to ignore the importance of wild plants. Plains Woodland ethnoarchaeological research must include a determination of the quantity and quality of the various wild plant species to the overall diet. It is clear from the information presented in Table 25 that wild species, including both weedy annuals and nuts, contributed to the caloric intake of Plains Woodland populations at the same time that the consumption of domesticates was increasing. The actual ratio of wild vs. domesticate plant use cannot be stated with any absolute certainty with the data provided; however, with greater attention to archeobotanical recovery and analysis, this type of research could prosper.

Aside from the theoretical issues, one of the biggest methodological stumbling blocks in Plains paleoethnobotanical research is the recovery method used during excavation. Without archeobotanical remains, it is impossible to document, or even convincingly argue, the importance of plants or the presence of early domesticates. However, that is exactly what is often done. Most pre-Village period Plains subsistence strategies are described as “hunting and gathering,” a conclusion often based on the identification of numerous faunal elements representing various animal species and the inferred use of plants, a conclusion based on the presence of grinding slabs and, if lucky, a few Chenopodium seeds. The recovery and identification of maize, even one kernel fragment, is frequently described as evidence of “limited horticulture” or “incipient agriculture” or even “experimental horticulture.” To adequately discuss the importance of both wild and domesticated plants, recovery techniques must be extensive, systematic, and consistent. Macrobotanical remains, phytoliths, and pollen are all valuable sources of information, and research designs which propose to reconstruct past subsistence strategies should address each source. Further, CRM projects which outline field and laboratory techniques should specifically describe the type of flotation technique used and the sampling procedure followed. Adequate funds should also be available to complete every step in the recovery, identification, quantification, analysis, and curation.

In this chapter, which focuses heavily on an overview of the plant subsistence strategies used in the Central Great Plains during the Woodland period, it is impossible to overlook the lack of, or limited amount of, botanical data from several of the complexes. By comparison, however, archeobotanical remains have been recovered in sufficient quantities from other Woodland complexes (i.e., Grasshopper Falls phase) which allow for a more in-depth discussion of past subsistence. Rather than attempting to generalize from what is known by applying the information to those complexes from which limited archeobotanical remains are available, this chapter concludes with suggestions for further research.

**Early Woodland**

Spanning a period of roughly 500 years, from 500 B.C. to A.D. 1 and located along the eastern margin of the Great Plains, are a series of sites that provide the earliest evidence of the Woodland pattern. Immediately adjacent to the boundaries of this study, five Early Woodland occupations are recognized from recent investigations along the Little Blue River in extreme western Jackson County, Missouri (Johnson 1992; Peterson 1982; Schmids and Bailey 1986; Wright 1980; Ziegler 1981b, 1981b). They are 23JAI59 (Traf), 23J4A0, 23J4A36, 23J4A38 (Bowlin Bridge), and 23J4A43 (McPherson). Directly within the current project boundaries, two contemporary sites in eastern Kansas, 14BN26 and 14JO46, were identified from surveys and limited excavations (Logan and Hiedden 1990; Johnson 1992). In northeastern Iowa, the Rainbow and MAD sites provide some of the best information on the developmental sequence of the Woodland period (Benn 1990), while to the north in southwestern Minnesota, Early Woodland sites are attributed to the Fox Lake phase (Anfinson 1982).

Gregg (1990) also describes an Early Woodland occupation at the Zahe site in southeastern South Dakota. While variations exist in the occupations from these different geographical areas, the primary characteristics which distinguish them as Early Woodland are the presence of thick, stone-tempered ceramics with cordmarked exteriors occasionally overlain in the rim area with incised geometric designs in association with bifacial knives conforming to the type Mason Contracting Stem of the Boxin type series (Monte-White 1968; Farnsworth and Asch 1986). The type of ceramic described closely resembles the Black Sand-Incised and Spring Hollow-Incised ceramics of the Midwest, now grouped in the Liverpool type series (Griffin 1952; Logan 1976; Farnsworth and Asch 1986; Farnsworth and Emerson 1996). Based on work in the Kansas City vicinity, Schmits and Bailey (1986:231-232) defined the Early Woodland Bowlin phase, a taxonomic distinction which may not be applicable to the more western occupations (Johnson 1992).

Several sites, located within the Flint Hills region of central Kansas and previously identified as Late Archaic, may be a part of the Early Woodland manifestation. Excavations of the Walnut phase occupation at the Snyder site (14BU09) in south-central Kansas and the Coffey site (14P01) in north-central Kansas have produced radiocarbon dates ranging from 530 B.C. to 20 B.C. (Grosser 1973; Schmits 1981). Triangular corner-notched projectile points recovered from these two sites are morphologically similar to those associated with the Early Woodland occupation at the Traf site (Schmits 1981:203). The designation of the Walnut phase as Late Archaic is due in large part to the radiocarbon dates and the absence of ceramics,
although the material culture remains and adaptation type appear to be very similar to that identified for the prairie-bordered Early Woodland complex.

In general, the quantity, type, and extent of cultural debris from these sites indicate a seasonal or temporary occupation of perhaps family related bands, not too different from that recognized from the preceding Late Archaic. Cultural debris tends to cover a relatively small area, with cooking hearthworkshop areas, lithic tool production areas, and pit features identified at several sites. Recovered floral and faunal remains suggest that the subsistence pattern also varied little, with the notable exception of the appearance of cultigens. Along with numerous goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), hickory (Carya ovata), and black walnut (Juglans nigra), indigenous crops are represented by domesticated achenes of marshelder (Iva annua var. macrocarpa) from the Traft site (Adair 1980).

Marshelder, or sumpweed (Figure 39), is a weedy annual dispersed throughout the Eastern Woodlands and Plains where it is frequently found in moist settings disturbed by annual flooding (Asch and Asch 1978; Jackson 1960; Yarnell 1972). Asch and Asch’s (1978) study of the nutritional content of the Iva seed (or achene, as the seed and pericarp combined are more properly called) indicates that it is a good source of food energy, high in protein and fat content and several essential vitamins and minerals. Smith (1992) provides a summary of the prehistoric use of this plant in the Eastern Woodlands, noting the early evidence for its domestication during the second millennium B.C. Like many indigenous plant species, the morphological effect of domestication on the marshelder plant is a significant increase in seed size. Collections of modern Iva annua seeds from the Illinois River valley area (Asch and Asch 1978), the eastern portion of the Central Plains (Adair 1988), and the central and western regions of Oklahoma (Drass 1995), indicate that achene size does not exceed 4.5 mm in length. Domesticated Iva annua var. macrocarpa achenes from archeological contexts range from approximately 4.8 to 10.0 mm in length, a size significantly larger than that produced by any wild plant today. As Yarnell argued over 20 years ago (1972, 1977), the evidence of aboriginal domestication of Iva is entirely dependent upon archeological data.

At the Traft site, four Iva achenes and seeds were recovered from two contexts. Size reconstruction is often necessary due to charring and loss of the pericarp (Asch and Asch 1985; Yarnell 1978). The Traft achenes measure 4.5-6.4 mm in length and 3.4-5.7 mm in width (Figure 40). Their average size of 5.4 x 4.2 mm (Adair 1990) provides the first convincing evidence for the presence of any domesticate in the Central Great Plains. The presence of domesticated Iva suggests that the Early Woodland inhabitants of the Traft site had more than a casual reliance on plants, but were instead deliberately planting and cultivating at least one native species. Recently (Adair 1993b), an examination of the morphological characteristics of the goosefoot (Chenopodium sp.) seeds recovered from the Traft site was made to determine the potential for the domestication of this weedy annual. Seed margin morphology, seed coat characteristics, and pericarp thickness were analyzed on several of the small seeds. No characteristics associated with the domesticated variety (Smith 1992) were observed, and one must conclude that the wild Chenopodium plant was the variety used by the prehistoric inhabitants of the Traft site.

Many of the archeobotanical remains from the Traft site were recovered from a large hearth complex; the possibility exists, therefore, for some of the small seeds to represent accidental charring and inclusions into the archeobotanical record. For plants such as goosefoot and pigweed, which tend to grow in disturbed ground around habitation areas and disperse thousands of mature seeds, it is almost impossible to determine accidental or intentional use unless sufficient flotation samples are taken from locations throughout the site to distinguish areas of concentration from areas of uniform seed rain. At the Traft site, flotation samples taken from every excavation unit and from each level clearly demonstrate the concentration of plant remains within the feature. Test excavations at two other Early Woodland sites, 23JA36 and 23JA40, were not as extensive as the investigations at Traft. The distribution of plant remains at these sites, therefore, cannot be presented in the same manner. At both tested sites, the amount of archeobotanical remains is relatively small, being limited to a few pigweed and knotweed seeds and nut shell remains of hickory (Table 25). Outside the study area, large seeded sunflower achenes (Helianthus annuus var.
macrorcarpa) were identified from the Boyer phase occupation of the Rainbow site (Benn 1990:195-200) along with numerous seeds and rind fragments of squash (Cucurbita pepo) and several tobacco seeds (Nicotiana rustica).

The appearance of tobacco in the Boyer phase represents the first recognition of this plant on the Plains (Adair n.d.). The extent to which these other cultigens were grown in the area is unknown. To date, squash has not been identified from a pre-Woodland component and although a single marshelder achene was identified from the Late Archaic Nebo Hill site (Root 1979), one cannot argue for its extensive use which culminated in domestication.

Middle Woodland

While the term Middle Woodland is often used in reference to complexes which display Hopewelian traits, other groups were living in the Central Plains during the same time but practiced a lifestyle in stark contrast to the more elaborate Hopewell. Three Middle Woodland complexes identified in the area are the Kansas City Hopewell, located around the confluence of the Missouri and Kansas Rivers (Johnson 1976, 1983; Wedel 1943); the Cuesta phase, recognized in Labette, Montgomery, and Greenwood counties in southeast Kansas (Brogan 1981; Marshall 1972); and the Valley variant, found throughout central Nebraska and western into the High Plains of Colorado (Hill and Kivett 1940; Kivett 1952; Bozell and Winfrey 1994). The extent to which the more easterly prairie-bordered Hopewell groups influenced the development of, or participated with, the westerly plains Middle Woodland groups is largely unknown. Butler (1988), however, reports on cordmarked ceramics and radiocarbon dates of ca. A.D. 100 from northeastern Colorado, suggesting that some expansion of eastern people or diffusion of ideas occurred during the early part of the Middle Woodland period.

The Cuesta phase is a local complex of the larger Cooper regional variant, originally defined from investigations along the Grand River in northeast Oklahoma (Bell and Baerreis 1951; Yehik 1983) but later expanded to include portions of southeast Kansas, southwest Missouri (Marshall 1972) and northwest Arkansas (Schultz 1969).

To the north throughout central Nebraska and westward into the High Plains of Colorado, Middle Woodland groups are recognized as the Valley variant. Although not well defined in the literature, sites assigned to the Valley variant include small probably temporary occupations, larger/more extensive occupations, and burials and suggest that some relationship existed between Hopewell and Valley.

Kansas City Hopewell

The Middle Woodland Kansas City Hopewell complex was defined by the early work of Matt Shippee (1967) and Waldo Wedel (1938b, 1943) in and around Platte County, Missouri. Across the state line in Wyandotte and Leavenworth counties, Kansas, Harry Trowbridge collected similar artifacts and conducted excavations at several sites, including the Trowbridge site (14WY1). Beginning in the late 1960s, archaeologists from the University of Kansas, first under the direction of Robert Squier and later supervised by Alfred Johnson, extensively investigated several Kansas City Hopewell sites, surveyed tributary drainages and recorded the distribution of Hopewell sites, and embarked on in-depth analyses of the recovered cultural remains. This work helped clarify the temporal and spatial extent, cultural variability, settlement and subsistence practices, and the diagnostic artifacts related to the Kansas City Hopewell (Adair 1977; Bell 1976; Brockington 1977; Hefner 1974; A. Johnson 1976, 1979, 1983; E. Johnson 1975; Johnson and Johnson 1975). Although much of this work focused on sites in Platte County, Missouri, recent investigations in Leavenworth County, Kansas (Logan [ed.] 1993; Wagner et al. 1989) have better defined the nature of the Hopewell occupation west of the Missouri River.

Kansas City Hopewell can perhaps best be described as a regional variant of the larger Hopewell cultural complex that existed throughout much of the Eastern Woodlands during the Middle Woodland period. As the westernmost recognized variant, it has been suggested that the Kansas City Hopewell complex originated due to a migration of people from the Lower Illinois Valley area, with comparisons frequently being made to the Bedford, Ogden, and Utica phase of the Middle Woodland, Havana tradition (Wedel 1943; Johnson n.d.). With the recognition of a local Early Woodland occupation in the Kansas City region, there also exists the possibility of an in situ development (Adair 1988; Logan [ed.] 1993). Both alternatives need further research.

Diagnostics of the Kansas City Hopewell include large (approximately 2 to 5 gallons), straight-walled vessels tempered with grit or sand and either decorated on the rims with a variety
of designs or left undecorated with smooth surfaces. The most prominent decorations are cross-hatched incisions, rocker-stamping, hemiconoid punctates, embosses, and lip notches (Figure 41). The vessels exhibit a wide mouth and rounded or subconical bases. Distinctive lithic artifacts include broad-bladed, corner-notched points (Snyders type) and subtriangular, contracting-stemmed dart points (Gary, Dickson, or Steuben types) (Figure 42). Also highly characteristic of the Kansas City Hopewell complex is the production and utilization of bladelets produced from a prepared core (Reid 1976; Wedel 1943). Other lithic artifacts include blocky endscrapers, drills, gouges, and chipped stone and ground stone axes and celts. Most of the lithics were manufactured from locally available Wintersett or Westerville cherts, although Reid (1976) has demonstrated that some exotic cherts were traded into the area from the Big Bend region of central Missouri.

The core area of the Kansas City Hopewell surrounds the confluence of the Kansas and Missouri Rivers. Isolated habitation sites and diagnostic Hopewelian ceramics have been found in all directions from this location. To the north, the Kelley site (14DP11) in Doniphan County, Kansas is perhaps the most northern occupation site known, although Kansas City Hopewell pottery has been collected from sites in Nemaha, Cass, Dakota, Buffalo, Webster, Richardson, and Jefferson counties in Nebraska. Diagnostic cross-hatched, dentate, or rocker-stamped designs on the rims distinguish these ceramics from those assigned to the Valley focus. Evidence of Hopewell contact or influence is seen to the west of the core area at habitation and burial sites in Douglas and Jefferson counties (Logan [ed.] 1993) and around Manhattan, Kansas (Schultz and Spaulding 1948; O'Brien et al. 1979). South of the core area, Hopewelian ceramics are reported from the El Dorado Lake area (Grosser 1973) in Butler County and into the southeast part of the state. The latter evidence may be more appropriately attributed to the Cuesta phase.

The Hopewell Interaction Sphere, a term introduced over 30 years ago (Struver 1964), describes an extensive trade network of the Hopewell people that included much of the eastern Woodlands of North America and reached south to the Gulf of Mexico and across the Great Plains to the Yellowstone region. It has been suggested that the Kansas City Hopewell people were not active participants in this exchange since exotics are relatively rare occurrences in Kansas City sites (Johnson 1979). Sixty-six items, most representing local imitations of trade items, have been recovered from eight sites (Logan [ed.] 1993; Johnson 1979; Wedel 1943). The nonlocal items include one fragment of a helmet shell from the Gulf Coast, three celts, three awls, four fragments of copper, one obsidian flake, and three small pieces of sheet mica (Johnson 1979; Logan [ed.] 1993). Recent analyses of several of the exotic artifacts identified at least one of the celts as copper (Logan 1993 [ed.]:152), which may have been quarried from the Great Lakes region. The source of the obsidian flake recovered from the Trowbridge site was identified as Obsidian Cliff in Yellowstone National Park, northwestern Wyoming (Hughes 1995).

A series of radiocarbon dates along with stylistic changes in the ceramics and bifacial tools was used to suggest three developmental phases for the Kansas City Hopewell. The Trowbridge phase is the earliest (A.D. 1-250) and is characterized by dentate-stamped and punch-and-boss decorations on vessel rims and broad-bladed projectile points resembling the Snyders.
type. The Kansas City phase of A.D. 250-500 is distinguished by incised cross-hatched lines and punctate designs on vessel rims in association with subtriangular, contracting stemmed or corner-notched projectile points. The final phase, representing the early Late Woodland in the Kansas City vicinity, is the Edwardsville phase (A.D. 500-750). Vessel rims are either undecorated or exhibit lip crepitations while projectile point styles include medium sized and smaller Scallorn styled corner-notched varieties.

Several of the large village sites, such as Trowbridge, Young (23PL4) and Renner (23PL1) are believed to have been occupied for the initial 500 years of the Hopewell span, while the Yeo (23CI199) and Miller (14YW8) sites are representative of the terminal phase. With (uncalibrated) radiocarbon dates of A.D. 170 ± 60 to A.D. 370 ± 80 (Table 24), the chronology of the Quarry Creek site (14LV401) suggests occupation(s) from the Late Trowbridge phase to the late Edwardsville phase (Logan et al. 1993:184-186). As Logan (1993 [ed.]:187-188) discusses, however, recent radiocarbon dates from several Late Plains Woodland sites in northeast Kansas suggest occupation of this area during the seventh and eighth centuries, which is roughly contemporaneous with the range of the Edwardsville phase of the Kansas City Hopewell. It is interesting then that none of the Plains Woodland sites display any Hopewelian material culture traits, despite the close proximity of the two complexes. Logan states that it is "difficult to imagine that a cultural barrier of some kind prevented the interaction of these cultures in the Lower Kansas River Basin." (Logan 1993 [ed.]:188). The more likely scenario is that the terminal dates for the Edwardsville phase are around A.D. 600-650 and that this period witnessed either the disappearance of the Hopewell culture, as in the Midwest, or its cultural transformation into a Late Plains Woodland adaptation. Such a research issue requires both the recognition of sites that could elucidate such a cultural/technological change as well as sufficient radiocarbon determinations from both late Hopewell and Plains Woodland occupations.

The settlement-subsistence strategies of the Kansas City Hopewell have perhaps received the greatest amount of research (Adair 1977; Bell 1976; Brown 1975; A. Johnson 1976; E. Johnson 1975; Pullen 1976; O'Brien 1982). Current understanding of these strategies indicates that the Kansas City Hopewell were well adapted to the ecological setting provided by the junction of two major rivers, the Kansas and the Missouri and their numerous tributaries. Primary environmental zones exploited were the floodplain forests and upland oak-hickory forests and prairie patches. White-tailed deer (Odocoileus virginianus), elk (Cervus canadensis), raccoon (Procyon lotor), turkey (Meleagris gallopavo), with lesser numbers of bison (Bison bison), were the basic animals hunted, although various fish, amphibians, reptiles, and migratory waterfowl added variety to the resource base. The floral remains exhibit an interesting mix of wild plants and cultigens and are suggestive of an increased reliance on local resources by groups who were becoming more sedentary. Although nuts, particularly hickory and hazel, are present in significant percentages in the archeobotanical record from the Late Archaic to the Kansas City Hopewell, the numbers of small seeded annuals and fruits increases significantly (Table 25). Seeds of goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), and knottweed (Polygonum sp.), along with plum (Prunus sp.), pawpaw (Asimina trifolia), and grape (Vitis sp.) comprise the majority of identified species from the Trowbridge (14YW1) and Young (23PL4) sites. Various grasses, some identified as panic grass, bulrush (Scirpus sp.), dock (Rumex sp.), and spurge (Euphorbia sp.) have been identified from several Middle Woodland sites in the Central Plains. Also present, but still in fairly low percentages, are the remains of indigenous crops of marshelder and sunflower along with the introduced cultigens squash (Cucurbita pepo) and maize (Zea mays).

The association of maize with Middle Woodland populations has been a source of debate for decades. Many archeologists were once convinced that the cultural complexity of the Hopewelian societies (most notably those complexes in the Ohio and Illinois River valleys) of 2000 years ago maintained a high population density, sustained by a productive and dependable subsistence economy based on maize agriculture (Spaulding 1955). Flotation sampling from many sites over the past 40 years, as well as more recent studies of 14C/13C isotopic ratios in human bone, have, however, combined to demonstrate that maize was not a staple resource during the Middle Woodland period (Bender et al. 1981; Lynnott et al. 1986; Smith 1992). In addition, many maize remains were found to be associated with later components. While the appearance of maize in the river valleys of the Eastern Woodlands is confirmed by direct accelerator dates on maize remains (Chapman and Crites 1987; Ford 1987; Smart and Ford 1983; Riley et al. 1994) from the Holding, Edwin Harness, and Icehouse Bottoms sites, some continue to argue that its economic importance in the Middle Woodland diet is not sufficiently evaluated (Riley et al. 1994).

Maize has been recovered from four Kansas City Hopewell sites: Trowbridge (14YW1) which yielded the largest sample consisting of a nubbin cob and about 90 isolated kernels; Renner (23PL1) which contained two isolated kernels (Wedel 1943); four cupule fragments and one kernel fragment from the McPherson (14LV357) site (Wagner et al. 1989); and three cupules from the Quarry Creek site (14LV401) (Adair 1993b). From a temporally equivalent complex, Benn (1990) identified one maize kernel from the early Late Woodland occupation at the Rainbow site in northwest Iowa. Radiocarbon age determinations were recently made on the maize samples from Trowbridge, McPherson and Quarry Creek sites (Table 26). Previously described as representing an early Chapalote-like variety by several ethno botanists (Cuiter and Blake 1973; Ford 1984), the Trowbridge corn is instead associated with a protohistoric component at the site. The three AMS dates on the Trowbridge corn are 220 ± 50 (UGR-3357), 70 ± 60 (Beta-75015) and 170 ± 60 (Beta-75016) RCYPB (Table 26). The cupule recovered from the McPherson site was direct dated to 900 ± 40 RCYPB (A.D.1050) while the Quarry Creek remains yielded a date of 1880 ± 50 RCYPB (A.D.70). The McPherson
site sample clearly reflects an association of the maize with the later Village period occupation at the site, while the Quarry Creek sample, at first glance, seems to confirm a Middle Woodland affiliation. However the Δ²⁹C value on this sample is -25.6, obviously incorrect for a C₃ plant such as maize, suggesting that the charcoal submitted was not Zea mays. While additional maize remains were identified from the Quarry Creek site (Adair 1993a), further direct dating of this cultigen should perhaps await a larger sample from other Middle Woodland sites. In the meantime, however, the potential association of maize with the Middle Woodland Kansas City Hopewell period should not be totally disregarded, but clearly the arrival of this cultigen in the eastern Plains needs further research.

Table 28. Accelerator Dates on Zea mays from Kansas City Hopewell sites.

<table>
<thead>
<tr>
<th>Site/Provenience</th>
<th>Lab No.</th>
<th>Date</th>
<th>A.D.</th>
<th>18D/²⁹C</th>
</tr>
</thead>
<tbody>
<tr>
<td>14LY357 Unit 4, level 3</td>
<td>UCR-3355</td>
<td>900 ± 40</td>
<td>1050</td>
<td>1165 -11</td>
</tr>
<tr>
<td>14LY401 Feature 6, 80-80 cm below surface</td>
<td>UCR-3356</td>
<td>1880 ± 50</td>
<td>70</td>
<td>130 26.5</td>
</tr>
<tr>
<td>14WY1 Feature 13b, 9&quot; below surface</td>
<td>UCR-3357</td>
<td>220 ± 50</td>
<td>1730</td>
<td>1666 10.7</td>
</tr>
<tr>
<td>14WY1 Feature 13b</td>
<td>Beta-75015</td>
<td>310 ± 60</td>
<td>1540</td>
<td>1638 10.5</td>
</tr>
<tr>
<td>14WY1 Feature 13b</td>
<td>Beta-75016</td>
<td>400 ± 60</td>
<td>1550</td>
<td>1473 11.0</td>
</tr>
</tbody>
</table>

Another cultigen that continues to be associated with the Kansas City Hopewell complex is the common bean (Phaseolus vulgaris). During excavation at the Renner site (25PL1), a seed "resembling the modern pinto" (Wedel 1943) was recovered. Rumors surrounding this discovery describe the remain as either rapidly disintegrating after excavation, or being crushed beyond identity after being stepped on in the field. Regardless of the rumors, this specimen does not exist in the collections from the Renner site at the Smithsonian, despite a catalog entry for both the corn and the beans. Furthermore, the arrival of the common bean into the American Bottom area is now generally accepted to have occurred after A.D. 1000 (Lopatin 1992, 1994). If beans were recovered from the Renner site, as Wedel describes, then they were probably associated with the later Steed-Kisker occupation. Without the actual specimens, however, there is no way to make a definite identification. The presence of the common bean within a Middle Woodland context has been repeatedly questioned (e.g., Ford 1979; Adair 1988), but somehow, its association with the Kansas City Hopewell complex continues in the literature (Riley et al. 1990).

Based on variation in size, location, artifact density, and function, three classes of Kansas City Hopewell sites are recognized. Large villages, which are frequently located near the mouth of streams tributary to the Missouri and Kansas rivers, often extend over 5-10 acres. Isolated postmold stains and occasional daub fragments hint of the presence of some kind of structure. The most common features at the large sites, however, are the numerous storage pits. Twenty-nine trash filled storage pits were identified during the excavations at the Young site, while 15 such features were identified at the Trowbridge site. These features are frequently large subsurface constructions, filled with village trash consisting of floral and faunal remains; ceramics; lithic; bone; and ground stone tools; and charcoal. Nearby thick midden deposits combine to suggest a fairly extensive occupation. Current thought suggests that the storage pits may have been constructed outside of any habitation structure and perhaps grouped together off to one edge of the site.

Smaller sites, ranging in extent from 2 to 5 acres and originally suggested (Johnson 1976) to be of ancillary support to the larger villages, comprise the second type of Kansas City Hopewell site. These sites are often located on terraces within the valleys of streams tributary to the Missouri and Kansas Rivers. The smaller size of the site, the limited quantity of refuse, and a restricted range in functions as defined by the tools, all combine to indicate a shorter period of occupation. A few radiocarbon dates also indicate that these smaller sites may not have been occupied until later in the Middle Woodland sequence, an interpretation which also led to the suggestion that these sites represent budding-off communities formed by population pressure at the larger village sites (Johnson 1979). Alternatively, they have been suggested to be resource exploitation stations for the maintenance of the larger villages. Johnson 1976, 1979), a suggestion not yet substantiated by the identification of recovered floral and faunal remains.

Burial mounds comprise the third type of Kansas City Hopewell site. Located along the bluff ridges of the Missouri River, most have been destroyed by treasure seekers before any professional excavations were conducted in the area. A few exceptions include the Cochran Mound (25PL86), the Cogan Mounds (23PL125), and others noted in Shippee (1972) and Wedel (1943) (Figure 43). Earthen mounds often cover a central stone vault tomb, although skeletal remains have been recovered from both the tomb and the surrounding fill. Burial types include primary and secondary inhumations and cremation. Burial goods include both utilitarian items and artifacts especially manufactured as grave goods. Burials have also been exposed at several village sites, such as Renner and Aker, where both adults and children were interred into shallow pits within midden areas.

Despite the fairly extensive investigations into the Kansas City Hopewell complex, there remains quite a lot to learn about these people. In terms of the subsistence strategies used, most of the larger sites were excavated before fine screen recovery techniques were routinely used, consequently the floral remains tend to be the larger sized, such as noted in the remains from the Trowbridge site. Although the "Apple Creek" flotation method (Stueve 1968, Pearsall 1989) was used at the Young site, the fine screen mesh size used approached 1/4" and many
small seeds would not have been recovered. In addition, many samples remain unsorted. Although a more mechanized flotation method (a variation of the SMAP barrel) was used during the excavation of the Quarry Creek site (14LV401), many unsorted samples are curated due to lack of funds. Analysis of some of this material may help to address current research questions. Included are: (1) If the smaller sites were settled to exploit resources for the maintenance of the large villages, what plant species were involved in this strategy? (2) Was there a shift in subsistence over time to include the introduction of tropical cultigens, as recognized for the more easterly Middle Woodland? (3) Why are maygrass and little barley, so common in eastern Hopewell sites, not present in the archeobotanical record from the Kansas City region? Is it a different adaptation on the prairie border or are our recovery and identification techniques inadequate? (4) Does the appearance of cultigens imply population pressure (as Johnson 1979 suggests) with crops viewed as a safeguard to resource depletion? Maize has been recovered from several Middle Woodland sites in the Eastern United States (Asch and Green 1992; Smith 1992) in quantities so limited that its importance as a food item has been questioned.

Cuesta Phase

The Cuesta phase of southeast Kansas was initially defined by Marshall (1972) from excavations at the Infinity site (14MY305) in Montgomery County, Kansas. This phase is a local complex of the larger Cooper regional variant, originally defined from investigations along the Grand River in northeast Oklahoma (Bell and Baerreis 1951; Vehik 1983). A series of related sites in the Elk City Lake and Big Hill Lake areas of Kansas, along with diagnostic ceramics, combined to suggest that Cuesta was similar to Hopewell manifestations in Missouri and northeast Oklahoma, although somewhat later than the Kansas City Hopewell. Radiocarbon dates place the Cuesta phase between A.D. 700-1000 while speculation that a migration of Middle Woodland people into the area may have been responsible for its origin has been presented. At present, however, no data have been collected to support this suggestion, although the ceramics clearly exhibit Hopewelian designs, such as dentate stamping, punctates, and stick impressed (Marshall 1972). In large part, the ceramics closely resemble those recovered from Kansas City Hopewell sites as well as the Cooper site in northeast Oklahoma. A preliminary study of the Cooper ceramics indicates significant differences exist between these wares and those of the Kansas City Hopewell (Cook, personal communication 1994). Studies such as this, in addition to a tighter chronology for Cuesta phase sites, may provide the evidence needed to establish the origins of this phase and its relationship with eastern and northern Hopewell groups.

From survey and excavation work in the Big Hill Lake region of southeast Kansas, it has been suggested that variability existed in the Cuesta settlement pattern (Brogan 1981; Thies 1982a, 1985; Jones and Witty 1980). Cuesta settlements include large nucleated villages, while smaller, perhaps functionally oriented, sites are also noted. Brogan (1981) suggested that this settlement arrangement may be related to the carrying capacity of the floodplain resource zone, although significant differences in the floral and faunal remains have not been observed between the large and small occupation sites. Cuesta villages contain from five to 10 houses, defined as either oval structures measuring 8-12 m by 11-15 m or square houses about
divided into six different component types: Cuesta Decorated, dentate variety; Cuesta Decorated, punctate variety; Cuesta Decorated, smooth stick impressed variety; Cuesta Decorated, cord-wrapped, stick impressed variety; Cuesta Plain; and Cuesta Plain, decorated lip variety. Cuesta ware is indurated clay tempered and vessel shape is defined as relatively large with an elongated shape and a conoidal or round base. The third ceramic ware is identified as Montgomery cord-roughened and is only minimally represented in the collection from the Infinity site. Brogan (1981) does not offer a description of this ceramic type. Projectile points are described as expanding stem dart points, conforming to the Snyder and Ensor types, contracting stem dart points of the Gary type, and smaller corner-notched Scallorn type arrowpoints. Endscrapers, side scrapers, bifacial knives, modified flakes, and drills are also recovered. Chert types for the various tools are not presented, although it is important to note that three flakes of obsidian were recovered from the Infinity site. The source of this obsidian has not been identified.

Subsistence practices of the Cuesta phase are described as hunting and gathering with evidence of limited horticulture—a similar economic mode as that attributed to the Kansas City Hopewell. Remains of large mammals, such as bison (Bison bison) and deer (Odocoileus sp.), are associated with faunal elements of turkey (Meleagris gallopavo), raccoon (Procyon lotor), beaver (Castor canadensis), dog (Canis sp.), rabbit (Sylvilagus sp.), turtle (Testudines), and various rodents. Floral remains, indicative of the proposed gathering and horticulture activities, can be summarized in one sentence. Two fragments of acorn (Quercus sp.) were identified from the Infinity site; one corn kernel, a fragmented sunflower achene, a plum pit (Prunus sp.), and a few hickory (Carya sp.) shells were recovered from 14LT304; and nutsHELLS, probably also hickory, were also recovered from 14LT316. Although Brogan (1981:70) suggests that these remains indicate a "subsistence base with a reliance on a riverine oak-hickory resource zone," the archeobotanical data are, in reality, insufficient to address issues of either reliance or the exploitation of any particular resource zone. Acorns, hickory nuts, sunflowers, and plums are all consumed by wildlife and single remains could easily be deposited within an archeological context through nonhuman activities.

Additionally, the sunflower can survive in a number of different habitats, including recently disturbed ground surrounding habitation areas. While the corn kernel is more indicative of human activities such as planting and harvesting, this sample could not be relocated during a recent inspection of the 14LT304 collection. However, three isolated corn cupules were identified from a "charcoal" matrix collected from a storage pit at this site (Adair, unpublished notes), reaffirming the association of corn with the Cuesta complex. Without systematic flotation recovery techniques, however, archeobotanical remains cannot be retrieved in the quantities or contexts needed to identify the use of wild or cultivated plants and the gathering strategies simply become assumed rather than demonstrated activities. Ongoing excavations of a
Cuesta occupation in Bourbon County, Kansas (Feagins, personal communication 1995) may help to better define the subsistence base, as systematic flotation sampling is a critical component of the investigations.

Valley Complex/Focus/Variant

Excavations at the Schultz site (25YV1) in west-central Nebraska over 50 years ago disclosed a pre-Village ceramic-making occupation which was used to formally define the first Middle Woodland taxon in the state (Hill and Kivett 1940). Numerous investigations over the next several decades helped to better identify the Valley complex in Nebraska and to distinguish it from Middle Woodland complexes to the south and east (especially the Kansas City Hopewell) as well as later Plains Woodland complexes (Bozell and Winfrey 1994). The spatial and temporal limits of the Valley variant are, however, still not as clearly defined as one would like. Site distribution extends from the Missouri River westward along the Platte, Loup, and Niobrara Rivers to the central and western portions of Nebraska, thus incorporating both the prairie and plains environments. To the south, a Valley burial site has been investigated in Doniphan County, Kansas (O'Brien 1971), while Valley sites have also been reported in the lower Republican and Kansas river drainages around Manhattan, Kansas (O'Brien 1984b). Eastern Valley sites are located primarily along the Missouri River drainage, such as indicated by the Rainbow site in northwestern Iowa (Benn 1990). Valley ceramics are also reported from eastern and central Wyoming (Connor 1993; Miller et al. 1986; Bozell and Winfrey 1994), central South Dakota (Hoffman 1968), northwestern North Dakota (Kivett 1949), and Yuma County, Colorado (Kivett 1949). Radiocarbon dates from four Valley component sites (Table 24) indicate a temporal range from about A.D. 1 to A.D. 500, a span roughly contemporaneous with the Kansas City Hopewell and overlapping the Keit and South Platte complexes.

Bozell and Winfrey (1994) provide the most recent summary of the Valley focus in Nebraska. Of special interest is their list of the approximately 30 Valley complex sites which have been excavated or tested. Most of these sites, located in Knox, Dison, Platte, and Cedar counties, were investigated between the late 1930s and the mid-1950s by researchers with the University of Nebraska-Lincoln and the Nebraska State Historical Society. Artifacts, primarily the ceramics, recovered from these sites provided the basis for most of the literature dealing with this complex. Valley ceramics are described as thick-walled, conical vessels with designs similar to Middle Woodland Havana ware of the Midwest (Hill and Kivett 1940; Benn 1990). Rim decorations include embosses or punctates, incised lines, dentate stamping, cord-wrapped rod impressions, and lip-notchings. Some vessels, especially those from western Valley sites, exhibit undecorated rims and a cord-roughened body. Projectile points are large corner-notched forms with expanding stems similar to the Snyder type, a common Middle Woodland style. Other tools include bifacial knives, scrapers, drills, retouched and utilized flakes, celts, hammerstones, grinding stones, and atlatl weights (Bozell and Winfrey 1994). Bone tools are fairly common and include awls, perforated bison phalanges, flakers, and expedient butchering tools.

Valley variant settlements often contain the remains of one or more circular to oval structures built over an excavated basin or on the unprepared ground surface. Excavations at the Schultz site (25YV1) disclosed ten possible structures ranging in size from 7.3 by 6.1 m to 1.7 by 1.9 m (Hill and Kivett 1940; Bozell and Winfrey 1994). All were constructed over a shallow basin and most contained centrally placed hearths. The superstructures were relatively light, being manufactured with small poles and covered with skins or mats. Some variation is evident, however, with the recovery of daub at the Wallace site, suggesting a wattle and daub covering. Shallow, basin-shaped exterior pits are often associated with Valley structures. As discussed below, Keith variant sites, including Doyle (25RW28) and Massacre Canyon (25HK13), exhibit structures similar to those associated with the Valley variant.

The four sites which provide the radiocarbon determinations for the Valley focus, and yield the most information on settlement and subsistence practices, were excavated during the 1970s and 1980s. Included are the MAD site (13CF1011/102) and Rainbow site (15PM91) in northwest Iowa, the Wallace site (25GO2) in Gosper County, Nebraska, and the Taylor Mound burial site (14DP3) in Doniphan County, Kansas. Subsistence evidence suggests a primary dependence on bison (Bison bison), deer (Odocoileus sp.), and antelope (Antilocapra americana), with a lesser reliance on smaller mammals, birds, and mussels (Kivett 1952; Falk and Semken 1990; Winfrey 1991). Bozell and Winfrey (1994) suggest that the reliance on bison may be a function of site location, with a greater use of the animal in the western part of the Valley range. At the Wallace site, over 56% of the identifiable fauna is pronghorn, with bison represented by only 6.2%. Falk lists 29 different species of vertebrates from the Valley variant components at the Rainbow site. Like the Kansas City Hopewell, fish are rare or absent from the faunal remains, despite the extensive use of flotation at several of the sites (Falk and Semken 1990).

Evidence for the use of either wild or cultivated plants as part of the Valley component at the Rainbow site subsistence strategy is not abundant. Botanical remains were not recovered from the western Valley sites, while flotation samples taken from the Wallace site (Adair, unpublished notes) have so far yielded limited quantities of goosefoot (Chenopodium sp.), bulrush (Scirpus sp.), and sedge (Carex sp.) seeds. Cucurbits, goosefoot seeds, and one maize kernel were recovered from Middle Woodland contexts at the Rainbow site (Benn 1990:193-209). Combined, the archeobotanical evidence is much too limited to suggest any characteristic trend in plant use for the Valley variant. The geographical extent of the complex is also too broad to expect a single pattern of wild plant resource use. One research interest, however, could focus on the presence and distribution of the introduced domesticates squash (Cucurbita pepo) and corn (Zea mays).
Although squash was recovered from earlier components at the Rainbow site, the maize from the Valley component may be the earliest association of this cultigen with a Plains complex. Given the current understanding of the distribution of these cultigens throughout the Woodlands of eastern North America (Smith 1992), it seems likely that both plants were introduced into the Plains from the east. The extent of any diffusion of these plants westward from the prairie edge complexes during the Middle Woodland period is unknown, although the obvious similarities in ceramic designs between the Kansas City Hopewell and the Valley complexes indicates that some westward dispersal of ideas occurred.

The association of Valley cord-roughened and Harlan cord-roughened (representative of the Keith complex) ceramics at the Whalen site in Sherman County, Nebraska, further suggests a temporal overlap of the Middle Woodland and Plains Woodland cultures. Bozell and Winfrey (1994) describe the Keith complex as encompassing both the Middle and Late Woodland expressions. In this context, it is appropriate to note that a scapula tool exhibiting extensive silicon polish was recovered from the Keith complex Doyle site (25RW28) in Red Willow County, Nebraska. Artifacts such as this are commonly identified as agricultural tools when associated with Villager period sites, so its association with an earlier time period is intriguing. Radiocarbon dates from the Doyle site (Table 24) indicate an occupation during the mid to late sixth century, although the artifacts are more typical of styles associated with the later Late Plains Woodland period. The Keith focus will be described in greater detail below.

Late Plains Woodland

For approximately 500 years, or roughly A.D. 500-1000, prehistoric populations in the Central Great Plains exhibited a lifestyle notably different from the Middle Woodland expression but without the presence of a village orientation. During this time, people tended to group themselves in small, nuclear family-sized houses of wattle and daub construction; reside in one location for at least part of the year; develop a dispersed hunting strategy; increase their consumption of agricultural crops; and create local styles of globular shaped ceramic vessels. The latter characteristic in particular has been used by researchers to distinguish local Woodland complexes. However, as presented below, certain traits assigned to one ceramic style of a particular Woodland taxon tend to also be present in other Woodland complexes, suggesting either the frequent exchange of ideas or styles between Woodland peoples, or that the differences between complexes are subtle and may not warrant separate taxonomic designations based on ceramic designs.

Keith Focus/Variant

Extensive archaeological investigation in the Republican River basin of Nebraska in the 1930s and 1940s resulted in the recognition of the Keith focus (Kivett 1953). Additional key sites, excavated in the following decades, further identified the temporal and spatial distribution of this complex. Keith complex sites are located throughout southwestern Nebraska, north-central and northwestern Kansas, with some Keith-like materials being recovered from eastern Colorado (Bozell and Winfrey 1994; Kivett 1953; Phillips 1963; Wedel 1959). Originally identified as a focus (Kivett 1953), the taxonomy of this complex changed when Johnson (n.d.) reidentified the focus as a variant, and Wedel (1986) referred to Keith as a phase. Johnson further suggests that Keith may represent temporally and/or spatially distinct adaptive patterns. Radiocarbon dates, however, are not numerous and suggest a broad range from about A.D. 1 to A.D. 800 (Adair and Brown 1987; Grange 1980; Wedel 1986) (Table 24). Several early dates from the Doyle site infer a Middle Woodland association.

The settlement pattern of the Keith complex consists of small hamlets, temporary camps, and burial mounds or ossuaries. Most sites are located on terraces of major rivers (e.g. the Republican and Arkansas rivers), although some temporary camps are found in rockshelters. Major sites assigned to the Keith focus include Woodruff ossuary, 14PH4 (Kivett 1953); West Island, 14PH10 (Witty 1966b); Vohs (Witty 1966), Massacre Canyon, 25HK13 (Kivett 1953); 25FT18 (Kivett 1953, Gunnerson 1987); Cooper (Witty 1966); Doyle, 25RW28 (Grange 1980); Coal Oil Canyon, 14LO401 (Bowman 1960); Young, 14SC1 (Wedel 1959); and 25HN12 (Adair and Brown 1987).

Small villages or hamlets are identified by the remains of structures. Grange (1980) describes these structures as round, basinlike pit houses about 4 to 5.5 m in diameter. They contain interior hearths, concentrations of shell and burned rock, extensive amounts of ceramics, chipped stone tools, and faunal remains. Subfloor burials have also been encountered. Lacking evidence of posts or superstructures, the houses have been interpreted as temporary (perhaps seasonal) shelters that were probably reoccupied. Hearths have also been located outside of the dwellings, such as noted from West Island (Witty 1966b). The size of the structure suggests that small groups (i.e. nuclear families) were the likely residents. Whether they lived in the structures on a temporary or permanent basis remains to be researched, although the amount of cultural detritus might suggest that the period of occupation was fairly lengthy.

The recovered faunal remains indicate a diverse exploitation strategy and may represent more than one season of hunting. Identified species are dominated by the remains of deer (Odocoileus spp.) and antelope (Antilocapra americana), but also include beaver (Castor canadensis), raccoon (Procyon lotor), badger (Taxidea taxus), coyote (Canis sp.), jackrabbit (Lepus californicus), prairie dog (Cynomys sp.), cottontail (Sylvilagus floridanus), various rodents, migratory birds (e.g. Canada goose, mallard), owl (Otus sp.), hawk (Accipitridae), turkey (Meleagris gallopavo), prairie chicken (Tympanuchus sp.), turtle, and frog. The bison is represented by only a few elements, suggesting to Bozell and Winfrey (1994) that the use of the bison was reduced significantly during the Middle Woodland period (keeping in mind that the Keith focus is viewed as overlapping the Middle and Late Woodland periods).
Unfortunately, no floral remains have been recovered from Keith complex sites, a situation best explained by the lack of appropriate fine-scale paleobotanical recovery techniques. The contents of a single feature from site 25HN12 were floated using a version of a SMAP barrel, although only wood charcoal fragments were identified (Adair and Brown 1987). The extensive numbers of milling and grinding stones in Keith sites suggests, however, that plants may have retained a fairly significant level of importance (Adair and Estep 1991). As mentioned above, the recovery of a scapula digging tool suggests that plants, such as possibly the prairie turnip, were important resources to the Keith folks.

Ceramics from Keith focus sites are identified as Harlan Cord-Roughened. Vessels of this ware are vertically cord roughened, frequently tempered with crushed calcite, and almost always lack decoration. Other characteristics include wide orifices, thick walls, and flattened lips (Kivett 1953). Krause (1995) has recently suggested a continuity in ceramic production sequences between the Keith and Upper Republican wares. If true, this suggests not only a fairly lengthy time span for Keith, but a regional transition from the Woodland to the Central Plains tradition.

Projectile point styles represented at the earlier component sites, such as the Walter site (14LA2), are similar to those found in Valley complex sites and are predominantly large corner-notched forms with expanding stems. The smaller corner-notched forms (Scallorn-like), assumed to be associated with the bow and arrow, occur at later component sites, including the Vohs (14OB401), West Island (14PH10), and Coal-Oil Canyon (14LO401) sites. The bone artifact industry includes awls, beads, perforated bison phalanges, flakers, scapula cutting or digging tools, and rib shaft wrenches. Modified shell artifacts are abundant, from both burials and habitation sites. Included are pendants, gorgets, and beads manufactured from local mussel shell, although a few species of Oliviella and Marginella, presumably acquired through trade, also occur. The size of the habitation sites and the number of adjacent burial sites suggested to Kivett (1970) that Keith people may have been bound by communal burial sites. Burial sites such as the Woodruff ossuary (14PH4), perhaps the best known western Plains Woodland burial location, attest to the skills and combined effort of a number of individuals in the construction of the burial pit.

Greenwood Phase

The Greenwood phase, formally defined by Witty in 1982 (1982a:207-213), identifies Plains Woodland components in the central part of the Flint Hills and the western part of the Osage Cuesta which existed between A.D. 400 to A.D. 1000. Several Greenwood phase sites were excavated in the early 1960s and include the type sites of Two Dog (14MO301) and Cow-Killer (14OS347). Like many of the other Late Plains Woodland manifestations, the Greenwood phase is believed to have developed from an indigenous Woodland and/or Late Archaic culture (Brown and Simmons 1987) and many have been influenced by the contemporaneous Cuesta, Grasshopper Falls, Butler, or Keith complexes which surround the geographical extent of the Greenwood phase. So similar are some of the characteristics to other Woodland taxa that O’Brien and Rager (1985) suggested that Greenwood and Butler phases probably represent the same cultural group. One major distinction, however, is the presence of later Pomona-like ceramics in Greenwood phase sites, suggesting both a long temporal span for the Greenwood complex and a possible development of the Greenwood into the Village period Pomona variant (Witty 1978).

Characteristics of the Greenwood phase include long to oval shaped houses, similar to those defined for the Cuesta phase, with central hearths and evidence of wattle and daub construction (Blakeslee and Rohn 1982). Both interior and exterior pits occur, features which suggest the storage of artifacts or food stuff for longer periods of preservation. Ceramics consist of two types that were defined by Calabrese (1967c). These are the Verdigris and Greenwood types. The Verdigris type includes straight walled, conical shaped vessels with cord-roughened exteriors and smoothed surfaced, conical-shaped vessels with slightly thicker walls. The temper is predominantly crushed limestone, although small amounts of clay or crushed bone have also been recorded. Greenwood ceramics are globular shaped with sloping shoulders and constricted orifices. Exteriors are cord-roughened and vessel walls are noticeably thinner than the Verdigris type, a characteristic which may reflect a use of the pot for long-term simmering of foods (cf. Braun 1981). Thinner, more compact ceramic vessels distribute heat more evenly.

A variety of faunal remains recovered from excavations of the Cow-Killer (14OS347) and Curry (14GR301) sites are representative of at least 26 taxa, including deer (Odocoteles sp.), wapiti (Cervus canadensis), bison (Bison bison), raccoon (Procyon lotor), cottontail (Sylvilagus floridanus), beaver (Castor canadensis), coyote (Canis sp.), bobcat (Lynx rufus), prairie dog (Cynomys sp.), gopher, woodrat and other rodents, turkey (Meleagris gallopavo), prairie chicken (Tympanuchus sp.), various migratory birds, turtle, and snake, and attest to a diffuse hunting strategy, a characteristic shared by other Plains Woodland complexes. Floral remains are not abundant from Greenwood phase sites due to absence of flotation recovery techniques. Black walnut shells (juglans nigra) and unidentified "small seeds" were recovered from the Cow Killer site (Reynolds 1984a), although the low frequency of these remains does not argue for their use as food by the prehistoric inhabitants. An exception to this is the Silves site (14MM13), where Blakeslee and Rohn (1982) report on the recovery of goosefoot (Chenopodium sp.), pigweed (Amaranthus sp.), blackberry (Rubus sp.), vetch (Vicia sp.), black walnut (Juglans nigra), hickory (Carya sp.), hazelnut ( Corylus americana), and a single fragment of maize (Zea mays). While the preservation of the corn does little to help define the subsistence mode of the Greenwood phase, its association with a Plains Woodland component adds another account to the growing evidence for the distribution of this cultigen throughout the eastern portion of the Central Great Plains prior to A.D. 900. One only wonders
what might have been recovered from Greenwood phase sites if flotation had become a standard recovery technique in the 1950s instead of 20 years later.

Grasshopper Falls Phase

The Grasshopper Falls phase was initially defined by Reynolds (1979b) on the basis of information provided by surface and excavation remains from over 100 sites in Jefferson, Atchinson, Shawnee, Jackson, and Osage counties, Kansas. Sites share similarities in terms of structural remains, settlement patterns, and artifact content. As Baugh (1991) emphasizes, perhaps the most consistent attribute of the excavated sites is the presence of one or two oval patterns of postmolds. Based on this characteristic, Grasshopper Falls phase sites have been described as representing nuclear or individual family households who resided in semipermanent structures located along river drainages of the Dissected Till Plains of northeast Kansas. Radiocarbon dates from several sites indicate a temporal span of A.D. 700-1000 (Table 24).

In addition to the habitation structures, architectural features include internal and external storage pits, and internal and external hearths (Figure 45). The latter feature is not always present within the house area, suggesting perhaps a warm weather occupation. Pits are described as exhibiting a circular orifice and extending to a depth of 8 to 40 cm below surface, with little to no variation between internal and external characteristics. The depth of some of the larger pits may well suggest a need for storage (Baugh 1991:54-55). Excavations at the Avoca site (14JN332) in Jackson County disclosed a house which appeared to have been rebuilt at least once, and perhaps twice (Baugh 1991). The structure was a relatively large 132.98 m², elliptical house with approximately 39 perimeter posts and possibly six interior posts. Following an interpretation of reuse, however, some of the perimeter posts may actually represent interior posts of the remodeled structure. Other Grasshopper Falls phase structures range in size from 10.58 m² (14JF307) to 41.22 m² (14JF350, House 1) to 91.10 m² (14SH322, House 2). The variations in house size are suggested to be a function of length of occupation or group size.

The presence of daub scatters and thick concentrations of daub, such as identified from the Reichart site (14F448) and Avoca (14JN332) sites, provides good information on the mode of construction (Baugh 1991, Logan 1990b). Reynolds (1987a) has suggested that although daub may have been an important construction material, it was not entirely necessary to spread mud over the entire structure. The primary covering may have been grass thatch with mud "plastered selectively on these covers where the structures were most vulnerable to the elements" (Reynolds 1987a:178). The most vulnerable locations are interpreted to be along the lower portions of the structures. Baugh (1991:46) challenges this idea, noting that most of the daub from Grasshopper Falls phase structures is associated with roof fall.

Ceramics, labeled Grasshopper Falls ware, are angular grit tempered (quartz, feldspar) or less frequently, sand tempered vessels. Exterior surfaces are cordmarked, smoothed, brushed, or polished. There is little to no decoration. Termed a utilitarian ware (Reynolds 1981:88), it is most commonly in the form of medium to large conical-based pots with straight to slightly bulging sides.

Chipped and ground stone tools are typical of other Plains Woodland complexes. Projectile points include both medium to large corner-notched points with expanding stems and small corner-notched varieties, and mark the transition from the use of the atlatl to the bow and arrow. Other tool categories include celts, drills, gouges, thin bifaces, end scrapers, hafted scrapers, and side scrapers. Mullers, celts, grinding slabs, hammerstones, and abraders comprise the ground stone category.

Direct information on the subsistence practices of Grasshopper Falls phase people is restricted to floral and faunal remains recovered from a few sites. In particular, excavations at the Avoca site (14JN332) recovered numerous bison (Bison bison), white-tailed deer (Odocoileus virginianus), dog/ coyote (Canis sp.), cottontail (Sylvilagus floridanus), turtle, and fish elements and suggest an exploitation of the adjacent floodplain prairies and forests. Floral remains recovered from several of the features provide some of the first good evidence for the use of plants during the Late Plains Woodland period and shed light on the developing agricultural strategies. Wild
plants and nuts are represented by goosefoot (*Chenopodium* sp.), grape (*Vitis* sp.), spurge (*Euphorbia* sp.), violet (*Viola* sp.), hickory (*Carya* sp.), and black walnut (*Juglans nigra*). Although there has been no attempt to analyze the goosefoot seeds for the presence of morphological characteristics due to domestication (Smith 1992), recovered marshelder (*Itea annua*) and sunflower (*Helianthus annuus*) seeds and achenes clearly exhibit the large size due to domestication (Adair 1991). The 12 *Itea annua* achenes and seeds recovered from the Avoca site range in size from 4.9-7.2 mm (length) to 2.6-5.5 mm (width) and average at 5.8 x 3.6 mm. In addition, 10 fragments of corn (from both cob and kernel) were identified. The three domesticated plants accounted for 44% of the total archeobotanical seed assemblage and indicate an importance not previously recognized for the Plains Woodland period.

Although a fragment of a large sized sunflower achene was reported from the Cuesta occupation at site 14LT304 (Adair 1988), the first good evidence of domesticated sunflower in the area comes from the Late Plains Woodland period. A common plant throughout the Plains (Figure 39), the sunflower is the only plant of New World origin that was domesticated prehistorically and became an important crop in modern times. Like the marshelder, domestication status of the common sunflower is determined by the size of the seed. A single sunflower achene was recovered from Hearth 1 at the Avoca site and was size reconstructed to measure 6.9 x 2.8 mm. (In order to make measurements on archeological specimens comparable with those from modern collections, one must make correction for loss of pericarp and/or shrinkage due to carbonization. The most commonly used formula is that suggested by Yarnell (1978) in which achene lengths and widths are increased by 11% and 27% respectively, and kernel lengths and widths are increased by 30% and 45%, respectively.)

The lengths of wild achenes (kernels in their shell) of *Helianthus annuus*, collected from modern stands within the area, range from 3.9-5.2 mm while prehistoric varieties from Late Woodland through Village period contexts measure 5.1-14.6 mm (Adair 1988) (Figure 46). Thus, the single Avoca specimen, while significantly larger than wild seeds, falls in the smaller range of recorded cultigen *Helianthus* from prehistoric Central Plains sites. Asch and Green (1992:25-47) provide an informed summary of the size ranges of the eastern “wild sunflower” (*H. annuus* ssp. *annuus*), the common western “wild sunflower” (*H. annuus* ssp. *lenticularis*), and the giant monocarpic domesticate (*H. annuus* var. *macrorapbus*) according to Heiser’s (1950, 1951, 1954, 1955, 1976, 1985) extensive research and discuss the evidence for early domesticated sunflower in the Middle West.

The archeobotanical remains recovered from the Avoca site support the claim that without systematic flotation, reconstruction of the subsistence pattern of Late Plains Woodland peoples will continue to overlook the relative importance of plants and domesticates as well as the evidence for the emerging agricultural economy. Before the Avoca excavations, corn was the only recognized cultigen of the Late Plains Woodland period; one kernel having been recovered from the Stiles site (14MM13), one cupule fragment identified from 14JN349, one kernel recovered from 14BU57 in Butler County, Kansas, and several kernels reported from the Lawson site, 25PT12, in northeastern Nebraska. For the most part, these single fragments were the only botanical remains recovered, or at least the only remains included in the literature.

From the Two Deer site (14BU55) in south-central Kansas, a transitional Woodland/Village occupation with an average radiocarbon date of A.D. 1000, a much greater quantity of corn was recovered, along with domesticated squash, marshelder, and sunflower (Adair and Brown 1978). In addition, a recent analysis of a small number of goosefoot (*Chenopodium* cf. *berlandieri*) seeds from this site revealed the presence of a thin testa and truncated margins (Adair 1993b), both known characteristics of the domesticated variety (Smith 1992). If this weedy annual is counted as a domesticate (a determination that really needs more research, since these characteristics can occur in small percentages in wild populations), the cultigens from the Two Deer site account for 68% of the total seed assemblage (the figure drops to 49% if the *Chenopodium* seeds are excluded). A comparison of the percentages from Avoca and Two Deer suggests that domesticates increased in importance during the Late Plains Woodland period, but that wild seeds, as well as nuts (over 4,600 fragments, approximately 108 grams, of nutshell remains were recovered from the Two Deer site) continued to be important.

Preliminary and ongoing analyses of flotation samples from the Loseke Creek complex Andrews site (25DO12) in east-central Nebraska, tend to confirm the pattern of about equal importance of cultigens and wild plants for the latter part of the Late Plains Woodland period. This pattern changes significantly during the Plains Village period. From House 4 at the Patterson site (25SY33), a Central Plains tradition site in east-central Nebraska, cultigens, dominated by corn, accounted for 96% of the identified assemblage (Adair 1992) and nuts decreased significantly, being represented by only 232 fragments (28.8 grams).
Hertha Phase

The Hertha phase was defined by Blakeslee and Rohn (1982) for the Late Plains Woodland components identified in the Bull Creek locality in the Hillsdale Lake area, Miami County, Kansas. The spatial extent of this phase was broadened to include the northeastern portions of the Osage Plains in Kansas and the Western Prairies in Missouri. Radiocarbon dates (Table 24) indicate a temporal span of A.D. 365 to A.D. 760, roughly contemporaneous with the mid to late Middle Woodland period.

Five types of sites were recognized for the Hertha phase: (1) habitation sites with no more than one house per site; (2) upland camp sites situated on bluffs along major streams; (3) lowland camp sites that are linear arrangements situated on natural levees; (4) limited activity sites; and (5) sites for which no function can be assigned (Blakeslee and Rohn 1982:1272-1275). All of the sites investigated were determined to represent winter habitation or campsites, and most are now inundated by the lake. Architectural features include oval-shaped houses with central rock-filled hearths (hence the determination of winter occupancy), hearths of burned earth and charcoal, and cache/trash pits. At site 14MM26, an oval postmold pattern suggested that house structures measured about 5 to 5.5 m by 6.5 to 7 m (Arzt et al. 1975).

Ceramics associated with the Hertha phase are mainly of one type but with various kinds of temper. Vessels are globular with medium to high rims, with cord-roughened exterior surfaces. Rims are vertical to slightly flaring and lips are rounded to flattened. Decoration, when present, consists of incised, notched, or crenated lips. Tempering materials include grog, crushed granite, sand, crushed and burned bone, shell, and non-tempered sherds. These ceramics share some of the characteristics defined for the Greenwood phase, as well as limited rim decorations similar to styles found in the late Middle Woodland, Edwardsville phase.

The chipped stone tool assemblage includes small corner-notched (Scallorn type) projectile points, indicative of the use of the bow and arrow, as well as medium to large corner-notched or expanding stemmed points more commonly associated with the atlatl. Bifaces, drills, retouched and utilized flakes, and large scrapers are also present in the assemblage, although ground and pecked stone tools are rare. No bone tools have been recovered.

Subsistence data is also quite limited, a fact that researchers have attributed to the proposed seasonal occupancy of the sites (Blakeslee and Rohn 1982:1263). Identified faunal remains suggest that hunting deer (Odocoileus sp.), bison (Bison bison), jackrabbit (Lepus sp.), and turtle, and gathering freshwater mussel were common activities. The exploitation of mussels, however, seems an unlikely activity if the sites were occupied mainly in the winter, as suggested by Blakeslee and Rohn (1982) . Flotation of feature fill at the William Sherwood site (14MM309) produced charred black walnut and hickory shells and a few pigweed seeds (Blakeslee and Rohn 1982:961-963). While the nut shell fragments may represent deliberate procurement for food or fuel, the presence of only a few pigweed seeds could be due to natural seed rain rather than any cultural factor.

According to Blakeslee and Rohn (1982:1271), the Hertha phase differs significantly from all of the surrounding Early Ceramic (Woodland) complexes defined so far. The only criterion given, however, is the lack of the conoidal vessel form and this appears to have been based on a sample of less than 200 sherds from the William Sherwood site. No basal fragments were recovered. The adaptation and subsistence practices appear strikingly similar to that described for the adjacent Greenwood phase. Some researchers have assigned the Hertha phase to the Pomona variant (Brown and Simmons 1987).

Wakarusa and Deer Creek Phases

Both of these phases were defined by Johnson (1998b) from investigations conducted along the Wakarusa River in Douglas and Shawnee counties, Kansas. Both were recognized by the remains of wattle and daub structures, storage pits, and hearths. The Anderson site (14DO32) is representative of the Deer Creek phase, while the Kampschroeder site was assigned to the Wakarusa phase. Both sites exhibit similar ceramics which can be described as relatively thick walled, elongate jars with slightly excavate rims and rounded lips. Exteriors are vertically cordmarked, occasionally smoothed over. The temper is either grit or sand. Logan (1990b) remarks on the similarities of this ceramic type with that defined for the Grasshopper Falls phase. Work at the Anderson and Richland sites yielded small corner dart points indicative of the use of the bow and arrow. This tool type is not currently associated with the Wakarusa phase.

The Richland site (14SH101), tested in 1989, disclosed the presence of a crematorium. This feature was identified by the concentration of burned limestone, burned earth, and charcoal, a few chipped stone artifacts and ceramic pieces, and an abundance of human remains. Two individuals were represented in the fill, an adult male and another individual, age and sex undetermined. This site produced the first radiocarbon date for the Deer Creek phase (Table 24). A few Chenopodium sp. seeds and fragments of black walnut shells were recovered from the cremation feature although it is unsure if these represent food remains (Adair 1990).

Sterns Creek Complex

Sterns Creek is one of the least understood complexes in the Woodland sequence (Haas 1983), being identified from only four sites. Although it was perhaps one of the earliest formally defined taxa for cultures ancestral to the Nebraska phase (Strong 1935), its spatial and temporal dimensions and diagnostic characteristics have waxed and waned over the years. Haas (1983) provides an excellent historical perspective on Plains Woodland taxonomy and the placement of Sterns Creek. Sterns Creek components are found in the Eastern Glaciated Region of eastern Nebraska to southeastern South Dakota and are located on buried alluvial terraces at junctures of tributaries entering the Missouri River floodplain (Haas 1983:31). Villages
are small but include structural evidence and numerous hearths, trash-filled pits, and cache pits. At the Walker Gilmore site, one structural pattern was consistently found in the three main Woodland bearing zones (Zones 2, 3, and 4). The structures have been described as having two converging exterior walls with the possibility of smaller interior support posts and measure about 15-25 feet long by 1-4 feet wide. They are associated with one or more trash-filled storage pits and less frequently, an interior hearth. The sequence of construction of these structures at Walker Gilmore indicates that the site area was reoccupied on several occasions. The recovery of “vegetal fibers” from the early investigations at Walker Gilmore lead Strong (1935) and Wedel (1961a) to suggest that the structures were more typical of the Eastern Woodland type than that common to the Plains. These vegetal fibers have not been identified, however, and they may be remnants of interior mats or cordage rather than wall coverings.

Sterns Creek ceramics reflect a Late Woodland technology with simple-stamped surface treatment, extensive smoothing of body and rim, a more globular orientation, thinner vessel walls, a greater rim inflection, and limited decoration focused on the lip. Haas describes four ceramic types for the Woodland zones at Walker Gilmore: Sterns Creek Ware, Sterns Creek Tool-Impressed, Sterns Creek Plain, and Missouri Bluffs Cord-Impressed Ware. The presence of small jars was suggested to reflect the storage of seeds.

Subsistence strategies included the exploitation of both small and large mammals, including deer (Odocoileus sp.), beaver (Castor canadensis), canid (Canis sp.), rabbit (Sylvilagus floridanus), squirrel, muskrat, migratory waterfowl (great blue heron, Canada goose, ducks, and sandhill crane), bobwhite, turkey, rails, crow, finches, grouse, turtle, and catfish (Falk and Argus 1983). Identified seeds include squash (Cucurbita pepo) and gourd (Lagenaria siceraria) seeds, groundnut (Arachis hypogaea), and black walnut (Juglans nigra) (Cutler and Blake 1983). Given the excellent preservation at Walker Gilmore, several of the squash seeds were not completely charred but survived through dessication. The presence of a relatively large quantity of these cultigens led Haas (1983) to suggest that squash harvesting was a primary subsistence activity at Walker Gilmore.

Losecke Creek Variant

Sites assigned to this complex are distributed along the Missouri River from central Nebraska to south-central South Dakota. They are also recognized in western Iowa (Benn 1981), in southeastern South Dakota and in northeastern Nebraska (Kivett 1952). The spatial distribution of the Losecke Creek variant is somewhat comparable to that of the Valley complex. Settlement pattern includes villages or hamlets of extensive temporal duration or frequent reoccupation (similar to Grasshopper Falls and Keith), as demonstrated from excavations at the Faye (25PT9), Lawson (25PT12), and Arp (39BR101) sites. Clusters of structural remains, storage pits, and interior and exterior hearths at both sites suggest that each site contained from four to eight houses roughly 4 to 6 feet in diameter (Kivett 1952, Gant 1967). Temporary camps are identified at the Tramp Deep site (25KX204) in Knox County, Nebraska, and at the 39BR102 in southeast South Dakota (Hurt 1961).

Subsistence includes hunting, gathering, and cultivating. Evidence for hunting is represented by the remains of bison (Bison bison), deer (Odocoileus sp.), antelope (Antilocapra americana), wapiti (Cervus canadensis), and smaller mammal forms. Gathering is evidenced by the recovery of plum pits (Prunus sp.) from the Arp site and Chenopodium sp. from the Andrews (25DO12) site. Cultigens are represented by remains of a few maize kernels from the Lawson site, chaffed corn remains from the Arp site, and an as yet unquantified but relatively substantial amount from the Andrews site (Adair, unpublished notes).

Losecke Creek ceramics may have derived from the earlier Valley Cord Roughened ware (Hurt 1952) since the two types exhibit a close similarity in exterior cordmarking, and decorations such as bosses and punctuations. As defined by Benn (1990), Losecke ware incorporates previously defined types from Nebraska, South Dakota, and western Iowa, including Faye Cord Impressed (Kivett 1952) and Missouri Bluffs Cord Impressed (Keyes 1949). In western Iowa, the Late Woodland ceramic style leads directly into Great Oasis and Plains Village ceramics (Benn 1990), while in South Dakota it is believed that Losecke Creek influenced the development of the Initial Middle Missouri pottery types (Johnston 1967).

South Platte Phase

The South Platte phase was proposed by Butler (1988) to include all of the High Plains Woodland complexes previously defined as separate taxa. Basically, Butler argues that taxa such as Parker, Graneros, Hog Back, and Franktown do not exist as separate and valid taxonomic units since they cannot be defined or distinguished on the basis of ceramics, lithics, house styles, location, or duration of occupation. The South Platte phase therefore encompasses these previous designations and is defined to include all Woodland complexes located in the northern half of the Western Plains subarea, from the Palmer Divide north to about the Wyoming border and from the Front Range to the High Plains border at about the Kansas state line. This area approximates the South Platte drainage basin, or roughly the High Plains and Front Range of the Rocky Mountains. Woodland sites in this area date from ca.1850 to 800 B.P. (AD 100-1150) (Table 24). Sites are distributed along the upper reaches of the North Platte, South Platte, and White River drainages in Colorado, Nebraska, South Dakota, and Wyoming. Outlying components are found in the western Sand Hills and the Republican River drainage of Nebraska. Sites are found along streams or within rock shelters. The paucity of rich sites suggests a somewhat mobile lifestyle.

South Platte ceramics are very similar to Harlan Cord-Roughened, lacking only the calcite tempering. Kivett (1952) assigns South Platte ceramics to Ash Hollow Cord-Roughened. Bone tools are not as frequent as from Keith sites but include awls, beads, and flakers. Modified shell is also infrequently
recovered. South Platte burials are mainly single flexed individuals interred in specially prepared pits. Grave goods are present and are usually more abundant when associated with infants and juveniles. A single burial excavated in western Sioux County, Nebraska yielded a ceramic vessel typical of Central Plains Woodland styles. However, the biological similarities of this skeleton more closely compared to ones from adjacent but culturally unrelated populations to the west in Wyoming (Gill and Lewis 1977) than to Woodland populations in central and eastern Nebraska and Kansas. The authors state that this tends to support a concept of the spread of Woodland culture across the Plains (Gill and Lewis 1977:72).

Subsistence during the Woodland period in eastern Colorado includes emphasis on wild plants and small and large game animals. The plant remains from the LoDaïska site indicate the collection of a variety of different plant types, such as small weedy annuals (Chenopodium sp. and Carex sp.), fruits (Prunus sp.), nuts and berries (Craetaegus sp. and Quercus sp.), grass (gramineae), and bulbs (Allium sp.). Also of interest is the recovery of several cobs and kernels of maize (Irwin and Irwin 1955; Galinan 1985). Corn has been recovered from other Woodland occupations in southeast Colorado (Campbell 1976; Eddy et al. 1982), although the context of some of the remains within recent rodent caches makes its association directly with the Woodland period somewhat questionable. Given the proximity of the eastern and southern Colorado Woodland complexes to the Southwest, where corn becomes well established during the Basketmaker period, it would not be unreasonable to hypothesize on the spread of corn north and east through the high altitudes of Colorado and eastward to the foothills of the Rockies. This route was actually proposed some time ago (Galinat 1965, 1985). Eighty (1984), on the other hand, believes that both the evidence for corn and the cordmarked ceramics in the High Plains Woodland sites is evidence of trade or contact from the East.

Ash Hollow focus

The Ash Hollow focus of the Plains Woodland pattern was formally proposed by Irwin and Irwin (1957) after Kivett (1952) suggested that the adaptations at such sites as Ash Hollow Cave and Kelso in western Nebraska differed from the Keith and Valley complexes. Also included with the Ash Hollow complex were the Agate Bluff site in north-central Colorado and Component B at the Hatch site in northeast Colorado (Irwin and Irwin 1957; J. J. Wood 1967). More recently, Bozell and Winfrey (1994) place the Ash Hollow Cave, LoDaïska, and Kelso sites with the South Platte complex.

The ceramics from these sites are described as thick with cord-roughened exterior surfaces. Sand is the major temper used although clay and shell has also been reported (Kivett 1953). Decoration is rare but can be identified as a thin band of cord impressions applied diagonally to the lip. Vessels are described as exhibiting an elongate body with a conoidal base. Kivett (1953:37) thinks that the lack of fabric or cord impressions on the interior of Ash Hollow vessels distinguishes this type from Harlan Cord Roughened while the total absence of elaborate rim decorations distinguishes it from the Valley Cord Roughened type.

Aside from the ceramics, there appears to be quite a bit of similarity between the Ash Hollow, Keith, and Parker complexes. Projectile points from Ash Hollow Cave and the Kelso site include stemmed, corner-notched, and small, side-notched triangular forms. Other lithic artifacts include endscrapers, side scrapers, ovoid knives, retouched and utilized flakes, and ground stone milling stones and abraders. Bone artifacts include tubular beads, disk beads, and splinter awls. Burials assigned to the Ash Hollow focus compare to those described for the Keith complex. A sizeable ossuary, containing over 35 individuals (both adults and children), was located near Scottsbluff in western Nebraska. Like the “beaded boy” from the Woodruff ossuary (Kivett 1953), an infant exposed in the Scottsbluff ossuary was wrapped with over 700 tubular beads (Gunnerson 1987). The ossuary contained primary, secondary, and cremated burials.

The subsistence practice of the Ash Hollow complex is represented only in the recovered faunal remains. No plant remains have been recovered, although Irwin and Irwin (1957) report on the presence of a yucca fiber rope from the Agate Bluff site. From the Kelso site comes information to complement the diffuse hunting strategies already described for the Doyle and Lawson sites. Identified animal remains included bison (Bison bison), deer (Odocoileus sp.), antelope (Antilocarpa americana), beaver (Castor canadensis), coyote (Canis sp.), badger (Taxidea taxus), prairie dog (Cynomys sp.), jackrabbit (Lepus sp.), cottontail (Sylvilagus floridanus), and turtle (Testudines). Without flotation to recover small elements, the importance of foods such as fish and rodents cannot be addressed.

Central Great Plains Woodland Period Research Needs

Despite the recognition of 17 phases or complexes assigned to the Woodland period in the Central Plains, there remain significant questions concerning the distribution of basic traits, the chronological developments within and between the phases, and the responses brought on by economic and technological changes. For the area as a whole, well defined and unique cultural assemblages with adequate radiocarbon dates are a major stumbling block. When many of the complexes or phases were originally defined 40 to 50 years ago, they were identified on the basis of a relatively small assemblage of ceramics and chipped stone tools. While several of these have been grouped together by recent research (Butler 1988; Bozell and Winfrey 1994) and can now be recognized by a common name, we still have a limited understanding of how the prehistoric inhabitants adapted to a specific area and how their adaptation may have differed from a cultural phase located in another area. In particular, our meager substantive
information pertaining to subsistence practices, and in particular to the use of plants in the diet, critically inhibits our ability to address Woodland subsistence over time and space.

Most of the archeobotanical data presented in this chapter is described in a presence/absence format; the data are too insufficient to quantify in a meaningful way. Archeobotanical remains comprise only one of the various types of artifacts or cultural debris produced, altered, or arranged by prehistoric inhabitants. Yet these remains are only one of the few that can directly aid subsistence, dietary, or nutritional research. Charred seeds, nutsheils, and tubers can provide convincing evidence for the selection of certain plants for food, while changing frequencies or percentages of select species over time and space can help document economic change. Quantification of these data are critical if we continue to label the adaptive pattern of the Woodland period as "Incipient Horticulturalists." Such a term implies that cultivated or domesticated crops were initially incorporated into the subsistence realm and that this beginning laid the foundation for an increased reliance on these foods. Was this increase over time a gradual and progressive pattern, or was it marked by rapid and dramatic changes in the importance of certain species?

To date, very few Central Plains Woodland archeobotanical assemblages can demonstrate the increased use of domesticates (either native or introduced) over time, or show any corresponding decline in the use of wild plants. Several factors are probably equally responsible for this, including inadequate recovery methods and techniques (waterscreening and flotation are not identical techniques), insufficient funding for the identification and analysis of archeobotanical remains, and poor preservation of plant remains in open air, clay soils. Each of these obstacles can be challenged by requiring that the collection, identification, and presentation of archeobotanical remains be included with the rest of the assemblage. Archeobotanical remains are not restricted to charred seeds and nutsheils but also include preserved pollen and phytoliths.

It will always be important to describe distinctive cultural characteristics of the Woodland period and to note how these characteristics vary through time and space. The origins of decorative ceramics, the function of different ceramic vessel shapes, the widespread use of the bow and arrow, and the arrangement of people into social structures of varying sizes are all important and critical areas for future research for the Central Plains Woodland period. If subsistence patterns are also viewed as important and critical areas of research, greater attention must be given to archeobotanical remains. With sufficient and representative botanical assemblages, it is also possible to go beyond subsistence research and address such things as discard patterns, functional use of different features, differential use of foods by select, perhaps sociopolitical, members, reduction or depletion of deciduous trees in the floodplain forests to increase farming acreage, and trade with adjacent areas for select items.
6 The Plains Village Period on the Central Plains, by Brad Logan

The archeological concept Plains Village was defined by Lehmer (1954:139) as a pattern. It has since been applied as a form of adaptation to some Plains environments during the Ceramic age or as a chronological period, which in the Central Plains dates ca. A.D. 900-1500. Plains Villagers are distinguished from Woodland cultures or adaptations by distinctive traits in their lithic, ceramic, and modified bone assemblages, changes in settlement/subsistence patterns, house forms, and evidence of an increasing reliance on domestic plant foods, including corn, beans, squash, sunflowers, and marsh elder (Lehmer 1954; Wedel 1959). Although the degree of reliance on cultivated crops has not been satisfactorily quantified, it is apparent from the relative abundance of preserved plant remains that it was significantly greater than that of preceding ceramic cultures (Adair 1988). The practice of horticulture or small-scale agriculture in combination with continued dependence on hunting and gathering led to a more sedentary lifestyle than that of Plains Woodland groups in the Central Plains.

Six cultures characterized by the Plains Village pattern have been recognized in the region. These are the Pomona variant, Steed-Kisker phase, three comparable complexes assigned to the Central Plains Tradition (CPT)—Nebraska, Smoky Hill, and Upper Republican—and the St. Helena phase. The Upper Republican complex has been divided by some archeologists into three subphases, Solomon River, Classic Upper Republican, and Loup River, in chronological order. Only the last two of these are now in vogue, and the most recent, Loup River, is also referred to as the Itskari phase. Two complexes, Oneota and White Rock, are generally assigned to the Protohistoric period and are so treated here. However, both have their origins, at least temporally, in the Plains Village period. Oneota, as it is represented in the states of Iowa, Nebraska, and Missouri, extends into the historic period.

In general, these cultures are distinguished by temporal, geographical, and/or formal differences, which are described below.

Pomona

The Pomona variant was first defined as a focus (Witty 1967, 1978, 1981), but has been recently redefined as a variant with four phases (K. Brown 1985). Site descriptive reports relevant to this complex include those by Moore, Birky and Smith (1964), A. E. Johnson (1968), Wilmet (1970), Carrillo (1973), Artz et al. (1975), Stein (1976), Schmids, Reid et al. (1980), Brogan (1982), Reynolds (1987a), Brown and Ziegler (1985), Blakeslee and Rohn (1986), Williams (1986), and Logan and Hedden (1993). Radiocarbon dates from Pomona sites are listed in Tables 27 and 28. Core areas of all phases of the Pomona variant, as far as they are currently known, were limited spatially to eastern Kansas, although it has been suggested that western Missouri served as a resource area at certain times for some phases.

The most salient characteristic of Pomona that distinguishes it from complexes of the Central Plains tradition is house form, or rather, the lack at most Pomona sites of any distinctive habitation structure. Lodges of oval outline have been discovered at some sites, but most Pomona occupations have structures represented by ambiguous scatters of postmolds. The houses lack central hearths but intramural storage pits may occur (Witty 1967, 1978, 1981). Pomona sites in the Hillsdale Lake area of northeastern Kansas exhibit some variety with respect to settlement type, where Blakeslee and Rohn (1986:1285-1287) recognized seven kinds of sites. These include extended communities, isolated habitation, small campsites, large camps, large linear limited function sites, small limited function sites, and butchering stations. This variety may be applicable to Pomona throughout its range.

Kenneth Brown (1985) has suggested that the Pomona settlement pattern was a continuation of the preceding Plains Woodland and Late Archaic patterns in the same region. This was characterized by a shift between upland, warm weather settlements and lowland, cold weather sites. Our knowledge of the former sites has been hampered by the bias toward investigation of sites on terraces in valley settings. Seasonal abandonment of sites to pursue game in the mixed grass prairie to the west of the project area and in the Ozark Highland to the east (i.e., resource areas) has also been proposed as part of the Pomona settlement-subistence pattern.

While maize has been found at Pomona sites, remains are not abundant and are poorly documented (Adair 1988:38). Too often, Pomona sites fail to yield any remains of this domesticated plant (e.g., Blakeslee and Rohn 1986:1302). Excavations at the Shadow Glen site (14Q021) in northeastern Kansas, which included systematic recovery of flotation samples (not yet completely sorted and identified), yielded a few kernels and a cupule of maize. At present, the evidence for agriculture is scant. While scapula hoes have been found, they are not nearly as prevalent as these farming/gardening implements are at other Plains Village sites. This scarcity of agricultural evidence provides support for the interpretation of Pomona as an adaptation derivative from an indigenous Plains Woodland culture (Witty 1967, 1978, 1981; K. Brown 1985).

Pomona pottery is distinctive from the ceramics of other Central Plains Villagers. Small to medium-sized vessels of globular shape may be either cordmarked or plain with relatively high, straight, and generally undecorated, unthickened rims. Temper is variable but most frequently consists of crushed sherd. Grit or sand may also occur and shell temper appears in low frequency in the northern part of the variant's range, perhaps reflecting not only proximity to but interaction with Steed-Kisker (Witty 1967:2, 1978:60, 1981:78; Wilmet 1970; K. Brown 1985).
The four phases recognized by Kenneth Brown (1985) are summarized below. These are based on limited cultural attributes as well as geographical ranges and temporal spans that, in some cases, overlap. Future research will probably require some revision of these taxa (cf. Logan and Hedden 1993:25-26).

Clinton phase. Brown (1985:446) redefined this phase, originally proposed by A. E. Johnson (1968) from excavations in the Wakarusa River drainage, as characterized by arrow points made from nonlocal cherts and ceramic vessels with undecorated lips. Use of shell temper in the pottery was variable. Chronological placement is A.D. 960-1330. Sites of this phase are located in Kansas drainages south of the Kansas River.

Wolf Creek phase. Brown (1985:446) introduced this phase as a new taxon. It is characterized by the exclusive use of local cherts for the production of arrow points, the lack of decoration of the lips of ceramic vessels and the rare use of shell temper in their manufacture. The Wolf Creek phase dates from ca. A.D. 980 to A.D. 1325. Geographically, it is restricted to the Neosho and Verdigris River drainages, though hunting camps affiliated with it may occur in the Truman Reservoir locality in Missouri.

May Brook phase. Brown and Ziegler (1985) originally defined this phase from excavations in the Little Blue River drainage in Jackson County, Missouri. It has subsequently been refined on the basis of an investigation at one of the type sites by Schmits (1981) and by more comprehensive comparative research by Brown (1983:447). The latter summarizes the phase as follows: arrow points are made of nonlocal cherts, and ceramic vessels exhibit decorated lips (exclusive of knobbing) and frequent use of shell temper. Chronological placement is A.D. 1150-1285. Sites of this phase are distributed throughout
the Wakarusa, Neosho, Marais des Cygnes, and Verdigris river drainages in Kansas and the Little Blue and Truman Reservoir localities in Missouri.

**Apple Valley phase**. Brown (1985:447) introduced this taxon and distinguished it from others of the Pomona variant by the presence of knobs on the lips and rims of ceramic vessels. Other forms of lip decoration are known for this phase, and shell temper occurs consistently in the ceramic assemblages of Apple Valley sites. Arrow points made of nonlocal cherts rarely occur in the lithic assemblages. The chronological placement is A.D. 1500-1550. Geographic distribution of this phase includes the Delaware, Bull Creek, Verdigris and Neosho River localities. The Delaware River drainage is suggested to have been its core area.

Recently, A. E. Johnson (1991) has suggested the Pomona variant was ancestral to the historic Kansa. His interpretation is based on similarities in settlement patterns and house structures. However, others have disputed this interpretation by interpreting the Pomona people as Caddoan rather than Siouan (Vehik 1993), attributing the occupation of the Fanning and Doniphan sites to the Kansa rather than, as A. E. Johnson (1991) does, to the Oto (Henning 1993), or by noting the distinction between Pomona and Kansa ceramics and house forms (Logan and Hedden 1993).

**Steed-Kisker**

Steed-Kisker is a Mississippian-influenced or derived complex centered along the lower Missouri River trench north of Kansas City. It was first recognized by Wedel (1943) following excavations at the type site (23PL13) and at a few burial sites in Platte County, Missouri. Though several other settlements and burial sites in the Kansas City locality have been described (Calabrese 1969a; Shippee 1960, 1972; O'Brien 1978a, 1978b, 1981, 1993; Chapman 1980:156-160), little fieldwork has been done at Steed-Kisker sites in Missouri since completion of the Smithville Lake project in the late 1970s (O'Brien 1977b; McHugh et al. 1982; O'Brien and McHugh 1987). Radiocarbon dates taken from Steed-Kisker sites are listed in Tables 29 and 30. The most recent investigations of Steed-Kisker occupations have focused on sites in Leavenworth County, Kansas. These include the 1988-1989 excavations of the Kansas Archaeological Field School at the Zacharias site (14LV380) which is on Salt Creek, a west bank tributary of the Missouri River (Logan 1988, 1990a:23-39; Logan and Ritterbush 1994:5-6), and the 1995-1996 excavations of the DB site, a multicomponent occupation on an upland ridge near the confluence of those streams (Logan 1995c, ed.J 1996, 1997).

Ceramic traits of the Steed-Kisker phase display obvious similarity to Middle Mississippian cultures of eastern Missouri and western Illinois, and on this basis the culture has been attributed to a migration of peoples from those areas (Wedel 1943; O'Brien 1978b, 1981; Chapman 1980:156). O'Brien (1978b, 1981, 1988, 1993) has been the strongest advocate of this view, inferring a trade relationship between Steed-Kisker and Cahokia. Others consider the Mississippian tradition manifestation that developed locally (Henning 1967). O'Brien (1978a; 1978b; 1981, 1993) places the temporal span of the Steed-Kisker phase from ca. A.D. 1000-1250, though recent review and calibration of the available radiocarbon dates indicate a broader span, ca. A.D. 950-1400 (Logan 1988; Logan and Ritterbush 1994).

Settlements of this complex consist of remains of one or two shallow pit houses of subrectangular outline. These occur on terraces along tributary streams of the Missouri, Platte, and Little Platte rivers. Sedentism is indicated by trash-filled storage pits and the presence of extensive burial grounds near some settlements. Hunting, gathering, and horticulture are reflected in the lithic tools, faunal, and floral remains. Long distance hunting has been suggested as one facet of Steed-Kisker subsistence; an inference based on data from a single site (Vista Shelter) in the Ozarks of southwestern Missouri some 100 miles from the core area (W. R. Wood 1968).

Ceramic artifacts include shell-tempered bowls and jars with plain surfaces, a variety of incised lines or scroll designs, and appendages such as lugs or loop handles (Wedel 1943:95-97; Shippee 1972). Calabrese (1969a:70-73) refers to Steed-Kisker pottery as Platte Valley ware. Chapman (1980:159, 292-293, 297) recognizes two wares, Platte Valley Plain and Steed-Kisker Incised. Other artifacts include clay and stone pipes, animal and human effigies, triangular side-notched and side-and-base-notched arrow points, small scrapers, alternately beveled knives, ground stone tools and axes, sandstone shaft abraders, and worked hematite (Wedel 1943; Shippee 1972; Chapman 1980:156-161). Burials are generally extended, though flexed and bundle skeletal remains are also found, and include associated grave goods, such as bowls and arrow points (Wedel 1943; Barnes 1977; O'Brien 1977b).

The relations between Steed-Kisker and other Plains Village complexes in the lower Missouri and Kansas River valleys are as yet poorly understood. Calabrese (1969a) has suggested that the Steed-Kisker phase was ancestral to the Nebraska phase. However, a number of radiocarbon dates from sites of both complexes clearly demonstrate contemporaneity and, consequently, do not support the hypothesis of an ancestral relationship. The geographic ranges of the Nebraska and Steed-Kisker cultures overlapped in the region of St. Joseph, Missouri, where several sites have yielded mixed ceramic assemblages of Platte Valley (i.e., Steed-Kisker; Calabrese 1969a) and Nebraska wares (Feagins 1988; cf. Logan 1997). Whether this association indicates contemporaneity and interaction of two distinct populations is as yet unknown.

Testimony to interaction among or between contemporary groups of the Plains Village period, including Steed-Kisker, Nebraska and Pomona, is the frequent association of ceramics indicative of each complex at sites in northeastern Kansas. Pottery characteristic of the Steed-Kisker phase was recovered at the Keen site, an occupation attributed to the Pomona culture, in the Delaware River valley (Witty 1983). Witty (1983) interpreted this as evidence of contact and some form of exchange. The frequent association of ceramics of the Steed-Kisker phase and the Pomona variant at sites in Stranger Creek
basin, a north-bank tributary of the Kansas River located between the Delaware and Missouri River valleys, led Logan (1985, 1988) to suggest that it had been a shared frontier. Recent excavations at the Zacharias site have yielded additional evidence of contact between these cultures or populations (Logan 1988, 1990a).

Central Plains Tradition

The Central Plains tradition (CPT) was first outlined by Lehmer (1954), primarily in contrast to the Middle Missouri and Coalescent traditions of the Northern Plains, on the following basis:

1) Villages are small, unfortified, and composed of houses, usually square, with four primary post supports centered on a hearth, that were arranged in no particular order.

2) Burial places consist of hilltop ossuaries located near the villages.

3) Ceramics consist of grit-tempered vessels, either plain or cordmarked, with flared or thickened (collared) rims and tool-pressed decorations.

4) Arrow points with base or multiple side notches, diamond-beveled knives, chipped celts, equal-arm elbow pipes, bone awls made from deer cannon bones, single-hole arrow shaft wrenches of bone and antler, figurines.

Lehmer based his definition of the CPT on data from sites of Upper Republican and Nebraska aspects, as they were then referred to in the Midwestern Taxonomic System. A third “aspect,” Smoky Hill, was added by Wedel (1959). With minor variation (e.g., the predominance of sherd temper in the paste of Riley Cord-roughened ware), it fits this general outline. Each of these complexes has since been taxonomically redefined as phases (L. Brown 1967; Blakeslee and Caldwell 1979) and variants (Krause 1969). Indeed, the problems inherent in archeological systematics have been exemplified, for better or worse, by the taxonomic placement and interpretation of these Central Plains complexes (cf. Krause 1989). Other problems in CPT interpretations, including the relations among the complexes which comprise that tradition and between it and others north and south, are found in a volume of research papers, distilled theses, and condensed dissertations edited by Blakeslee (1978), subsequent critical review by Krause (1982), and comments on the latter (Blakeslee et al. 1982). Roper (1993) presents the most recent review of the tradition, particularly with respect to its putative ancestral relationship to the historic Pawnee.

The three complexes of the CPT, Nebraska, Upper Republican and Smoky Hill, traditionally have been distinguished on the basis of their geographic locations and ceramics. Nebraska is located along the lower Missouri River valley on the Iowa-Nebraska border southward to northeastern Kansas and northwestern Missouri. The Upper Republican and Smoky Hill variants both occur within the upper Kansas River basin. As originally defined, Upper Republican, as its name implies, was centered in the Republican River drainage of northwestern Kansas and southwestern Nebraska "mainly west of the Smoky Hills and north of the Arkansas River" (Wedel 1959-562). The Smoky Hill culture was centered along the Smoky Hill River eastward to the confluence of the Big Blue and Kansas rivers (Wedel 1959-562-563). The spatial gap between the core areas of these latter two variants has, however, become less distinct with surveys and excavations of Plains Village sites in the intervening area (Krause 1970; Lippincott 1976).

Differences in the material culture inventories between CPT variants are most noticeable in ceramic attributes, such as rim form. However, when analyzed along geographic gradients from the core area of one complex to another, these differences do not appear to be as distinct and may reflect spatial variations in the relative frequency of shared ceramic types (Hedden 1992). These variations, along with the blurring of geographic boundaries between variants, challenge the taxonomic integrity of the Upper Republican and Smoky Hill archeological complexes as originally defined (Steinacher 1976; Krause 1982; Blakeslee et al. 1982; Wedel 1986-132). A typological analysis by Hedden (1992) of Riley Cord-roughened rim sherds from ten Smoky Hill sites discerned a general directional trend in the relative frequencies of the various ceramic types. His geographical seriation suggests that rather than the discrete variants currently recognized as Upper Republican and Smoky Hill, there is a continuum which extends between the "boundaries" of those entities. The interpretation provided by Hedden demonstrates in a preliminary way the fragile nature of our current taxonomic conception of Plains Village cultures in the Central Plains.

In a statistical analysis of radiocarbon dates from CPT and other sites (i.e., Steed-Kisker, St. Helena and Initial Coalescent), Roper (1976) detected a northward trend from older to younger tests that she suggested mirrors a geographic extension of Plains Village cultures through time. Kvaam (1982) refined the trend-surface analysis about which, ironically, Roper (1985, 1994a, 1994b) had developed some reservations (largely attributed to inadequacies in the data she perceived after her own work). Kvaam (1985) then defended Roper's analysis, referring to the data weaknesses as "noise" inherent in most statistical analyses and took the opportunity to remind us that statistics are tools frequently used to illustrate perceptions often apparent. He noted (Kvaam 1985-263), for example, that the general outline of a northward trend through time of the Plains Village cultures compared by Roper (1976) can be seen by simply plotting the base data on a map. Most recently, Roper (1994a) has substantially revised her earlier scenario of CPT dynamics with respect to time and space, recognizing the greater complexity of cultural developments and relationships in the light of newer data.

Nebraska

The first CPT complex recognized by archeologists, the Nebraska phase (L. Brown 1967; Blakeslee and Caldwell 1979; Blakeslee 1978, 1990; Billeck 1993) or variant (Krause 1969, 1982, 1989) was referred to as the Rectangular Earth Lodge culture by Sterner (1914, 1915b), the first professional to define it. His investigations of this complex had been preceded by
the pioneering efforts of Gilder (1907b, 1909, 1911, 1912). Subsequent investigations of several habitation sites along the Missouri River trench in eastern Nebraska in the 1930s by W. Duncan Strong (1933, 1935) of the University of Nebraska and Columbia University, Earl Bell and M. R. Gilmore (1936) of the University of Nebraska, and Asa T. Hill and Paul Cooper of the Nebraska State Historical Society (e.g., Hill and Cooper 1936a, 1936b, 1938; Cooper 1936, 1939) provided the broad outline which still serves as the definition of the Nebraska culture. Subsequent research has included additional data acquisition and numerous attempts to enhance our understanding of the taxonomy, variation and development of this culture (e.g., Gunnerson 1952; Ives 1955; Anderson and Anderson 1960; Davis and Rowe 1960; Anderson 1961; L. Brown 1967; Gradwohl 1969; W. R. Wood ed. 1969; Krause 1969; Heavin 1970; Zimmerman 1971, 1976, 1977a, 1977b; P. C. Johnson 1972; Shaw 1974; Anderson and Zimmerman 1976; Hotopp 1978a, 1978b; Blakeslee 1978, 1989, 1990; A. Blakeslee and Caldwell 1979; McNerney 1987; Feagins 1988; Green 1990, 1992; Ludwickson and Bozell 1993; Billeck 1993).

The geographic range of the Nebraska phase extends along the Missouri River trench primarily in Nebraska, southward from Thurston County, but with an important locality along Keg and Pony Creeks near Glenwood, Mills County, Iowa (Anderson 1961; L. Brown 1967; Zimmerman 1971, 1976, 1977a, 1977b; Hotopp 1978a, 1978b; Blakeslee and Caldwell 1979; Billeck 1993). The southernmost extent of the phase is in Doniphan County, Kansas and Buchanan County, Missouri (W. R. Wood ed. 1969; Feagins 1988). However, at least one site (14J046) as far south as Johnson County, Kansas has been attributed to a Nebraska phase occupation (Logan and Heiden 1990). Radiocarbon dates for the Nebraska phase range from about A.D. 1000 to 1450 (Blakeslee 1990:29) in Nebraska and A.D. 1000 to 1250 in the Glenwood locality (Billeck 1993).

As Sterns (1915b) first described what is now called the Nebraska phase, one of its hallmarks is the rectangular or subrectangular lodge constructed of post supports and pole framework centered on a pit hearth and covered with earth or daub. Pits extending below the floor of these structures were used to store foodstuffs and other goods. Though some sites appear to have several such lodges, it is as yet debated whether these were contemporaneously occupied habitations of extensive villages (Gradwohl 1969) or serially occupied farmsteads (Blakeslee 1990).
The subsistence pattern is comparable to that of the Steed-Kisker phase, characterized by hunting of wild animals of the prairie-woodland-riverine habitats, gathering of wild plant resources, and a significant reliance on the cultivation of domesticated plants (Adair 1988). Blakeslee (1990) has suggested that Nebraska phase agriculture entailed slash-and-burn gardening, which depleted soil and required relatively frequent moves along tributaries resulting in a serial lodge occupations.

Ceramics include both shell-tempered and grit-tempered bowls and jars with lug and strap handles and rim-incipient designs. Distinctive wares that have been defined include McVey, Beckman, and Swaboda pottery (Gunnerson 1952; Ives 1955; Anderson and Anderson 1960). Variations of Nebraska phase ceramics have been established by Blakeslee and Caldwell (1979) and Billeck (1993). Both of these sources are major revisions of Nebraska phase spatial, temporal, and developmental parameters. Lithic artifacts are similar to those of the Steed-Kisker phase and other CPT complexes.

The extent of Mississippian influence on the development of the Nebraska phase has been the subject of considerable research. Several researchers have noted the diffusion or introduction of certain traits from Mississippian cultures in Nebraska phase ceramics (Strong 1935; Ives 1955; Wedel 1959:129-130; Anderson 1961; L. Brown 1967). Henning (1967) suggests such influence was indirect and channeled through the Steed-Kisker phase, which had established a pattern of cultural interchange. McNerney (1987) reviewed the effigy complex and some exotic ceramic vessels from Nebraska sites. He sees a connection between the Nebraska phase and populations of the southern section of the central Mississippi Valley subarea, Caddoan area, and Spiro-Southeastern Ceremonial complex.

Upper Republican

The Upper Republican manifestation of the CPT was initially described by Strong (1933, 1935) based on archaeological excavations in 1930 of the Lost Creek site (25FR3), in Franklin County, Nebraska. Subsequent excavations in the Medicine Creek drainage, a tributary system of the Republican River in Frontier County, southwestern Nebraska, added considerably to the data base of this complex (Wedel 1935, 1936a). Following the Second World War, the River Basin Survey program of the Smithsonian Institution augmented knowledge of this complex with extensive research in the Medicine Creek locality (Kivett 1949; Kivett and Metcalf 1991), in the Red Willow Creek area 35 km west of Medicine Creek (Grange 1980), and in the Solomon River valley of north-central Kansas (Carlson 1971; Lippincott 1976; Krause 1970). Additional investigations in the Medicine Creek locality included excavation of the Mowry Bluff site (24FT35) undertaken in 1967 as part of a seminar offered by W. R. Wood (1967). This project took as its research design a comparison of two sites of the Nebraska and Upper Republican cultures (cf. Wedel 1970). More recent work in that important area has been carried out by Roper (1988, 1991a, 1993) with support from the Bureau of Reclamation. This entailed excavations of a lithic workshop area at the Marvin Colson site (25FT158) and of House 4 at 25FT22. At present, extensive surveys of the Medicine Creek area are being conducted under a cooperative agreement between the Bureau of Reclamation and Wichita State University. To date, these surveys have considerably augmented the number of previously recorded Upper Republican sites in that significant locality (Bob Blasing, personal communication, 1994).

The geographic range of Upper Republican, as it is presently understood, is the most extensive of the three CPT complexes. Sites assigned to this complex are in the High Plains of southeastern Wyoming and northeastern Colorado (Irwin and Irwin 1957; Reher 1975; W. R. Wood 1967, 1971), as well as southwestern Nebraska (see references above), northwestern Kansas (Wedel 1959:381-407), and north-central Kansas (e.g., the Solomon River locality referenced above).

Temporally, the Upper Republican manifestation of the CPT has been divided into three units, only two of which are currently in vogue. Referring to the complex as a variant (a term he applied to Nebraska and Smoky Hill as well), Krause (1969) recognized, from oldest to youngest, the Solomon River, Classic Republican, and Loup River phases. Chronological placement of the first of these phases, Solomon River (cf. Carlson 1971), was based on radiocarbon assays done by the laboratory at Gakushuin University in Japan, determinations now generally regarded as suspect. Lippincott (1976; 1978), in a review based on ecological and formal archeological data, was critical of the sequence developed by Krause and Carlson. On the basis of more recently obtained radiocarbon dates from Upper Republican sites in the Solomon River locality, Blakeslee (1991) demonstrated the contemporaneity of sites therein with those previously regarded as Classic Upper Republican.

The Loup River (also called Iktkari) subphase (here adopting the taxonomic placement of Upper Republican as a phase) has proven more durable. This is despite the fact that its chronological placement has been revised and that its relationship to the subsequent Lower Loup phase, a protohistoric Pawnee manifestation in the central Nebraska drainage of that name, is not entirely clear. This regionally distinct expression of the Upper Republican culture was first recognized by archeologists on the basis of data from the Sweetwater site (25BF1), on a tributary of the South Loup River (Strong 1932; Champe 1936), and the Lohn Farm site (25FH2), which is located near the North Loup River valley (Hill 1932). These sites were assigned by Strong (1935:2) and Wedel (1954:252) to the Sweetwater focus of the Upper Republican aspect. Champe (1936) subsequently redelineated Sweetwater as the Loup River focus. Despite the paucity of supporting chronological information, Krause (1969) interpreted Loup River as the most recent Upper Republican phase (or subphase, depending on the taxonomic scheme). With more radiocarbon dates available, Ludwickson (1975; 1978) suggested a temporal placement of ca. A.D. 1250-1450 for Loup River. On the basis of
more recently obtained dates, Roper (1994a) suggests a placement of ca. A.D. 1150-1350, which makes it roughly contemporaneous with other CPT cultures.

The trait that most distinguishes Loup River from Upper Republican proper is the more variable house form, including both the rectangular or square shape of CPT lodges and a more circular lodge outline. Ludwigson (1978:96-97) has also noted the more varied topographic settings of Loup River sites. Beyond these distinctions, there is little in the formal characteristics of Upper Republican and Loup River to separate them. The following outline of ceramic, lithic, bone tool assemblages and subsistence patterns is applicable to both manifestations.

Upper Republican ceramics have been described by Wedel (1936:188) as belonging to two wares, thickened (collared) and unthickened, also referred to as classes I and II (cf. Wedel 1986:106-108; Strong 1935:248; Champe 1936:270-272; Cooper 1936:35-38). Vessels are small to medium-sized globular forms generally tempered with sand. Exterior surfaces are cordmarked and the body lacks decorative treatment. Decorated rims exhibit a variety of incised lines, including opposed diagonals, parallel horizontal lines, and chevrons, as well as tool impressions and finger-pinched nodes. Sigstad (1969:17-23) provides a detailed analysis of typical Upper Republican pottery from the Mowry Bluff site, Medicine Creek locality occupation. He defines a typical Medicine Creek paste, which is distinguished from grog-tempered ceramics. The former includes two wares, a collared form defined as Frontier ware, and an unthickened form called Cambridge ware. Miniature vessels were also represented in the assemblage.

Lithic tools are characteristic of Central Plains tradition chipped and ground stone tool assemblages. The former includes triangular notched and unnotched arrow points, a variety of bifacial cutting tools (such as typical alternately beveled knives) and axes. Ground stone artifacts include grooved sandstone adzes, especially of the paired type, manos, metates, hammerstones, pipes, and pendants (Strong 1935; Wedel 1936, 1986:111; Champe 1936; Klippel 1969; Calabrese 1969b). Exotic material indicative of trade is rare but includes copper (Wedel 1986:112-113), malachite and turquoise (Roper 1988). Raw materials for chipped stone tools are predominantly the brown to yellow silicated chalk of the Niobrara Formation known by a plethora of names (e.g., Niobrara jasper, Graham jasper, Niobrarite, Republican River
chert or jasper, Smoky Hill jasper; Wedel 1986; Wright 1985; Stanford 1974; Holen 1983b; Banks 1990; Hofman 1990a), as well as Flattop flint, Ogallala quartzite, Alibates agatized dolomite, and Permian cherts from the Flint Hills (Wedel 1986:111).

Bone, antler, and shell were shaped into a variety of usable forms (Falk 1969a:59-43; Wedel 1986:108-112). Bone tools include agricultural implements such as bison scapula hoes and knives, hide-working tools such as awls and needles, fishhooks, antler shaft straighteners, and picks. Ornamental items include beads of bone and shell and antler bow guards. An example of the latter is an artifact recovered by Strong (1935:111; Wedel 1986:112-113) from Graham ossuary in Harlan County, Nebraska, that bears an incised design reminiscent of the hand and eye motif of the Southeastern Ceremonial Complex. Exotic shell indicative of trade occurs in the form of Gulf Coast conch, freshwater snails from the Ohio and Wabash river systems, marine olivellans from the Gulf or Atlantic coasts, and marginella from the Florida or Gulf Coasts (Strong 1935:111-114; Wedel 1986:111).

Upper Republican mortuary sites consist of blufftop pit ossuaries, such as Graham (25HN5), into which the disarticulated bones of the dead were deposited (Strong 1935:108-114; Adair et al. 1987:78-89). Artifacts included with the remains include pottery, shell pendants and beads, arrow points, scrapers, modified bone tools, and copper ornaments.

Upper Republican subsistence patterns were dependent on agriculture, hunting, and gathering. Wedel (1986:114-121) has discussed the various implications of dry farming of maize in a marginal climatic region such as the Upper Republican River basin. Problems of crop yield, seasonal variations in rainfall and frost appearance, food preparation, and storage are explored. Adair (1988) also examines the development and practice of agriculture among CPT, as well as other cultures, in the Central Plains. The generalized and varied nature of Upper Republican hunting and gathering practices is also examined by Falk (1969a, 1969b), Mick (1983), Bozell (1991), and Scott (1993). Wedel (1970:1986:123-126) has critically reviewed W. R. Wood's (1969) interpretation of the need for long-distance bison hunting from the Medicine Creek locality. W. R. Wood (1971) offered as support of such forays the presence of Upper Republican sites lacking evidence for agriculture in eastern Colorado (cf. Reher 1973:119). More recent evaluation of these High Plains sites by both W. R. Wood (1990) and Roper (1990), however, indicates they appear to be evidence of local Upper Republican populations in that area who lacked the houses and farming practices of that culture and may therefore deserve special recognition as a distinctive phase of the Central Plains Tradition.

Smoky Hill

The Smoky Hill phase (L. Brown 1967) or variant (Krause 1969; A. E. Johnson 1973) was the last complex of the CPT to be defined. Of the three CPT complexes, it is the most poorly known, a reflection of the fact that fewer sites of this affiliation have been investigated and reported. Wedel (1959:563) distinguished it on the basis of geographic core area and its associated pottery, which he defined as Riley Cord-roughened ware. His type sites included Griffin (14RY21) and Minneapolis (14OT5; Wedel 1936:210-237), both extensive sites that included a series of lodge remains, and Whiteford (14SA1), a cemetery containing the interred remains of more than 140 individuals. Settlements occur throughout the core area, which centers on the Smoky Hill, Lower Republican, and Blue rivers in Ottawa, Clay, Riley, and Geary counties, Kansas. The extent of this complex into Nebraska, for example, along the upper Blue River drainage, is as yet unknown or poorly documented. Nonetheless, it is likely that it did extend into Nebraska given the presence of sites in Jewell and Washington counties, Kansas, just a few miles south of Nebraska (Witty 1978). Radiocarbon dates from Smoky Hill sites are listed in Tables 31 and 32.

Excavations of Smoky Hill sites were conducted in the 1920s-1930s by Floyd Schultz, a largely self-taught amateur archeologist from Clay Center, Kansas (Hawley 1991, 1993; Ritterbusch and Logan 1991, 1992). His extensive collection of artifacts and field notes was donated to the University of Kansas in 1949 and has since been the source of several research papers and theses at that institution (see Hawley 1993: Appendix E). Other reports and theses that focus on the Smoky Hill culture include Wille (1958), Witty (1963e), Sperry (1965), Kelly (1966), A. E. Johnson (1973), Steinacher (1976), M. Brown (1982), Donahue et al. (1988), Reynolds (1990), and Ritterbusch and Logan (1991, 1992). Several of the research papers and reports attribute assemblages to the Upper Republican culture, but, given their geographic location and artifact descriptions, these are more likely Smoky Hill (e.g., 14WH312, Theis 1982b; 14WH319, Reynolds and Wulffuhl 1991).

One of the best reported Smoky Hill settlements is Budenhbender (14PO4), located in the Tuttle Creek Lake area on a terrace along Spring Creek, a tributary of the Big Blue River in Pottawatomie County, Kansas. The remains of two to three houses were recorded, with one fully excavated in 1957 (A. E. Johnson 1973). The house form was circular, indicating more variety in CPT architecture than the more stereotypical subrectangular lodge. Four main posts, surrounding a central hearth, supported the central portion of the house. Two interior storage pits were found near the northern edge of the structure. Two more irregular pits occurred near its eastern edge. Traces of an entryway were found at the southern edge. The lodge, which was 25 ft in diameter and included about 490 sq ft (53 sq m) of floor space, is postulated to have housed from five to 10 persons. Associated with the structure and its features was a variety of lithic, ceramic, and bone artifacts. Chipped stone artifacts included triangular notched and unnotched arrow points, perforators, thin and thick bifaces, spokeshaves, endscrapers, side scrapers, retouched and utilized flakes, cores, and debitage. Ground stone artifacts included celts, pipes, manos, metates, grinding stones, hammerstones,
grooved and ungrooved abraders, and worked hematite. Bone tools consisted of an awl fragment, fishhooks, a bead, antler shaft straightener, and antler handle. In addition to the dominant Smoky Hill ceramic ware, a smaller but significant number of smooth, shell-tempered and incised sherds interpreted as evidence of Eastern contact were recovered. A single radiocarbon date of 760 ± 150 years B.P. (A.D. 1190 uncorrected), was derived from a post associated with the house.

Subsistence practices of Smoky Hill populations in the project area have been analyzed by Marie Brown (1982). Her analysis, based on the faunal assemblages from the Budenbender and Witt (14GE600) sites and 14RY401, is a detailed discussion of their utilization of a variety of animals from prairie, woodland, and riverine habitats as food resources and for bone tools. Sequences for the butchering of game and production of bone tools are presented. The latter artifacts at Smoky Hill sites include bison scapula hoes and knives, needles, awls, and beads, and deer mandible sickles or corn shellers (Figure 47).

Riley Cord-roughened ware, the artifact hallmark of the Smoky Hill culture according to Wedel (1959), consists of medium to small jars and bowls with cordmarked exterior surfaces and high, decorated rims often thickened with a fillet or collar (Figure 48). They are generally tempered with stone (either crushed grit or sand), which is characteristic of all CPT ceramics, or crushed sherd/clay, which is particularly diagnostic of Smoky Hill pottery. Decoration includes evenly spaced pinches or stick impressions at the base of the collar or fillet, tool impressions on the top of the lip, or diagonal incisions across the lip. Appendages such as strap handles and, more rarely, effigies (Figure 49) also occur. A ceramic typology for Riley Cord-roughened ware, based on decorative attributes, has recently been defined by Hedden (1992). Other ceramic artifacts include elbow pipes and perforated disks reshaped from body sherds (Figure 50).

Steinacher (1976) has reviewed data from six Smoky Hill sites, two in Geary County and the balance in Clay County. For his information on these sites Steinacher relied entirely on descriptive analyses of those assemblages conducted by undergraduate students at the University of Kansas during the 1950s. In particular, Steinacher focused on the ceramics from these sites in his effort to produce a temporal seriation and, more importantly, to determine the nature of the relationship between Smoky Hill populations and Mississippian (i.e., Steed-Kisker) groups of the eastern margin of the Central Plains. This relationship is thought to be best revealed in the presence of shell-tempered, incised ceramic ware. Steinacher concluded that Smoky Hill populations encountered westwardly moving groups of the Steed-Kisker phase in an "interface" zone, the western perimeter of which extended to the present Tuttle Creek Project Area and the confluence of the Republican and Smoky Hill rivers (i.e., near present Junction City). The interaction of these populations resulted in a readaptation of both cultures that resulted in the archaeologically recognized Nebraska phase (Steinacher 1976:109-114).

Steinacher's interpretation must, at this point in time, be considered hypothetical. Indeed, what is required is a reevaluation of some of its basic assumptions, particularly the nature of the so-called Mississippian ware that is frequently part of Smoky Hill ceramic assemblages. It has not yet been demonstrated whether this pottery is imported ware or made by the Smoky Hill people themselves. If it is of local manufacture, it may not be necessary to posit the taxonomic change suggested by Steinacher. It may be sufficient to simply

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**Figure 47.** Bone tools from the lodge floor of the Mugler site (14CY1) (from Ritterbush and Logan 1992:77).
recognize a certain degree of change in the ceramic inventory of Smoky Hill populations through time. At any rate, this aspect of the dynamics of the Central Plains populations of the Plains Village period still requires investigation (Beck 1995). Indeed, the incised and shell tempered pottery found at Smoky Hill sites should not be called Steed-Kisker or Platte Valley ware since its consistent decorative motif, a series of parallel, opposed-diagonal lines, is not matched by any such decoration in the pottery from Steed-Kisker sites. This distinction was first noted by Wille (1958) and later by Sperry (1965), who nonetheless referred to it as Mississippian pottery and went so far as to identify the Miller site (one of two he described which yielded such ceramics) as a Steed-Kisker occupation.

St. Helena

Less well known than any of the complexes discussed above, the St. Helena complex nonetheless occupies an important place in any discussion of the Plains Village adaptation of the Central Plains. It is particularly relevant to the CPT, as its characteristics have been seen as transitional between Nebraska
and Upper Republican since it was first defined as a focus by Cooper (1936). Moreover, it is temporally transitional between the CPT and later Coalescent tradition and geographically transitional between the Central Plains and Middle Missouri regions (Blakeslee 1988:1). Roper (1993) discusses St. Helena in the context of Northern Caddoan developments in the fifteenth and sixteenth centuries with particular reference to the relationship between Caddoan culture and the Initial and Extended Coalescent variants (after Lehmer 1971) of the Big Bend area of South Dakota. She notes that sites assigned to all three archeological taxa "at once reflect a good deal of continuity with the Central Plains tradition, a good deal of adoption of traits from the Middle Missouri tradition, and some ideas entirely new to the region" (Roper 1993:87).

St. Helena is confined to a small area of northeastern Nebraska along the Missouri River valley that includes the counties of Dixon, Cedar, and Knox. The original definition of the St. Helena "focus" by Cooper (1936) was based on Works Progress Administration (WPA) projects in Cedar County. Subsequent WPA projects to the south in Dixon County added to the number of known St. Helena sites (Frantz 1963). Other limited excavations at two sites of this complex were the only investigations of St. Helena between the WPA projects of the 1930s and projects supported by the Omaha District, U.S. Army Corps of Engineers in the 1980s (Blakeslee 1988:2). These focused on one site in Santee, Nebraska (Carlson 1976) and the Gavins Point site, a multicomponent occupation, in southeastern South Dakota (Hall 1961; L. Brown 1968; Zimmerman and Bradley 1978).

Data about St. Helena acquired from 1980 to 1985 resulted from a cultural overview of the Missouri National Recreation River, a 58-mile reach of the Missouri River from Ponca State Park to Gavins Point Dam (Ludwickson et al. 1987), a survey of the shoreline of Lewis and Clark Lake above Gavins Point dam (Blakeslee and O'Shea 1983), survey and testing of sites in the Coon Creek valley of Dixon County by the Wichita State University (WSU), Nebraska State Historical Society and Earthwatch, excavation of a house at Annie's site (25DX30) by the WSU and Earthwatch, and surveys in Dixon County by WSU with support from the Nebraska State Historical Society (Blakeslee 1988).

St. Helena was assigned, along with the Loup River phase, to the Basal Coalescent variant by Ludwickson and others (1987:165-166). They suggested the complex dated from ca. A.D. 1250 to 1400, though few reliable radiocarbon dates were then available. Three radiocarbon dates, corrected and calibrated, from Annie's site fall within the fifteenth century A.D. and indicate the complex extends to that time (Blakeslee 1988:10).

Although the St. Helena house form is comparable to that characteristic of CPT complexes, they occur in greater numbers at some sites. Ludwickson and others (1987:165) note that as many as 31 houses have been documented at some St. Helena sites, though not all could be considered contemporaneous as some may have been rebuilt or constructed after others had been abandoned.

Subsistence was like that of other Plains Village complexes, based on agriculture, hunting, and gathering. Evidence for long distance hunting by the occupants of House 2 at Annie's site was inferred from the wide catchment area represented by the high frequency of nonlocal lithics (Padgett 1988) and the absence of certain faunal elements (Manz and Blakeslee 1988).

Ceramics are comparable to CPT pottery, though a high proportion of the rims, particularly the collared forms, are decorated. A wide range of incised or trailed motifs is exhibited, including multiple bands on the collar face. Copies of vessels characteristic of Oneota, Mill Creek, and other Middle Missouri tradition complexes occur (Ludwickson et al. 1987:166).

Lithics and bone tools are like those described above for CPT complexes. Descriptive and processual (i.e., manufacturing sequence) studies of a wide assortment of bone tools, including scapula hoes, cleavers and knives, deer mandible sickles, awls, pottery making tools, fleshers, punches, picks, beamers, wrenches, scoops, etc. are presented by Hill (1988) and Giessen (1988).
7 The Protohistoric Period on the Central Plains, by Brad Logan

The period between the arrival in North America of Europeans and their first intensive exploration or settlement of the Central Plains (ca. A.D. 1500-1700) is called the Protohistoric or Late Ceramic period. This period was characterized by intermittent or indirect contact between some indigenous peoples and immigrant Euro-Americans or by no evidence of any interaction. It is that post-Columbian period for which there is little historical documentation of indigenous populations. This period in the Central Plains is represented by complexes identified, often through the direct historical approach, as ancestral Pawnee (Lower Loup), Plains Apache (Dismal River), and Ponca (Redbird). As noted in the introduction to the Plains Village section, two complexes, Oeeta and White Rock, have been regarded traditionally as protohistoric, though radiocarbon dating indicate both had their origins in the late Plains Village period. The complexes are discussed in approximate chronological order.

Oneota

In Missouri and Iowa, the Oneota culture has been linked to later historic Siouan groups (Henning 1970; Harvey 1979; Chapman 1980:236). In the Central Plains, Oneota is represented by only a few sites, Leary, Fanning, Doniphan, Stanton, and Ashland (Hill and Wedel 1936; Wedel 1959:131-172; Henning 1970:145-146; Harvey 1979:199-204). The Leary site (25RH1) is located in extreme southeastern Nebraska at the confluence of the Big Nemaha and Missouri rivers. Fanning and Doniphan are located relatively short distance from Leary in Doniphan County, Kansas. Stanton and Ashland, both multicomponent sites, are located in northeastern and eastern-central Nebraska respectively. A report on the Oneota component (Occupation B) at Ashland is provided by Hill and Cooper (1959:267-271, 275-278). Waldo Wedel (1959:170, 609) briefly evaluates the Oneota material from the Stanton site.

Ceramics from Leary, the most extensive of these Oneota sites, have been interpreted by Henning (1970) as indicative of occupation by both the Correctionville-Blue Earth and Orr phases of the Oneota complex. Both of these complexes are centered in Iowa. Leary also contains a Nebraska phase component (Hill and Wedel 1936; referred to therein as Upper Republican). Two houses have been excavated at the site, one excavated by the Nebraska State Historical Society in 1935 under the direction of A.T. Hill (Hill and Wedel 1936) and the other excavated in 1965 by Marvin Kvett and Wendell Frantz of the University of Nebraska, Lincoln (unpublished; see Corby 1975). Both are square and comparable to CPT houses. That dug by UNL may be Nebraska phase, as the ceramics associated with it. Radiocarbon assays from a post of that house yielded two widely divergent and unreliable dates. The house described by Hill and Wedel (1936:15-19), though comparable to CPT lodges in many respects, nonetheless was clearly occupied by Oneota people. Cache pits that contained Oneota ceramics had been truncated by the floor of the structure and clearly ante-dated it. Materials found on the floor were also Oneota.

In addition to the house, Hill directed excavation of 153 cache pits (others were found but not excavated), nearly all found during fruitless searches for more houses (Hill and Wedel 1956:19-22). Fifteen burials were also dug, three of which were house-intrusive and pre-dated that structure. Eight of the interments were extended, two were bundle and the remainder too fragmentary to determine the nature of burial (Hill and Wedel 1936:23-30).

The only radiocarbon assays believed to date the Oneota component at Leary, recovered by J. Mett Shippee from a pit that yielded Oneota pottery, are 740±55 B.P.: a.d. 1210 (Wis-151) and 600±55 B.P.: a.d. 1300 (Wis-155) (Henning 1970:153, 170).

Wedel (1959:171) has suggested that the Fanning site can be tentatively identified as an early Kansa manifestation, given several eastern traits in the recovered assemblage, yet he also believes it was occupied just prior to a.d. 1700 and may be evidence that corroborates the identification of the Kansa in that area on the Delisle maps of 1703 and 1718. A.E. Johnson (1991) has disputed this interpretation, however, and suggests sites such as Fanning and Doniphan were occupied by the Otro, another Siouan group. Johnson's view has, in turn, been criticized by Henning (1993) and Vehik (1993), who both support the argument for a late (seventeenth century) arrival of Dhegun-speaking populations, such as the Kansa, on the Plains.

White Rock

Most of our knowledge about the White Rock culture is still based on data from six sites and brief descriptive reports about them. These sites are located in three localities: Harlan County Lake in south-central Nebraska and the Glen Elder/Wacconda and Lovewell Reservoirs in north-central Kansas. Investigations in the Glen Elder area focused on the Glen Elder site (14ML1); in Harlan County Lake they centered on the Green Plum (25HN99) and Blue Stone (25HN45) sites; those in the Lovewell area occurred at the White Rock (14JW1), Warne (14JW2) and Intermill (14JW202) sites (Cummings 1953; Kvett 1947a; Rusco 1960; Neuman 1963; Marshall 1969b). However, ongoing investigations at Lovewell Reservoir have added significant temporal insights and promise to increase our understanding of this complex (Logan and Hedden 1992; Logan 1993; Logan and Banks 1994; Logan 1995a).

Though some traces of two habitation structures were found at the White Rock site, no satisfactory data concerning their architectural form could be obtained. No such information was forthcoming from any of the other five sites of this culture. Consequently, we have no knowledge of this formal characteristic of White Rock. Features such as hearths and storage pits (basin, cylindrical and bell-shaped) are associated with these sites, as is a variety of stone, bone and ceramic artifacts. Chipped stone and bone tools from White Rock sites are indistinguishable from those of Plains Village sites in the same area. Most distinctive of the culture, however, are the
ceramics (Rusco 1960; Marshall 1969b). Defined as Walnut
Decorated Lip, the ware consists of vessels of the same general
shape and form as Plains Village pottery. The pottery is
generally tempered with moderate amounts of medium to
coarse grained sand, though shell temper is evident in low
frequency in some vessels, and is easily distinguished by its
paste color (buff, gray or light orange), relative thinness (body
thickness ranges from two to eight mm with most sherds falling
within the 3-6 mm range), smoothed or simple stamped exterior
surfaces, and decorative motifs that consist of trailed or incised
lines on the lip, interior of the rim, or shoulder. Appendages
such as strap handles occur and are frequently decorated with
tool impressions or incised lines.

As defined by Rusco (1960), the White Rock “aspect”
included two “foci” (following the McKern Taxonomic System),
called Blue Stone and Glen Elder (cf. Kiehl 1953; Cummings
1953; Stephenson 1954). They were distinguished geographically
and with respect to their associated site
settlement types. Sites of the Blue Stone focus were limited to
small hunting camps along the Republican River in south-central
Nebraska. Sites of the Glen Elder focus occurred along the
Solomon River in Mitchell County, Kansas and White Rock Creek
in Jewell County, Kansas. These included larger settlements,
suggested to have been base villages with more substantial
house structures. Rusco (1960) suggested the two foci might
represent seasonally determined settlement types of one
population which adopted the Kansas localities as its core area
and the Harlan County area as a hunting territory.

Marshall (1969b) reevaluated the data from the six excavated
White Rock sites, with particular reference to the Glen Elder
site, and found no significant difference between the two foci.
He suggested they be reclassified into a single focus, called Glen
Elder. Because of the presence of Oneota-like pottery at several
of the White Rock sites, Marshall also compared their traits with
those of the Utz site, an extensive Oneota occupation in
Missouri. Differences between them were sufficient to
distinguish the White Rock culture from the more easterly
Oneota culture but similar enough to suggest some affiliation.
On that basis, he tentatively suggested the White Rock culture
represented the western penetration of a Siouan speaking
population during the Protohistoric period. He also suggested
that the presence of Walnut Decorated Lip ceramics in minor
amounts at sites of the Dismal River culture in south-central
and southwestern Nebraska and western Kansas also indicated a
relationship between White Rock and that ancestral Apache
culture, an interpretation critically reviewed below.

Small samples of ceramics noted in private collections from
other sites located on tributaries of the lower Republican and
upper Blue rivers support an extension of the White Rock
culture to this region (Ritterbush and Logan 1991:87-94). For
example, lithic in the form of a high frequency of jasper
and ceramic evidence from two sites (14CY5 and 14CV462) in the
Five Creek drainage, indicates that the White Rock culture area
extended eastward in the lower Republican River basin as far
as Clay County, Kansas. The presence of several pipestone
artifacts from 14CY5 in the Schultz Collection at the University
of Kansas Museum of Anthropology, as well others in private
collections in that county, supports such an interpretation and
also points to Oneota derivation of White Rock. Pipestone pipes
have also been recovered from the Glen Elder, White Rock, and

Brown and Simmons (1987:XXII-22) note that excavations
at the Spillway site in the Blue River valley, Pottawatomie
County, Kansas “yielded materials similar to the White Rock
aspect”. However, in his description of this material, Cumming
(1958:57) states that the limited assemblage from the Spillway
site precludes its cultural identification and that the dozen small
sherds in it “are suggestive of but certainly not identical to”
White Rock ceramics. He also notes (Cumming 1958:60-61)
that the limited artifact sample from the adjacent, and perhaps
temporary, Rainy site “is too small to permit the making of a
positive cultural identification” but that the presence of a
copper jingle and fragments of copper and iron, as well as shell-
tempered pottery may be indicative of an historic Kansas
occupation. Consequently, these sites do not provide
convincing evidence of White Rock in the lower Blue River
valley.

Precise temporal placement of White Rock is problematic.
Rusco (1960:43, 71, 75) and Wedel (1986:134-135) suggest a
date of ca. A.D. 1500-1600 for the complex based on the Oneota-
nature of its ceramics, the presence in low frequency of
shell-tempered “Oneota” pottery, and the relative absence of
Euro-American artifacts. Prior to radiocarbon dating of charcoal
from pit features at 14JW1 and 14JW24, the only other absolute
date for White Rock was a dendrochronologic determination of
A.D. 1614 on charred wood samples from the Green Plum
site (25HN39) (Weakly 1962). This date was in keeping with the
general temporal assignment of the White Rock aspect to
the protohistoric period based on relative means, particularly
the presence of Oneota ceramic ware at some White Rock sites
(Marshall 1969b). However, as radiocarbon dates from western
Oneota sites (e.g., Dixon, Leary, Guthrie) indicate, this complex
has a broad temporal range, ca. A.D. 900-1700, that spans the
late prehistoric and protohistoric periods (Henning 1970:168-
170).

Assignment of the complex to the protohistoric period
based on the presence of artifacts of Euro-American
manufacture is tenous. Marshall (1969b:91) suggests that such
evidence, in part, supports a temporal placement of Lovewell
Reservoir sites (White Rock, Warne and Intermill) ca. A.D. 1650-
1700. However, only the Intermill site yielded objects of Euro-
American manufacture. These were limited to a single tubular
cooper head and a few pieces of worked glass, all from shallow,
disturbed contexts (Neuman 1963). Recent surface survey of
Intermill also resulted in recovery of a fragment of an historic
clay pipe (Logan and Hedden 1992:57). The small sample of
historic material, its ambiguous context and the proximity of
the site to the historic nineteenth century settlement of Ruben
(14JW202), which might have been the source of some historic
artifacts at Intermill, undermine Marshall’s suggested temporal
placement.

Five recently obtained radiocarbon dates (Table 33), one
from a small pit feature at 14JW24 and four from two pits at
14JW1, now indicate a Late Prehistoric, Plains Village, period
origin of the White Rock culture. Such placement requires
revision of the relations between White Rock and cultures of
the Central Plains tradition, particularly Smoky Hill. A fourteenth to fifteenth century occupation of the lower Republican River basin by the White Rock culture may have been contemporaneous with Smoky Hill in the same region (Logan and Ritterbush 1994). However, to date, there is no evidence from any site of either archaeological culture of direct contact.

At present, it is possible to speculate that the lack of any evidence of contact between White Rock and Central Plains tradition populations suggests the latter had abandoned the area occupied by the former and that radiocarbon dating is too rough a measure to detect the time when one left and the other arrived. It is interesting to note that the area occupied by White Rock is believed to have been one of those not affected by the increased aridity of the Pacific I climatic episode, which has been touted by some (Bryson and Baeris 1968), criticized by others (Blakeslee 1993) as the cause of the migration of CPT populations from their core areas. Indeed, the core area of White Rock corresponds precisely with an area suggested to have experienced increased July rainfall during the Pacific I episode (Blakeslee 1993: Figure 1). The onset of the Pacific coincides roughly with the earlier dates of the White Rock culture. The circumstantial evidence provides the basis for hypothesizing the entrada of an Ocone population from the lower Missouri River region to the geographic niche that may have been forsaken by Smoky Hill and Upper Republican groups during the fourteenth and fifteenth centuries. Another hypothesis posits the displacement of CPT populations from the Lower Republican River valley by expansive Ocone migrants (Logan 1996a).

The terminal date of the complex has yet to be determined. That it may have extended into the protohistoric period is suggested by the presence of Wood Decorated Lip ceramics at the Burkett site (25NC1), a lower Loup occupation near Genoa, Nebraska. Of 41 Lower Loup sites whose ceramic assemblages he examined, Grange (1968:123; Plate 33) notes that only this site yielded such material, which suggests contact between the White Rock and Lower Loup cultures. It is noteworthy that according to Grange’s chronological ceramic sequence of Lower Loup pottery, Burkett was occupied during the earliest period of the sequence. A single radiocarbon date of 326 ± 100 B.P. (A.D. 1630) from Burkett was suggested by Grange (1968:129) to be slightly later than the earliest occupation of the site, which he believes dates ca. A.D. 1500-1650.

Contemporaneity of White Rock and Dismal River, a protohistoric Plains Apache culture of the Central Plains, has been inferred by Marshall (1969b:76) based on the association of ceramics of both complexes at some sites in Hooker, Cherry, Lancaster, and Sioux counties, Nebraska (Gunnerson 1965:207-208, 211, 227). However, Gunnerson (1960:259), who dates Dismal River to a 50-year period centered ca. A.D. 1700, suggests the “Glen Elder-White Rock” material predates Dismal River. Both Grange (1968:122) and Wedel (1959:59) have noted that no Lower Loup or Dismal River site has yielded evidence of contact between these two complexes, despite their temporal overlap during the late Lower Loup period. It is difficult to explain any association between White Rock and Dismal River when the former appears to have had only marginal contact with Lower Loup during the early period of that complex.

Thus, the present evidence appears to indicate a temporal span for White Rock from the thirteenth to the sixteenth centuries A.D. (ca. A.D. 1300-1500). Undoubtedly, more radiocarbon dates and ceramic cross-dating will further refine this tentative assignment.

Lower Loup

There is no dispute by archaeologists that the central-Nebraska culture referred to as lower Loup is the protohistoric expression of the Pawnee, who are grouped with the Kitsai, Wicita, and Arikara as the Northern Caddoan branch of the Caddoan linguistic family (Lesser and Weltfish 1952; Parks 1979; Lesser 1980:60-61). Strong (1955) so interpreted the culture, based on the 1901-1907 explorations by Blackman (1903, 1905, 1907, 1924) and subsequent excavation by the University of Nebraska Archeological Survey in 1931 at the Burkett and Schuyler-Gray sites. Confirmation was provided soon thereafter by Wedel (1936, 1938, 1940) using the same data. More recent perspectives of Lower Loup archaeology have included comparative and seriation analyses of ceramics (Grange 1968, 1974, 1984), interband relationships as reflected in ceramic variability (Grange 1979), lithic analyses focused on procurement strategies (Hudson 1982; Holen 1983a, 1983b, 1991), and comparison of Lower Loup hunting camps with models based on ethnohistoric data of Pawnee hunting practices (Roper 1989, 1992, 1994b). Biometric analyses of Lower Loup skeletal remains have demonstrated their close affinity to the historic Pawnee, evidence of an ancestral relationship also echoed culturally by common mortuary practices (Jantz 1977; Ubelaker and Jantz 1979; O’Shea 1984). Still subject to controversy is the validity of an ancestral connection between this complex and the Central Plains tradition, an idea first tentatively offered by Strong (1935:245-246).

Steinacher et al. (1991) evaluate data which they believe precludes interpretation of any ancestral relationship between CPT cultures and protohistoric Pawnee. Their major points of contention are: (a) a 200-year gap between the CPT and Lower Loup cultures; (b) major archaeological differences between them; (c) no demonstrable biological connection despite intensive analysis of skeletal remains between them; and (d)

Table 33. Radiocarbon Dates from White Rock Sites.

<table>
<thead>
<tr>
<th>Site/Fea. #</th>
<th>Lab #</th>
<th>14C Age</th>
<th>A.D.</th>
<th>Cal. Age 1</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>14JW1/4</td>
<td>Tx-7986</td>
<td>510±40</td>
<td>1440</td>
<td>1407 (1426)</td>
<td>Logan and Banks</td>
</tr>
<tr>
<td>14JW1/4</td>
<td>Beta-65893</td>
<td>720±70</td>
<td>1230</td>
<td>1281 (1288)</td>
<td>Logan and Banks</td>
</tr>
<tr>
<td>14JW2/4</td>
<td>Beta-53612</td>
<td>660±80</td>
<td>1280</td>
<td>1283 (1302)</td>
<td>Logan 1995</td>
</tr>
<tr>
<td>14JW1/8</td>
<td>Beta-73926</td>
<td>390±60</td>
<td>1560</td>
<td>1463 (1478)</td>
<td>Logan 1995</td>
</tr>
<tr>
<td>14JW1/8</td>
<td>Tx-8193</td>
<td>720±50</td>
<td>1230</td>
<td>1276 (1288)</td>
<td>Logan 1995</td>
</tr>
</tbody>
</table>

1. Stuiver and Pearson 1993; one sigma age range and (intercept).
"irreconcilable discrepancies between archaeological hypotheses and tribal origin accounts," in her review of these data and others for the Smithsonian Institution's Repatriation Office, Roper (1993) points out that it is unnecessary to posit any direct ancestral relationship between cultures within the geographic area of Lower Loup. Therefore, Roper argues that the northward movement of CPT populations to the Middle Missouri River region during the temporal hiatus (the Initial Coalescent period; Lehner 1971:111-115; cf. Lehner 1954:147-154), interaction with Siouan populations there and consequent transculturation, subsequent split of protohistoric Pawnee from their Caddoan kin, the Arikara, and return of the former to the Loup River basin as the Loup River culture is sufficient reason to accept an ancestral relation between some CPT groups and the historic Pawnee. The implications of this interpretation for the repatriation of mortuary and sacred artifacts from CPT sites under NAGPRA (Native American Graves Protection and Repatriation Act) are, of course, profound.

Formal characteristics of the Lower Loup culture have been described by Strong (1935), Wedel (1936, 1938b) and Dunlevy (1936). The results of more recent research are reviewed by Roper (1989:25-29, 1993) and O'Shea (1989). Dunlevy's (1936) detailed description of the Burkett and Schuyler-Gray sites, the type sites of the culture, established the Lower Loup focus as an archaeological taxon within the Midwestern Taxonomic System. Within that system, Dunlevy found Lower Loup to be comparable to Oneota and therefore part of the Upper Mississippi phase.

Wedel (1938b) compared Lower Loup, Oneota and Pawnee material culture according to a list of 120 selected traits in what has since been recognized as one of the classic examples of the direct historical approach to archaeological recognition of historic cultures. His conclusion that Lower Loup was closer to Pawnee than Oneota refuted Dunlevy's broader taxonomic assignment of that "focus". Wedel augmented his interpretation with a review of the ethnohistoric record that strengthened the Lower Loup-Pawnee connection.

Though less well known than the subsistence practices of the historic Pawnee, those of the Lower Loup appear to have been comparable to them. Hunting was primarily oriented toward bison with procurement of this game dependent to some extent on communal hunts beyond the village that were probably organized much like those of the later Pawnee (Roper 1989, 1992). Fishing of tropical and indigenous cultigens was an important part of an economy that also included the gathering of wild plant foods.

Settlements consist of unfortified villages on terraces and uplands in the Loup and Platte River valleys and along the lower reaches of their tributaries. Houses are comparable to Pawnee in outline and differ from those of Central Plains Tradition cultures. As represented at the type sites, they were circular earth lodges from 11 to 15 m in diameter with eastward oriented entryways and interior support posts arranged around a central hearth. At least one of the houses at Burkett had a bison skull altar on the side of the lodge opposite the entryway (Dunlevy 1936:160). Storage pits may be intra- or extramural and, like those of the Pawnee, are deep, bell-shaped features ranging in depth from six to eight feet.

Lower Loup ceramics are generally represented by globular jars of varying sizes with relatively thin walls, rounded to subconical bases, constricted necks and grit temper. Manufactured by the paddle-and-anvil technique, the vessels exhibit plain or simple-stamped exterior surfaces and incised or trailed decorations in the form of parallel diagonal or opposed parallel diagonal lines, chevrons and herringbone designs. Lips may be decorated with incisions or puncuates. Shoulders are flattened, angled but predominantly rounded in form. Appendages include strap handles of varying outlines with flattened rectangular or oval cross sections and, in low frequency, loop handles with round cross sections. On direct or collared vessels, these occur in pairs on opposite sides or as four handles at quadrant points. Braced vessels may have a series of multiple handles in the form of a cloister.

Grange (1968), in a detailed analysis of both Lower Loup and Pawnee wares, established several types distinguished by attributes in rim form (straight and flared, direct; solid and S-shaped collared; braced). Named Lower Loup wares are Nance, Burkett, Wright, Colfax and Webster with Nance Flared Plain being the predominant type. He further established a seriation of both Lower Loup and Pawnee ceramics that remains an essential tool for the relative chronological placement of sites, a function that will be discussed later with regard to the temporal placement of Lower Loup. O'Shea (1989:76), while lapsing the seriation, is critical of Grange's classification, calling it "over-precise". He believes the plethora of types recognized by Grange marks broad patterns of ceramic change that may reflect significant social developments in Pawnee history. O'Shea notes three parallel trends in ceramic change through time: (1) increase in the proportion of collared vessels vis-a-vis noncollared forms; (2) increase in the proportion of noncollared vessels with rim decoration; and (3) increase in collar height. All of these trends are in the direction of greater ceramic ornamentation and, as this change corresponds with the process of village aggregation among the Pawnee, they may indicate that the pottery served, in addition to its utilitarian function, as a means of expressing group or subgroup identity during that critical time.

Because of the paucity of useful radiocarbon dates (only three are available for Lower Loup; Roper 1993:11), Grange's (1968) seriation still lacks a temporal datum in real time. More recently, Grange (1984) attempted to fix the seriation calendrically by applying the historical archaeology method of ceramic formula dating. This effort is a revision of an earlier attempt (Grange 1974) that "resulted in considerable variety of initial and terminal dates for Pawnee pottery types" (Grange 1984:278). The revised Pawnee dating system is based on ceramics from the seven most securely dated historic sites. Its utility still requires verification through other absolute dating methods, such as radiocarbon and archeomagnetism. The lack of any reliable absolute dates from Lower Loup sites has thus far prevented determination of the time of origin of the culture. Grange (1984:276) assumes an appearance ca. A.D. 1500. In his most recent statement about the culture, Wedel (1986:153) brackets Lower Loup ca. A.D. 1550-1750. O'Shea (1989) skirts the issue by discussing the question of Pawnee history primarily in terms of ethnohistoric documents. However, he notes a
significant change in Plains settlement patterns from the small, scattered hamlets of the Plains Village adaptation ca. A.D. 1000 to 1500 to the large villages, such as those of Lower Loup, after that time. Roper (1993:11-12) conservatively accepts a midseventeenth century date for the appearance of Lower Loup while noting that archaeological evidence neither establishes nor precludes its existence "a century or so earlier."

Lithics from Lower Loup sites are comparable in most respects to those from other Central Plains protohistoric complexes. Unnotched, triangular arrow points, alternately beveled knives and small endscrapers are common finds. Other chipped stone tools include heavy duty bifacial tools, drills, notched flakes, and spokeshaves. Ground stone artifacts include grinding implements, sandstone abraders, pipes, and incised tablets. The relative frequency and variety of stone tools differs between village sites and hunting camps (Roper 1994b). More telling about lithic procurement activities is the relative frequency of stone tools and debris at protohistoric and historic Pawnee sites. Holen (1983b, 1991) has demonstrated that the long distance bison hunting trips of the protohistoric Pawnee from the Burkett and Gray (Schuyler-Gray) sites took them to areas that included key sources of lithic raw materials, Niobrara (a Cretaceous silicified chalk) and Permian cherts. The high frequencies of these "exotic" materials in the village assemblages reflect purposeful collection and preparation of blanks during the hunt, an example of an "embedded" (after Binford 1979) resource procurement strategy. Hudson (1982) has also shown how the importation of Euro-American metal tools to early Pawnee groups affected their stone-age technology. Chipped stone tools, including points, scrapers and cutting tools, were most rapidly replaced by metal equivalents; ground stone tools were more gradually supplanted, and sometimes actually enhanced as honing instruments for metal tools.

Items of bone and shell in Lower Loup assemblages do not differ from those at other Central Plains protohistoric sites. Scapula hoecs and other farming implements of bone and antler are ubiquitous. Bone awls, metapodial fleshers, antler shaft wrenches and cancellous bone paint daubers or hide glues are also common. Mussel valves were used as paint holders and corn shellers.

Euro-American trade goods occur with differing frequency and variety at both Lower Loup and historic Pawnee sites. Indeed, it was the presence of such items at the Burkett and Schuyler-Gray sites in the absence of any historic documentation of these settlements that led to their recognition as protohistoric (Strong 1935; Dunlevy 1956; Wedel 1936, 1938b). Recent analysis of trade goods at 25H1W16, an early Skidi village on the Loup River, has focused on their chronological value, as well as their reflection of cultural changes due to contact (Peterson and Watson 1993; Watson and Holen 1994).

Mortuary practices of both the Lower Loup and historic Pawnee consisted of primary, flexed, single inhumations (Ubelaker and Janz 1979:256).

Though considerable information is available for this protohistoric culture relative to others discussed herein, much more information can yet be culled from extensive, and as yet unreported, collections from Lower Loup and Pawnee sites. In summing the results of a symposium concerning the problem of Caddoan origins, Wedel (1979a) stressed that the question of cultural ancestry of the Pawnee remained unresolved, a status that has not since changed. Extensive investigation of the relationship between the late prehistoric and protohistoric Caddoan populations of the Lower Loup and Middle Missouri (Big Bend) rivers is still required for such resolution. O'Shea (1989:81-83) notes the general culture historical orientation of Pawnee archaeological investigations, as well as more recent studies of a more technological or processual nature (e.g., Grange 1979; Holen 1983b; Hudson 1982). He also points out the urgency of documenting collections long ago obtained that have languished without analysis and that, with proper study, might yet provide valuable insight to processes of culture change among the Pawnee.

Redbird

Little information about the Redbird "focus" has been gained since it was first defined by Wood (1956a; 1956b, 1956) on the basis of data from four excavated sites near the mouth of the Niobrara River in northeastern Nebraska. These sites, all small villages, and unexcavated campsites on the lower Niobrara and middle Elkhorn rivers, the latter a short distance south and east of the excavated sites, were attributed by Wood to the protohistoric Ponca, a Dhegah-speaking (Siouan) group related to the Omaha. The summary here is based primarily on Wood (1956), which was the final revised version of a series of works on this culture, the first of which was his Master's thesis (Wood 1956a; cf. Wood 1956b, 1957, 1959). Others who discuss this complex are Garrett (1964), who describes excavations at 25KX9, one of the sites analyzed by Wood (1965), and Ludwickson et al. (1987:174-178), who rely heavily on Wood (1956a, 1965) and replace the Midwestern Taxonomic System "focus" taxon with the Willey and Phillips term "phase".

The Redbird culture was initially perceived as intermediate developmentally between Lower Loup and the La Roche focus of the Choteau aspect of central and southeastern South Dakota, an inference that made the Redbird people members of the Northern Caddoan-speaking linguistic stock (Wood 1956a). However, later evaluation of the data led Wood (1965) to identify the archaeological complex with the Ponca of a.d. 1600-1700.

Ceramics dominant at sites of the Redbird focus are Evans and Mackay wares, which are diagnostic of the complex and distinctly different from Stanley Braced Rim. Small percentages of Oneota pottery are also characteristic of Redbird ceramic assemblages and these are compatible with the identification of the complex as Siouan. It is noteworthy that an historic site, Nanza Fort, documented by written records as having been a Ponca settlement and occupied from a.d. 1790-1800, was characterized by an archaeological record that included ceramics dominated by Stanley Braced Rim ware, generally associated with the Arikara, a Caddoan group closely affiliated with the Pawnee (Wood 1965:123-124; 1993:112-114). Though the pottery from Nanza Fort could have been made by Arikara women who married into the Ponca occupying Nanza Fort, the
absence of Evans and Mackay wares indicates the Ponca had lost or abandoned the production of their own particular "brand" of ceramics. The example of Na'za Fort provides a cautionary tale about too closely identifying the linguistic affiliation of an archaeological complex based on ceramics.

Redbird houses, based on the sample of 10 described by Wood (1965), were circular to slightly oval earth lodges with central hearths, extended entryways generally oriented eastward, and unprepared earthen floors from 8.5 to 19 m in diameter that offered between 57 and 280 m² of living space. They were situated on stream terraces or low bluffs and lack any evidence of fortification. That the Redbird economy had a horticultural component is indicated by the numerous scapula hoes recovered from nearly all sites. Bison were the most frequently hunted animals, though a variety of prairie-woodland edge game were also taken.

Chipped stone tools were made from a variety of raw materials, including Niobrarite, Bijou Hills and other quartzites, chalcedony and "variously colored" cherts (Wood 1965:103). The usual variety of lithics characteristic of Plains Village and protohistoric cultures of the Great Plains are represented, including triangular, generally unnotched, arrowpoints, endscrapers, expanding base drills, knives of various types including alternately beveled forms, and choppers. Ground stone tools include grooved mauls, pebble and discoidal hammerstones, millers, manos, pitted stone anvils, grooved axes, celts, and adbraders.

Modified bone tools include the aforementioned scapula hoes, and other items made from bison elements including horn core scoops, ulna picks, squash knives, rib arrowshaft wrenches, cancellous tissue abraders, and scored ribs. Serrated flesher made from split elk metapodials and various split bone awls were also produced. Deer antlers were modified into cylinders, tine flaking tools, and scraper halves. Mussel shells were shaped into pendants and hemispherical pieces (Wood 1965:103-109).

Euro-American trade goods, some of which were useful for dating the Redbird focus, are represented by small numbers of identifiable goods including a mattack, arrowpoint, tube, bangles (n=22) and glass beads (n=16) (Wood 1965:109-110).

Mortuary practices are poorly known. Only two burials, both of adult women, were found at 25KX9. One was a primary interment in a straight-sided, oval pit just beyond the wall of a lodge. The other was a primary extended burial in a pit within a lodge. Both burials included a few grave goods, such as an elk antler scraper handle, glass beads, brass bangles, and shaped mollusc shells. Craniofacial analyses have supported a close relationship between these Redbird individuals and the historic Omaha and Ponca (Jantz 1974).

It is unfortunate that no further work has been done on Redbird sites or with data from those previously excavated. Wood (1965) was quite clear about the problems of tribal identification of Redbird and the fact that they remain unresolved. The archaeological comparability of the Redbird focus with La Roche can be explained by the migration of the Ponca from the mouth of the Missouri River via the Big Sioux River area north of present-day Sioux City, Iowa to the mouth of the White River in south-central South Dakota, where they could easily have adopted traits from Caddoan populations there resident. Unfortunately, the historically documented dates of this migration, ca. 1670-1715, are inconsistent with those which place the Ponca at the Redbird sites near the mouth of the Niobrara at the same time. As Wood (1965:127-130) points out, either the dates of the archaeological complex or those derived from ethnohistorical data must be clarified to validate a Ponca identification of Redbird.

Dismal River

Dismal River is recognized as a protohistoric manifestation ancestral to the Plains Apache. Sites of this complex can be readily distinguished by certain traits, including a simple but distinctive pottery called Lovitt Plain and Lovitt Simple Stamped (which may actually be a single ware arbitrarily distinguished on sherds from the same vessel that exhibit different surface treatments). Other hallmarks are roasting or baking pits with bell-shaped cross sections, fired walls and often with burned-rock covered floors; tubular ceramic pipes sometimes referred to as "cloud blowers" that are reminiscent of Southwestern pipes; double bitted drills; house structures with five-post base patterns; absence of storage pits; and presence of trash-filled borrow pits (Gunnerson 1960, 1968, 1987; Wedel 1986:135-151).

Dismal River sites appear in a variety of topographic settings from the Black Hills in South Dakota through the western half of Nebraska and Kansas, eastern Colorado and the Oklahoma Panhandle. All village sites occur in the eastern portion of this range where rainfall conditions permitted more sedentism among these corn growing peoples. The western sites appear as small, more temporarily occupied camps. At least one site, the famous "El Cuartelejo" or Kansas Pueblo in Scott County, has ruins of a seven-room stone habitation (sometimes attributed to refugee Puebloans from Taos or Picuris) and remains of irrigation ditches (Gunnerson 1960, 1968, 1987:102-106). Trade with Southwestern groups is evidenced at some sites by such exotic items as Puebloan potsherds of a type called Ocate Micaceous or painted types such as Tewa Red-on-Buff; obsidian and turquoise from New Mexico, Olivella shell beads and a few Pueblo style shaft straighteners (Gunnerson 1987:105). Contact with Euro-Americans is limited to an iron ax found in a hearth at White Cat Village in south-central Nebraska, which Gunnerson (1987:105) suggests may have been left by a Pawnee raiding party, and two gunflints from that site. Other sites have yielded a few scraps of metal and such artifacts as jinglels and awls.

The Dismal River culture has been dated by dendrochronology and cross-dating of Puebloan pottery to a relatively brief period ca. A.D. 1675-1725. D. Gunnerson (1974) has demonstrated that many of the Dismal River people merged with the Jicarilla Apache to become the Llanoer Band about A.D. 1730. Others may have joined the Lipan. Gunneron and Gunnerson (1971) have suggested that the Northern Dismal River people may have become the Kiowa Apache. The disappearance of Dismal River in the late 1720s has been attributed to pressure from other Plains groups, such as the Pawnee and Comanche (D. Gunnerson 1974; Gunnerson 1987).
8 Historical Archaeology in the Central Plains, by William B. Lees

The intellectual foundation for historical archæology in the Great Plains was established with the emergence of the direct historical approach during the 1930s (Lees 1985; cf. Strong 1940, Wedel 1938a). A deductive, problem-oriented method that developed out of anthropology, the direct historical approach offered historical archæology a trajectory somewhat different than found elsewhere at the same time where the field was more closely allied with history than with anthropology.

The onset of a major archeological emergency following World War II (the reservoir salvage) upset this trajectory by overwhelming an emergent professional community on the Plains. The efforts of a handful of archæologists was spread increasingly thin as a result. Historians began to call the shots in terms of historical archæology, and deductive anthropology was replaced by inductive research that served in many cases only to illustrate history; in many cases historical archæology became the proverbial "handmaiden to history." The end of the interagency salvage work in 1959 found Plains historical archæology floundering at a time when the "new archæology" was gaining momentum. Lacking a convincing theoretical orientation, the Plains continued to languish as historical archæology grew and matured elsewhere.

Historical archæology has matured as a discipline within North American anthropology and, on the Plains, it is enjoying a renaissance of sorts. These developments are positive and the many individuals, both on the Plains and elsewhere, who have helped them come about are to be commended. There are nonetheless problems that cast a pall over the future of historical archæology in our area and that ultimately relate to the development and consumption of theory. These problems relate to academic and professional structure that grew out of the historical setting briefly reviewed above, but also relate to a fierce competition for cultural resources from development and recreational interests. The approach to our future must be both efficient and dynamic and must be based on a healthy theoretical arsenal that will allow the best use of a resource base that is at risk and with professional resources that are at best limited.

Resources at Risk

Well over twenty years ago, in 1972, Charles McGimsey challenged the profession when he wrote that:

The next fifty years — some would say twenty-five — are going to be the most critical in the history of American archæology. What is recovered, what is preserved, and how these goals are accomplished during this period will largely determine for all time the knowledge available to subsequent generations of Americans concerning their heritage from the past. (McGimsey 1972:3)

Although it may not be happening as rapidly as McGimsey predicted, that we are suffering rapid site denigration and loss is not at issue. At the same time, a focus on specialized studies in the last several decades has increased our ability to learn from a shrinking resource base. Further, the presence of deeply buried and supposedly well preserved resources have been documented throughout the Plains in potentially impressive numbers. These developments temper but do not erase McGimsey's prediction for the future of our resource base, at least for those resources from the prehistoric past. It is with less confidence that they apply to the bulk of the historic resource base.

McGimsey’s concern developed out of observations on sites visible on the surface; those that are easily impacted by agriculture and development projects. Most historic sites are of this type and as a whole are being rapidly lost through these processes; but this is nothing new. What is disturbing, however, is a growing threat to historic sites from hundreds of serious hobby collectors armed with sophisticated research skills, high-tech metal detection equipment, and perseverance. These individuals are identifying site locations through archival and informant research, are finding the sites through exhaustive survey work, and are systematically mining sites of their artifacts. Sites that are targeted by these individuals are diverse in range, but include military sites, contact period and late Native American village and farmstead sites, missions and agencies, Santa Fe and Oregon trail campsites, etc. We are competing fiercely for these sites, and we are loosing.

This is not a revelation and is not meant to condemn the metal detector hobbyist. Rather, we need to rethink our conservation ethic that sees archeological research as an adverse impact to be avoided in favor of putting sites in the "bank" for future research. We need to work with hobbyists and convince them of the importance of segregated, cataloged collections, of the importance of spatial information, and of the importance of sites in general. Further, if we can provide regular opportunities to be involved in controlled research we may develop a group of hobbyists satisfied to channel their efforts towards science. We have done this with amateur archeologists with great success, but have yet to reach the different audience represented by those using metal detectors. We need to build coalitions between archeologists and hobbyists so that we may benefit from their research and use their technical skills to our advantage. Finally, we can no longer fool ourselves into thinking that by avoiding sites we are saving them for our future. There is no historic site that is not threatened and, except for a few instances, there is no "bank" of historic sites. Excavated sites should be selected for their research value and all research should be conceived as salvage.

The Right Questions

Viewing research as salvage does not mean that it should involve atheoretical warehousing of collections. To the contrary, salvage requires efficiency and efficiency in archæology requires a theoretical perspective that is sophisticated and to
the point. In conceiving of research we must be able to ask the questions that will allow us to respond to others who may ask: what did this research tell us that we did not already know and that we wanted to know. We must focus on sites and questions that will profoundly expand our knowledge of the past.

In discussing research, it is important to recognize that most is being conducted within a compliance or CRM framework and that a relatively small percentage occurs outside this realm. In compliance settings, research is related to the National Register of Historic Places. A body of theory, which I will call "significance theory," has developed that seeks to relate research to the concept of eligibility for listing a site on the register; a site that is eligible is significant. Current views hold that the concept of significance is a relational or relative concept and that significance is not inherent in sites. Site significance is thus determined by its relation to something else, and in most cases this is supposed to be context statements presented in state plan documents. This succeeds, however, only when these contexts codify problem domains or research questions that are of legitimate interest and firmly founded on current theoretical formulations. It is clear from many significant justifications and data recovery plans that we are often on very shaky ground in this area.

There can be no doubt that compliance research is vital to Plains archaeology in that it offers our major funding opportunity. Sites so excavated may not be the first to come to mind in terms of research need, but are nonetheless of long-term importance in developing a broad, comparative data base that is currently lacking in most areas and for most periods of history. Here, we must recognize that many of the most vital questions posed by archeologists have resulted from inductive observations made from a comparative data set.

Research conducted outside of a compliance setting, on the other hand, has the potential to provide leadership in developing programs to identify and address important research questions. By being able to broadly consider the resource base, research in this area can target sites based on their potential to profoundly expand knowledge in a way that compliance archeology may never be able to. It is here that we have the potential and the responsibility to firmly engage anthropological research and to seek results of the widest merit and application.

I stress again that we must focus on sites that will significantly expand knowledge. I have already mentioned the crisis of site preservation and will next review the limited resources that we have to work with. Detailed investigations of sites outside the CRM setting is a luxury that must be approached with the utmost wisdom and forward thinking.

Focus on Infrastructure

It is a fact that the Great Plains lags behind most other regions of the U.S. in terms of the number of practicing professionals and in the strength of academic programs in archaeology. Given the challenges facing Plains archeology in general, then, none of us are in the best of worlds. But when we look at historical archeology the problem is magnified to such a degree that it is a wonder that anything happens at all. There is a very clear crisis in infrastructure that perpetuates the post World War II crisis in historical archeology on the Plains and that fails to recognize historical archeology as an anthropological pursuit.

Nonetheless, historical archeology in our region is increasingly required in compliance and interpretive settings. This development is the result of a growing and appropriate inclusion of historic sites of all periods under the compliance umbrella and an increased recognition of the interpretive potential of archeological research. This, however, is generally a development emanating from outside the Plains and has caught many Plains states off-guard because of their lack of trained historical archeology professionals; this has created a setting not unlike that of the reservoir salvage period. The result is an increasing number of cross-over professionals, many of whom are doing admirable jobs but most of whom have no background in historical archeology including the theoretical base that identifies it as patently anthropological in orientation.

It is important, however, to look at our academic infrastructure in light of this development. There is a growing interest and need for historical archeology on the Plains and elsewhere and, further, some expertise in historical archeology is recognized as a need for any professional working in agency or private sector compliance settings as well as those involved in research, museum interpretation, and teaching. Most academic programs, however, pretend this is not so and continue to graduate professionals as if the world belonged to the specialist and where the specialist is never a historical archeologist. The general lack of faculty and academic programming in historical archeology poses several serious problems for the Plains.

The first problem concerns the somewhat insular development of professionals and research. The lack of professionals serving as mentors presents an obvious problem for those seeking to specialize in historic sites and gives a signal of the non-importance of that area for those who could benefit from some exposure. A related problem is the lack of sufficiently trained professionals to handle the work currently available. Attractive projects are very often done, because of the lack of other options, by individuals with no background and who go into the project with an incredible handicap and with a very limited theoretical orientation.

Another problem is the lack of faculty to pursue directed research programs in historical archeology through their own work and through thesis and dissertation work of their students. There can be no doubt of the importance of such research on the development of theoretical approaches to specific regions or problems. While there is no necessary reason that this has to be accomplished in an academic setting, leadership for such a program is perhaps best vested there.

I am not suggesting that every academic program on the Plains go out and hire an historical archeologist, but that on the Plains we do need to provide increased opportunity for such training, where that training is anthropological, and where directed research programs can flourish. I would add that universities are missing the boat in terms of capitalizing on student interest, grant funding, and ability to build an anthropological bridge between other departments in terms of research and teaching opportunities.
Theory and the Future

The potential of the Great Plains to contribute to anthropological theory and to the anthropological knowledge of the historic period should be apparent. Over and over again, however, this very tenet is being questioned by those who do not understand that we are not seeking a redundant history of things trivial or things already known. Given some of the problems I have outlined, however, this questioning is not surprising because we have very little to point to that is different from this stereotype. Plains historical archeology very clearly needs to break out of this stereotype and reconnect with the pursuit of anthropological knowledge. There are some very compelling reasons to do so:

First, the Great Plains contains many, many historically disenfranchised groups—those groups for which archeology is the primary or only source of historical and anthropological information. A concerted research focus on African-American slave life in the Southeast and Caribbean has resulted in a geographically expanding body of knowledge that has not only written a culture history previously lacking but has provided the data for addressing questions of general anthropological interest. We have the same potential on the Plains and I believe we must increasingly identify and target similarly disenfranchised groups and build an anthropological history that will not exist otherwise.

From my own interest, the Native American groups that were resettled to Kansas in the 1830s from the Great Lakes region present a perfect example. Known primarily from scattered missionary and traveler accounts, the farmsteads and villages occupied by these people prior to the Civil War hold data that can write an anthropological history of their lives that can be reconstructed in no other way. To me this has profound value. This value is increased dramatically when a comparative approach is taken between the Shawnee and Ottawa, for example, and between Ottawa life prior to and after removal to Kansas.

Second, the Great Plains offers some of the most profound situations of cultural diversity and change to be found anywhere in North America and particularly during the nineteenth century. The comparative, ethnological laboratory offered in the Great Plains is an incredible resource and offers unique potential to evaluate and expand theories of consumerism, acculturation, and ethnicity—to name a few examples—against the patently multicultural and rapidly changing fabric of the nineteenth century Great Plains.

If historical archeology is to improve its contribution to the anthropological history of the Great Plains, it must fully engage an anthropological approach and current theoretical discussions. We appear caught in a circular trap, however, because this may not happen without change in infrastructural commitment to historical archeology which may, in turn, not come about because of the current lack of a truly anthropological approach in Plains historical archeology. But while this circle remains in place, the resource base continues to degrade, good research opportunities are lost, and the true contribution of the Great Plains to the anthropology of the historical period continues to languish. To be sure, significant contributions will continue to emerge from the Plains, just as they are now. But if we choose to consciously reintegrate historical archeology into the framework of Plains anthropology, the breadth and vitality of these contributions to the substantive and theoretical knowledge of the historic past will certainly blossom.

Adaptation Types

The discussion of adaptation types becomes difficult after the transition into the historic period because of the cultural and economic diversity and the rapidity of change that characterizes this period. Further, not only is change rapid, but it is uneven across the study area. Where broad adaptation types, possibly tied to differing environments, may have characterized this period in prehistory, and while these may have changed in lock-step as time progressed, this is no longer the case after the Spanish entrada of the sixteenth century. In the following centuries, there is significant change in the makeup and nature of the Native American settlement of the study area, and a growing influx of those descended from Europe, Africa, and Asia. And when we arrive in the nineteenth century and the period of territory and statehood formation, the study area is divided into three political units, Colorado, Nebraska, and Kansas, that have differing trajectories of development.

Adaptation types as intended in this study are a construct that, if properly developed, should allow us to understand the archeological record. Because of the variables outlined very briefly above, the concept of adaptation types that is used in the following is one that is derived out of the archeological record or, where the record has yet to be exposed, the expected archeological record. By reviewing the archeological resources that have been documented in the study area, significant groupings of sites are developed using a combination of cultural, topical, and functional criteria. A culture-chronological framework simply does not work unless it is done with subregions. While this is feasible, more desirable is the ability to discuss research and research needs from the perspective of the entire study area and, in some cases, from beyond.

The adaptation types for this study unit, and brief descriptions of their intent, are:

Indigenous Native Americans. At the time of European contact, a variety of Native American peoples are known to have inhabited the study area. These groups, regardless of their longevity in this area prior to this contact, are referred to as the indigenous Native Americans. They remained an important population for the study area for much of the historic period, although most were removed to other lands during the nineteenth century.

Resettled Native Americans. During the nineteenth century, reduced lands were negotiated for many of the indigenous groups in the study area, and many were eventually removed entirely to other areas, generally to what is now Oklahoma. Into this setting, although primarily in eastern Kansas, were interjected numerous Native American groups who had agreed to exchange their lands in the northeast for reserves in the study area.
Transportation. Transportation is a major theme in the nineteenth and twentieth centuries in the study area, but was important earlier as well. The river trade on the Missouri River and tributaries was critical in the history of the area, and affected all peoples. Likewise, major trails such as the Oregon and Smoky Hill trails had profound impacts on the development of the region, as did the development of a network of railroads starting in the mid-nineteenth century. Finally, the development of systems of rural roads and highways has left a probably indelible imprint on the countryside.

Military. Although military sites cannot be understood without reference to many other factors, they represent a peculiar adaptation type that can stand alone. Military sites include forts, campsites, and battlefields.

Rural Settlement. Most Native American and military settlement is rural, and most transportation systems are rural. Here, however, we look at the settlement that came to characterize the study area during the nineteenth century and which brought scores of European-American, African-American, and Asian-American emigrants from the east to the study area in pursuit of agricultural livelihoods.

Urban Settlement. Urban settlement developed hand in hand with the rural settlement introduced above and cannot be understood otherwise. Nonetheless, urban settlement represents a different adaptation type than does rural settlement and deserves separate consideration.

Industrial. Sometimes rural and sometimes urban, industrial settlement was important in the nineteenth and twentieth centuries in the study area. It, like the urban settlement, is distinct in terms of adaptation and is thus treated separately.

None of these adaptation types can or should be considered as mutually exclusive categories. The cultural setting of the area was dynamic, ever changing, and interactive over the course of the last several centuries. Each of these adaptation types could be found during most of this period, and together they form a cultural network that defined the workings of the region. Once again, the goal here is not a culture-historical scheme, but one that can be used to order and discuss archeological resources, and to order and discuss archeological problems.

In the following narrative, each of these adaptation types is reviewed in more detail. First, a review of some of the key examples of investigated sites is presented. This is intended to provide the reader with an example of excavations at sites assigned to a particular adaptation type. No attempt has been made to review all of the pertinent excavated sites. This review is followed by a discussion of the nature of any gaps in the data on this adaptation type, and with a discussion of appropriate research goals and problem domains. In all cases, it should be assumed that data gaps do exist, and that these are substantial. In no case has sufficient archeological research been conducted so as to exhaust the need for additional investigations. Also, the research goals and problem domains that are presented are examples rather than prescriptions, and are not intended to be comprehensive. The range of possible research goals and problem domains that can be discussed is broad and will vary based on individual scholar, the particular site, and the project that causes research to be undertaken. Knowing the literature, the research deficiencies, and devising realistic and useful research problems is a professional responsibility of the individual archeologist.

Indigenous Native Americans

Substantial work on sites occupied by Native Americans indigenous to the study area has been conducted. These sites range from protohistoric to those dating relatively late in the historic period, and consist of village sites. Because these sites have been of interest to prehistorians, sites of this adaptation type have received more attention than other types, and thus this type is best known of any adaptation type reviewed in this section.

Sites related to indigenous Native Americans were among the first to receive serious attention by Plains archeologists. Notable here is the pioneering work of Waldo Wedel of the Smithsonian Institution on the Pawnee sites in Nebraska in the 1930s. These sites were excavated to solve a problem involving the relationship of prehistoric cultures of the region to the historically known groups such as the Pawnee. His excavations and subsequent analysis stands today as a key example of the application of the direct historical approach (Wedel 1936).

Most sites of this type in this region have been excavated, however, to allow cultural-historical reconstructions. The Scott County Pueblo in western Kansas, where excavations began with the work of S. W. Williston and H. T. Martin of the University of Kansas in 1897 and 1898, is a good example of this approach. Subsequent work by Wedel in 1939, by James Gunnerson of Northern Illinois University in 1965, and by the Kansas State Historical Society in 1970, 1975, and 1976 all focused on understanding the lifeways of this site's inhabitants, of determining its historical placement, and determining the identity of the builders/occupants.

Besides the excavations of Pawnee sites in Nebraska in the 1930s, certainly the most massive excavations within the study area — of any adaptation type — have been the excavations conducted on proto-Wichita sites in Kansas. The first scientific excavations on these sites was conducted by Wedel in 1940 at the Tobias site in Rice County, Kansas. On the surface, the site is characterized by about 19 low mounds and, beneath the surface, by innumerable cache pits and other features. Wedel's 1940 investigations at this site focused on the excavation of 12 cache pits and the testing of three mounds. One of these mounds was actually a complex made up of a large, low mound and surrounding depressions known locally as the "council circle." Wedel's work resulted in the conclusion that most of the low mounds were refuse rather than house mounds, but that the mounds and depressions making up the council circle represented the remains of semisubterranean pit-structures. Wedel spent several other seasons at Tobias as did the Kansas State Historical Society which now owns this site (Wedel 1959).

In addition to Tobias, Wedel and the Kansas State Historical Society have investigated a number of other Wichita sites in Rice County, as well as sites in Marion and Cowley counties in Kansas. Sites in all three areas show similarities, yet there are noted differences. All show some evidence of contact with Europeans although this evidence is strongest in the Rice County sites (Wedel 1959).
In 1939, 1940, and 1941, the site of the Big Village of the Omahas was excavated by John Champe and Paul Cooper using WPA crews. This was one of many WPA projects that received little attention in the archeology of the region because of the lack of a report, until recently, of the findings. This Big Village of the Omaha was occupied between 1775 and 1845 and represents a key site for this adaptation type within the study area. Five earth lodges, six exterior bell-shaped storage pits, and deposits of village refuse were excavated at this site. In addition, excavations at two cemetery sites adjacent to the village were conducted. The material culture from this site shows a rich complement of trade goods which reflect the prominent role of the village in the Missouri River trade of this period (O'Shea and Ludwickson 1992a).

Future Research Needs

A substantial amount of research has been conducted into the indigenous Native American sites of the study area of which the above review provides but a sample. Some notable gaps in data exist, however, such as the lack of substantial excavation of contact or early historic Kansa sites. A more pressing gap exists in the lack of reports on many of the excavations described above. Until these are available it will be difficult to conduct meaningful synthetic work on the problems to which these sites may contribute.

Research in this area needs to continue to grapple with the question of the prehistoric origins of these groups. This cannot be done, however, without working hand in hand with the prehistoric record of this and perhaps other regions (cf. Lightfoot 1995). As to the contact and early historic sites represented, work needs also to continue on the identification of the specific historic identities of the occupants of the sites, and of their relationships to other groups and to the natural resources they relied upon. What is the meaning of the three large clusters of proto-Wichita sites, for example, in chronological and cultural terms? The massive amount of material out of the ground makes it almost unconscionable that we do not have answers to basic questions such as these about the proto-Wichita.

Another need centers around the protohistoric occupation of the western part of the study area, on the high plains. In particular, some controversy exists on the nature of the use of this area during this period, and the identity of those responsible for certain complexes, and in particular the Dismal River complex. Relationships between the Dismal River and other contemporary complexes to protohistoric complexes to the east, such as Pawnee and Wichita, needs to be fully explored.

Resettled Native Americans

The Native American groups that were resettled to the study area during the early nineteenth century, and in particular to eastern Kansas, have received relatively little archeological attention. This lack of attention runs contrary to the significance of this settlement for the history of the study area and the fact that there is a great lack of information about certain aspects of this settlement. The data gaps that are present here are similar in structure to those that are found among other historically disenfranchised groups such as African-American slaves (cf. Ferguson 1992). The potential of archeology to contribute to the understanding of this adaptation type is therefore substantial.

Illustrative of this is the lack of information on the settlement pattern of these groups. The location of missions and other prominent sites (prominent from a Euro-American perspective) are all that are recorded for most of the reserves. In the former Pottawatomie reserve near Topeka, Kansas, a collector has located a series of apparent farmstead sites along a small drainage. This settlement pattern, and information for individual sites, comment on an aspect of the history of the study area that is not recorded and the proper study of which will yield significant historical and anthropological information.

Three examples are illustrative of the few excavations that have been conducted on this adaptation type. In 1968 the Great Plains Archeological Field School (University of Kansas, Kansas State University, Wichita State University) excavated three historic period burials dating to the 1840 to 1860 period. A range of artifacts was found on the site, including an iron tankard, flintlock pistol barrel, strike-a-light, pocket knife, brass pendant, brass bells, and a variety of glass beads. Analysis suggested a possible Sac affiliation (Scott 1976).

Site 14SH315, a domestic trash pit dating to the midnineteenth century, was excavated in 1969 by the Kansas State Historical Society because of its location in the now cancelled Grove Reservoir. Artifacts and other remains were found within a filled depression and are interpreted to be discard items that were intentionally placed in the depression. Evidence of nearby domestic structures was lacking but it is suspected that they were located on the uplands to the east of the site (Reynolds 1987a:97).

The artifacts recovered from the site revealed an interesting blend of both Native and Euro-American items. Some of these items, like the iron arrowpoint, were either made by Native Americans or were specifically manufactured for trade with them. The other historic artifacts found at the site are of common utilitarian origin and are items used widely by both Native Americans and Euro-Americans during the nineteenth century. The trash deposition event at 14SH315 is tentatively dated to the period from 1847 to 1875, with the actual date probably falling before the Civil War, and a Pottawatomie cultural affiliation is suspected (Reynolds 1987a:98).

In 1985 the Kansas State Historical Society and the Kansas Anthropological Association undertook excavations at the site of Josiah Meeker's farmstead at the Ottawa Baptist Mission in Franklin County, Kansas. This site was occupied between 1845 and 1856 by Meeker and until about 1860 by others. Meeker served as a missionary to the Ottawa who had been relocated to Kansas from Ohio in 1836. Meeker is well known in Kansas history for establishing the first printing operation in Kansas at the Shawnee Baptist Mission in 1834. In 1837 he established a mission among the Ottawa, but this was destroyed by the devastating flood of 1844. In 1845 he relocated the Ottawa Baptist Mission to higher ground at the site investigated in 1885. Meeker moved his printing operation from the Shawnee Baptist Mission to this second Ottawa Mission in 1849 (Lees 1986).

Excavations focused on two areas: the site of Meeker's dwelling and the site of his printing office. The site of the dwelling was visible on the surface as a large depression flanked
by two low mounds of limestone rubble. Excavations at the
site of the dwelling resulted in the discovery of a cellar, six
foundation piers, and two fireplace foundations. Based on these
features and historical documents, this building was interpreted
as an L-shaped structure formed by a kitchen attached to the
back of a rectangular building. No definite architectural remains
were discovered at the site of the printing office. Verification
that the area investigated was associated with the printing office
came, however, through the discovery of a number of pieces
of lead alloy printer's type and through the demonstration that
there were other differences in the distribution of artifacts
between this area and the location of the dwelling (Lees 1986).

Future Research

There are substantial gaps in the data related to this
adaptation type. This conclusion is commanded by the basic
paucity of excavated sites associated with this type. Also
important is the fact that many of the site types associated with
the resettled Native American are poorly recorded historically.
The dwelling sites, small industrial sites, and many aspects of
life and activity on mission and other non-Native American sites
are not recorded or are poorly recorded.

A focus on the identification of the full range of site types
associated with this adaptation type is needed. The
investigation by excavation of a sample of site types is necessary
to produce the data to begin examination of research questions
and to construct general interpretations of poorly recorded
aspects of life of these Native Americans and other
disenfranchised individuals in their midst. Comparative analysis
between sites in Kansas and sites in the areas from which these
groups were removed also has potential for defining differences
or similarities in adaptive approaches taken by the same cultures
in different areas.

Transportation

It is somewhat surprising, perhaps, that a wide range of
transportation-related sites have been investigated within the
study area. Transportation sites include the actual routes of
current, improvements such as bridges, sites providing direct
service to transportation, and vehicles of transportation.

Actual roads that have been investigated include work on
documenting the Fort Zarah Road (and associated ford and
bridge sites) in Kansas. Although not an excavation project,
documentation of these transportation features is fundamental
to an understanding of the historic use of the study area.
Related to the operation of a road was the Mahaffie Farmstead
located along the Santa Fe Trail in eastern Kansas. Portions of
this site were excavated in 1986 to better reveal the nature of
this place at the time of its use as a stop along the Santa Fe
Trail. Similarly, the Hollenberg Pony Express Station in Kansas
was excavated to provide evidence of the use and appearance of
this site during its brief use by the Pony Express. A similar
goal guided the excavations of the Rock Creek Station in
Nebraska.

Excavations of the Steamboat Bertrand in a former channel
of the Missouri River in Nebraska and the Great White Arabia
in Kansas provide striking evidence of river transportation in
the study region (Hawley 1995; Petsche 1974). The Missouri
River was a major transportation route of the Central and
Northern Great Plains during the nineteenth century and
before. Both boats sank fully loaded on their way upstream,
the Arabia in 1856 and the Bertrand in 1865. Much of their
cargo and the ships themselves were well preserved due to their
waterlogged state, and much of the collections are preserved
in museums, operated by the federal government in the case of
the Bertrand, and privately in the case of the Arabia. These
boats and their cargoes provide important time-capsule views
of trade and commerce on the Missouri River, material culture
available on the Plains, transportation technology, and changes
in these variables as reflected in the 10 years that separate their
sinking.

Future Research

A great amount of very good archeological information
exists on transportation-related sites in the study area. The
collections from the Arabia and Bertrand are an incredible yet
untapped resource for the study of the midnineteenth century
in this area. Considering the fundamental role of transportation
for the historic period utilization of the project area, however,
more research is needed to identify and document the types of
construction used in the transportation systems, and the nature
and form of sites directly servicing transportation routes.
Notably lacking in the discussion of transportation-related sites
are sites related to railroads. An area of great importance here
is the process of railroad construction, and in particular the
temporary railroad camps associated with the construction of
the network of railroads in the region.

Military

Military sites include forts, campsites, and battlefields.
Military sites, and in particular forts, have traditionally received
a substantial amount of interest from archeologists. This is due
partly to the importance of these sites in the history of an area,
and also partly to the fact that forts have been the focus of
efforts of restoration and interpretation for many years.
Battlefields and campsites were for many years believed to be
unaccessible using traditional archeological techniques but have
recently become the focus of new interest using metal detector
surveys.

The first military site to receive extensive excavation within
the study area is the site of Fort Atkinson in Washington County,
Nebraska. Fort Atkinson was occupied between 1820 and 1827
and was located on the Missouri River. Excavations were
conducted at this site by the Nebraska State Historical Society
for six seasons between 1956 and 1971. Work at this site was
focused on recovering information needed to interpret and
reconstruct this site. The multiple seasons of excavations
resulted in the investigation of a broad range of buildings and
other features at the site and the post cemetery, and the
recovery of a substantial collection of tightly dated artifacts
(Carlson 1979).

Similarly, excavations at Fort Scott, Kansas, were conducted
to assist in the reconstruction of this site by the National Park
Service. Fort Scott was a short-lived (1842 to 1853) U.S. military
outpost that was established along the Western military frontier
in what is now Bourbon County in southeastern Kansas. During the period from 1958 to 1972, the Kansas State Historical Society conducted archeological investigations of 20 fort-related structures within the area of the original Fort Scott (Reynolds 1987b).

These investigations also resulted in the collection of more than 36,000 items of material culture which include such varied artifacts as objects of metal, leather, glass, ceramics, paper, bone, rubber, plastic, wood, cloth, shell, brick, mortar, coal, plaster, and numerous examples of butchered animal bone. Both military and civilian items are represented in the sample and many items can be related to specific functions such as transportation, weaponry, construction, clothing, recreation, etc. Datable items cover a temporal range from the very early history of the fort (1840s) to the mid-twentieth century (Reynolds 1987bii).

The Fincher site (14LV358) was one of a number of archeological sites identified within the Fort Leavenworth Military Reservation by Barr (1977) and Rowlison (1977). As originally observed, this site was characterized as a scatter of nineteenth century artifacts in an undeveloped portion of the fort. Test excavations were conducted by American Resources Group, Ltd. of Carbondale, Illinois, at this site in 1988 after earth-moving activities associated with the operation of the Fort Leavenworth Hunt Club disturbed what excavations showed to be midnineteenth century dump deposits. Analysis of the artifacts from these three areas suggests they were deposited there between 1840 and 1880, and that they probably represented refuse from an enlisted soldier context (Wagner et al. 1988).

Archeological research was conducted by the Kansas State Historical Society at the Mine Creek Civil War battlefield between 1989 and 1991. This work was initiated to begin the process of developing an interpretive plan for the battlefield, which was owned and under development by the Kansas State Historical Society. Utilizing a crew of metal detectors to systematically scan the battlefield, artifacts from the battle were found, excavated, recorded, and their locations precisely mapped. Over a square mile was surveyed using this process, and analysis of the location of artifacts revealed patterns related to the battle. The conclusion was easily reached that the battlefield covered substantially more ground than had previously been thought, and that a considerable portion of the battlefield was located beyond the limits of the land owned by the state (Lees 1994).

Future Research

The above examples illustrate some previous archeology on military sites within the study area but do not approach the number of sites for which investigations at one level or another have been undertaken. Other military sites, it should be noted, were discussed or are subsumed under the transportation adaptation type.

Despite significant research on military sites, additional excavation is needed to provide additional information on the diverse range of sites associated with the military occupation of the study area. Notably lacking is excavation information on temporary camp sites used by the military and on sites such as blacksmith shops, stables, and laundries that served to support the military. A more important research need, however, is undoubtedly the need to use the information out of the ground to conduct research on questions related to the supply of posts in the study area with material goods manufactured elsewhere, the subsistence of soldiers stationed at the posts with regard to the importance of domestic vs. wild food sources, the relationship between different social and economic classes present in nineteenth century forts, and the social and economic relationship between soldiers and civilians living in adjacent communities or on post. Once questions such as these are addressed, data missing from the collection of excavated sites will become more apparent and will increasingly direct future research.

Rural Settlement

Certainly the key industry in the study area was agriculture and the range cattle industry. These were and are patently rural endeavors but are tied into urban settings through transportation links such as roads and railroads. Sites associated with this adaptation type are receiving increasing attention, yet given their overall importance in defining the character of the study area relatively little has been done. Some examples of this research follow.

The Black Ranch was one of a number of large ranches established following the Civil War in western Kansas. Historical research failed to provide any clear information on the initial establishment of the Black Ranch, but the 1878 date on the barn at this site clearly indicates it was established by that date. At the time of the 1984 testing, the site was characterized by a substantial number of standing buildings and other features. These included a standing frame dwelling, a sandstone spring house, a sandstone barn (dated 1878), a modern metal shed, a modern concrete block and metal shed, a trenched silo, a windmill, a twentieth century tractor barn, a poured concrete barn foundation, a modern concrete-block garage, a twentieth century frame outbuilding, a 1930s frame outbuilding, a frame privy, two privy pits, three poured concrete slab foundations, a cistern, a brick-lined shaft well, and two frame chicken coops. This architectural record obviously reflects the use of this site from at least 1878 up to the construction of Kanopolis Lake in the 1940s (Lees and Shockley 1986).

The archeological testing of this site involved the intensive survey of the site, the mapping and recording of all observed features, and the excavation of four 1 x 1 m test pits. Two of these test pits were excavated near the nineteenth century dwelling, one by the 1878 sandstone barn, and one near the foundation of a probably twentieth century barn. In addition, tests with bucket augers were excavated into three privy pits located near the dwelling. These test excavations demonstrated the general good state of preservation of the subsurface archeological remains at the site. They did not, however, result in any information about the site that was not readily apparent from a study of the site's architecture, which provided good information on the age of the site, its length of occupation and use, and the function of structures and parts of the site (Lees and Shockley 1986).
The Huse corncrib was excavated in 1975 because it was superimposed over a relatively well preserved Kansas City Hopewell site known as the Ashland Bottoms site (14RY605), Riley County. Excavations were conducted by Dr. Patricia J. O'Brien of Kansas State University for research and educational purposes (O'Brien et al. 1987). The Huse corncrib was one component of a farmstead that was established probably in the late 1860s. The corncrib itself dates to the nineteenth century and was torn down in 1969. Excavations revealed the limestone footings of the corncrib, a feature interpreted as a gravel drain associated with the corncrib, and a square post mold located adjacent to one of the corners of the corncrib.

The analysis of this site approached it from an experimental perspective. From an independent set of historical and oral historical information, something of the function of this site and its specific and general historical setting were known. A comparison of the site content, or the artifacts from the site, to documented site function was then made as a means to examine the ability of archeology to interpret site function. It was found that the only artifacts found during the excavation that were specifically related to the use of the site as a corncrib was the distinctive foundation and some corn. The majority of the other artifacts found at the site were associated with drinking and smoking behavior, the repair of farm equipment, use by animals to devour scavenged food, and use of the corncrib for equipment storage.

Because of impending destruction by highway construction, the Martin Farmstead in Republic County, Kansas, was extensively documented. This site was occupied between 1875 and 1992 by a series of families. Investigated through architectural analysis and recording and through archeological excavation were an 1875 and 1885 stone cabins along with a storm/root cellar, garage, drive-through corncrib, blacksmith shop, bank barn, and other features. This comprehensive approach to the recording and study of a farmstead allowed a discussion of the structure of this site and its evolution through time, and a relationship of this evolution to the various occupants of the place (Schoen 1994).

Future Research

Rural settlement is without a doubt the adaptation type that is both characterized by the largest number of resources within the study area but is also the type that best characterizes the settlement and evolution of the study area during the past one to two centuries. Significant data gaps exist however, in that relatively few sites of this type have been investigated. A diversity of rural sites exists based on modes of production (farming, ranching, etc.), time period, social and ethnic ties of the inhabitants, proximity to urban centers and transportation, etc.

Within the study area, there are many segments of the rural settlement pattern that are very poorly known historically and for which archeology is the best way to build an historical narrative. Even for those sites for which historical documents exist, the organization and structure of the farmstead and the evolution of this organization through time in relation to changing production, technology, and transportation is poorly known. The need is thus for the development of more case studies dealing with the farmstead as a collection of buildings and activity areas, similar to that seen for the Martin Farmstead, that can be used to address questions such as those alluded to here.

Urban Settlement

Archeology within urban areas, and focused on the urban historic landscape, has only recently been attempted within the study area. As a result, despite some major urban archeology projects, the record from investigated urban sites is minimal.

Although archeology within urban areas and archeology of urban settlement have been major endeavors in certain parts of the country, notably the northeast and mid-Atlantic, this has not been the case in the west. To a very large degree this has been the result of a conventional wisdom among planners, preservationists, and archeologists that the archeological record within modern urban areas has been destroyed. This has been shown to be patently untrue in those areas where attempts have been made to discover the record, including a number of cases within the study area. A good example of this is the research conducted on the Lincoln Pottery Works in Lincoln, Nebraska, but which is discussed in the Industrial Adaptation Type.

Several other examples are illustrative of urban settlement, and involve excavation within modern urban centers as well as excavations of former urban centers.

An unofficial cemetery was established in Topeka in 1855 shortly after the town's founding. This cemetery served the community until an official cemetery was established in 1859. Between 1859 and 1864, the burials made in the first cemetery were removed to the new cemetery. In 1986, commercial development on the south edge of downtown Topeka resulted in the discovery of human skeletal remains. Research showed that this construction was at the location of the original 1855-1859 Topeka cemetery and it was inferred that the discovered bones were interments that had been missed when the cemetery was moved in the 1860s (Good 1986).

Monitoring of construction within an area of two city lots resulted in the identification of five graves, three of which were empty. Bones recovered from two of the graves were interpreted as a male and a female, both of whom were between 22 and 25 at the age of death. Both individuals were reinterred in the Topeka Cemetery with much fanfare (Good 1986).

Quindaro was a speculative, Euro-American townsite established on the banks of the Missouri River in 1857. Although it was a speculative enterprise, it was also associated with Free State interests and received some backing from the New England Emigrant Aid Society. Although it was one of many towns established on the Missouri River during the Territorial Period, Quindaro was the only one that was sympathetic to Free State interests. Quindaro enjoyed a substantial but short-lived boom and, for a variety of converging reasons, it failed in the first years of the 1860s. Following the failure and abandonment of the town, the Quindaro area became a locus for settlement of refugee African Americans, initially from Missouri but later from other areas of the South. The African Americans
established an unofficial community by the name of Happy Hollow within the former plotted townsite of Quindaro.

Plans to develop the Quindaro townsite as a private landfill resulted in intensive archeological investigation of the area. Initial, Phase I reconnaissance of the proposed landfill was conducted in 1984 by the Kansas State Historical Society (Reynolds 1984b), and was followed later in 1984 by an intensive, Phase II survey conducted by Environmental Systems Analysis (ESA) of Kansas City (Lees 1984). The Phase I identified 20 features or potential features within the project area, while the Phase II survey documented 50 archeological features, most of which represented structure remains.

Phase III testing of features within the proposed landfill began in late 1984 and was completed in mid-1985. Testing investigated a large number of features, including a linear trash-filled pit located in the vicinity of the Quindaro House hotel, the Wyandotte House hotel, a general mercantile store at 4 Kanzas Avenue, a commercial building at 38 Kanzas Avenue, a probable commercial building at 10 Kanzas Avenue, an office building at 21 Kanzas Avenue, a store and office building at 161 Main Street, and a probable commercial building at 9 or 11 Kanzas Avenue. Other tested features include the brewery, a lime kiln, a commercial building on 75 and 76 Levee Street, the Climbdown newspaper office at 47 Kanzas Avenue, probable commercial buildings at 39 and 40 or 42 Kanzas Avenue, and probable dwellings at 23 Kanzas Avenue, 42 "P" Street, and 45 Kanzas Avenue. Additional features, including Quindaro city streets and later features associated with Happy Hollow, were also tested to varying degrees (McKay and Schmits 1986).

Phase IV data recovery excavations have been conducted at a number of locations within the proposed landfill. These excavations and continued historical research have resulted in new interpretations of the historical associations of many of the features described in Phase II and III reports. Phase IV investigations and a final interpretation of all the discovered features is not available due to the cancellation of the landfill project and the cancellation of the archeological contract.

The old Marmaton townsite, 14BO4, was inventoried during the 1967 survey work conducted by the University of Kansas in Bourbon County at the site of the then proposed Fort Scott Lake. Test excavations were conducted there during the University of Kansas' 1968 field season and was intended to establish the degree of preservation of this site which had been cultivated for several decades (Bradley and Harder 1974).

Old Marmaton was established in 1858 at a location about one mile south of the present town of Marmaton. Between 1858 and 1863, Marmaton served as the county seat of Bourbon County. In 1864 the town was attacked by a large band of raiders, and much of the town was burned and a number of citizens killed. In 1882, Marmaton was moved to its present location in order to be adjacent to a railroad (Bradley and Harder 1974).

According to Bradley and Harder, at the time of the 1968 work the site was “marked by depressions where former streets have intersected the gravel road to the north, and also by larger depressions which may have been the locations of buildings (Bradley and Harder 1974:32).” At that time, the majority of the site was located in a cultivated field, which was covered with a scatter of historic artifacts. Three different areas of this site were investigated.

The first area to be tested was the suspected location of the hotel, which was determined on the basis of historical documentation. Some historic artifacts such as glass, ceramics, and nails were found in the plowzone in these trenches, but no material or evidence of features was found below this level. Based on this, and information from the landowner that this area had been bulldozed, test excavations in this area were abandoned. A second area investigated was characterized by a roughly circular scatter of limestone rubble that excavations identified as a well whose shaft was lined with dry-laid limestone. The final area investigated was characterized by limestone rubble on the surface. These excavations revealed no pattern to this rubble and no evidence of the presence of a structure at this location (Bradley and Harder 1974).

The Riggs house is a standing Italianate dwelling located at 1501 Pennsylvania in Lawrence, Kansas. Construction on the Riggs house was begun in the spring of 1863, but the unfinished brick structure was burned during Quantrill’s raid on Lawrence in August of 1863. Construction and reconstruction of the building resumed after this event, and the dwelling was occupied in November of 1864 (Jones and Nemec 1986).

The Riggs house served as the site of a dig conducted in 1971 by Dr. Carlyle S. Smith of the Museum of Anthropology at the University of Kansas. Two slightly irregular test pits, approximately three feet square, were excavated along the east foundation wall of this structure beneath a window of the original kitchen for the dwelling (Jones and Nemec 1986).

The artifacts recovered from this excavation include a relatively large number of fragments of ceramics, bottle glass, window glass, glass tableware, nails, and other artifacts. These artifacts were apparently largely found in the builder’s trench, and all appear to date from the mid-nineteenth century. All of the artifacts are relatively large, indicating that they probably represent secondary refuse that was intentionally discarded at this location. The conclusion of the report, based on Dr. Smith’s hypotheses, is that these artifacts were among the items destroyed during Quantrill’s raid, and that they were disposed of in the still open builder’s trench.

Future Research

Archeology within modern urban areas must be taken as one of our major needs within the study area. Urban development is currently having the most drastic affect on the cultural resource base within the study area. In many cases, however, this impact is on resources that while they are in a modern urban area now were not urban during their use. Also, within modern urban areas are, however, archeological sites that represent early urban settlement.

Although resources within urban areas are certainly among the best documented of any adaptation type, this generalization is deceptive. Urban resources described in a variety of documentary sources may still remain relatively unknown in terms of their precise construction, physical layout, and change through time. Likewise, the relationships between specific resources and other sites with the community is something that
is rarely discussed in archival sources. Finally, there are many resources and population groups that remain invisible within urban areas despite an apparently abundant archival record.

The challenge of urban archaeology within the study area is thus to build and understanding of the full range of urban resources and populations at various periods in time; to develop historical information on those resources and populations that are otherwise historically disenfranchised, thus providing a more comprehensive urban history; and to use this setting to examine questions of material culture supply and consumer choice, of urban subsistence and health issues, and of comparative social and economic relations within an evolving urban landscape. To date, while substantial information on early urban centers is available from a number of excavations within the study area, in particular the site of Quindaro, none of these questions or others similarly relevant have been adequately addressed.

Industrial

Industrial settlement has been a key element of the nineteenth and twentieth century development of the study area, but is certainly an area that has been neglected archaeologically. Industrial production must be understood as something that ranges from small-scale industrial production on a farmstead to temporary industrial production to large-scale commercial industrial operations. Small scale and temporary production has been an element of life within the study area for several hundred years, with large-scale commercial production becoming important starting in the early 19th century along the Missouri River.

The most important study to date has been the excavations of the Lincoln Pottery Works (25LC42) in Lincoln, Nebraska, in 1986 and 1987 (Schoen and Bleed 1989). The Lincoln Pottery Works dates to the 1880 to 1902 period. It produced a wide variety of utilitarian stonewares and was one of hundreds if not thousands of such works that could be found in the United States at that time. Excavations of this site exposed several of the pottery's kilns and thousands of waster sherds, allowing a detailed technological and typological study. The study is important in that it was the first major industrial archeology project in the study area.

Also, excavations were conducted in the vicinity of a small print shop operated by Jotham Meeker at the Ottawa Baptist Mission between 1845 and 1860 (Lees 1986). In this shop he printed religious tracts in English and Ottawa. Although no architectural remains of this building were found, a scatter of printer's type was found near the documented location of this shop.

New Chelsea was a town started in the late 1860s and chartered in 1870. It represented the movement of the earlier county seat of Chelsea to a location with more favored access to transportation, including location along a proposed railroad. When the railroad did not materialize, the community declined and by 1900 was largely abandoned (Roberts 1982).

The 1979 excavations at the blacksmith shop resulted in the discovery of four features. These features were: 1) a brick and limestone concentration that was interpreted as the foundation for a forge, 2) a basin shaped, clay-filled pit located near the first feature and interpreted as a clinker pit, 3) a limestone filled pit near the first feature, interpreted as the foundation for an anvil, and 4) a small, shallow circular stain of uninterpreted function. Artifacts recovered from the excavations included a number of items that appeared related to the specialized function of this site, and which included blacksmithing tools, iron raw materials and waste, and clinkers. A variety of other artifacts were also found, with most of these including iron artifacts which were possibly the by-product of the smithing operation. Very few domestic type artifacts were found (Roberts 1982:561-567).

Based on a consideration of the distribution of materials in the excavated area, two specialized work areas were identified. These were located on either side of the general work area where the forge and anvil were interpreted as having been located. To the north of the forge was the interpreted location of a specialized work area which may have focused on wagons; to the south an area reflecting a farrier specialization was identified. The lack of evidence for a structure at this site resulted in speculation that this was an open-air blacksmith shop; a type of operation known to have existed at New Chelsea (Roberts 1982:598-602).

In 1996 remains of the dam for the Shawnee Mill in Johnson County, Kansas, was discovered and investigated. Shawnee Mill is one of the earliest industrial complexes in the study area and dates to the 1835 to 1844 period. At this site were a grist and saw mill operated for the benefit of the Shawnee who had removed to this area by provisions of an 1825 treaty. The mills were destroyed in the devastating flood of 1844. Although none of the mill buildings has been found, the remains of the mill dam have been found and documented and provide a significant insight into early industrial construction in the study area (King 1996).

Future Research

The paucity of sites that can be referenced in an archeological discussion of industry is clear illustration of the magnitude of gaps in archeological knowledge on this topic. Other industrial sites are to be expected in the region, including mining sites, other pottery works, blacksmith shops, foundries, sawmills, gristmills, shoe manufactory, rock quarries, and brick works. Some of these industries, such as mining and brick manufacturing, were prominent in some areas and sustained towns and a local infrastructure of sometimes substantial proportions. More typical over the region as a whole was small scale industry serving local need.

Documenting the range of industrial technologies, and the evolution of these technologies, represents a major research question begging to be addressed through archeological research. The nature of small industrial establishments is of particular interest because these are most certainly the most poorly documented. The blacksmith shop, for example, was probably ubiquitous on the rural and urban landscape, but is extremely poorly known in terms of the industrial structure of the shops and in terms of its relationship to an individual residence and to a rural or urban community.
9 Bioarchaeological Research in Northeastern Colorado, Northern Kansas, Nebraska, and South Dakota, by Douglas W. Owsley and Karin L. Bruwelheide

Until the late 1950s, few professional archeologists in the Plains were concerned with the recovery and curation of human skeletal remains (Bass 1981). M. W. Stirling of the U.S. National Museum (Wedell 1955) and John Champe of the University of Nebraska (O'Shea and Ludwickson 1992a) were exceptions. Williams (1993) provides a brief summary of early twentieth century archeological investigations in the Northern Plains that included the recovery of human remains. Additional historical information and commentary can be found in Bass (1981) and Hughy (1980).

Prior to 1950, there were no physical anthropologists in the Great Plains and few studies of human skeletons. These few presented measurements and general information on small samples or unusual skulls and were especially concerned with specimens that appeared primitive and possibly of great antiquity.

Modern physical anthropology in the Great Plains began with the River Basin Surveys (RBS) program, which led to the salvage recovery of large numbers of skeletons and the training of students qualified to analyze these materials. Federal archeologists working under the auspices of the RBS program (1945-1969) conducted their salvage excavations in conjunction with collaborating institutions (e.g., universities and state historical societies) at several burial sites in South Dakota before they were destroyed or inundated by waters impounded by new dams along the Missouri River.

The history of this federal salvage program and the specially created South Dakota State Archaeological Commission, which conducted salvage work during this era, can be found in Helgevold (1980) and Lehmer (1971). W. R. Hurt, the professional archeologist who replaced W. H. Over as director of the University of South Dakota Museum in 1949, maintained an active archeological program on behalf of the South Dakota Archaeological Commission and the Museum. Hurt excavated two large and well-preserved Extended and Postcontact burial samples, Four Bear (39DW2) and Swan Creek (39WW7) (Hurt 1957; Hurt et al. 1962).

Federal archeologists excavated small numbers of skeletons from several Coalescent tradition sites along the Missouri River, including Black Widow Ridge (39ST203), Cheyenne River (39ST1), and Leavitt (39ST215) (Lehmer and Jones 1968). At the Buffalo Pasture site (39ST216), the commingled and incomplete skeletons of 28 individuals, which had been unearthed and scattered by heavy machinery while obtaining fill dirt for the Oahe dam, were gathered by construction workers and RBS archeologists (Lehmer and Jones 1968). Middle Woodland Sonota complex burials were recovered from several mounds, including Arpan (39DW252), Swift Bird (39DW233), Grover Hand (39DW240), and Boundary (32ST1) (Neuman 1975).

William Bass, a physical anthropologist for the Smithsonian Institution and the University of Kansas, worked to define the role of physical anthropology in the RBS interagency archeological program and developed techniques for the efficient recovery of large skeletal samples. Through 14 field seasons (1957-1970), he directed excavations of four Anishinaabe cemeteries—Larson (39WW2), Leavenworth (39CO9), Mobridge (39WW1), and Sully (39SL4) (Bass et al. 1971; Bass 1981). Often the work took place only slightly in advance of the rising water level. Bass's excavation at Mobridge began in 1968 and continued through 1970. One of Bass's students, Douglas Ubelaker, and T. Dale Stewart of the U.S. National Museum, directed a final season (in 1971) at Mobridge (Owsley et al. 1982).

Unlike other cemetery investigations along the Missouri River, Bass's objective was comprehensive recovery, rather than limited testing or the collection of isolated skeletons from habitation areas. Three or more field seasons were devoted to threatened sites. Field objectives included defining the limits of a cemetery and recovering and preserving all skeletal material from it. Bass (personal communication 1994) estimates that 90% of all burials in the Larson cemetery were recovered. The recovery of unusually large and well-preserved skeletal samples (e.g., nearly 700 individuals from Larson) eliminated the effect of differential preservation as a major source of recovery bias. Most burials were primary interments, rather than secondary, which further increased the likelihood of complete skeletal recovery. Further, there was no evidence of sociocultural exclusion based on age, sex, or class. (The Postcontact Coalescent tradition Anishinaabe characterizedly placed graves in a cemetery near a village [Lehmer 1971]. For additional ethnohistoric and archeological information about Plains Indian mortuary practices, see Orser [1980], O'Shea [1978], Ubelaker and Willey [1978], and Snortland [1991].) There is little ethnohistoric information to indicate that specific segments of the population were buried elsewhere. Thus, these samples seem to be largely representative of the mortality profiles of the original populations, a basic requirement for paleodemographic and paleopathological research.

After the RBS unit closed in 1969, few burials were excavated except for the occasional limited collection of remains exposed by erosion or looting. Even during the RBS program, limited time and funds restricted sampling to only a few burial sites. As a consequence, many sites and remains in riverine environments frequently have been exposed and lost. As Rose et al. (1982:91) noted, "Shoreline erosion, subsequent exposure and destruction of archeological remains are facts of life for the Federal impoundments in the Dakotas." Displaced skeletons are often incomplete and lack well-defined archeological provenance. For example, of 44 human skeletons acquired from 14 locations along Lakes Oahe, Sharpe, and Francis Case and analyzed by Rose, Marks, Kay, and Riddick (1984) under contract to the U.S. Army Corps of Engineers, Omaha District, only two had been discovered by professional archeologists, and a third by a Park Ranger. Disturbed burials lacking specific context are
difficult to analyze and interpret, for a sample's "heuristic potential depends to a large degree on a proper understanding of burial or skeletal context." (Rose et al. 1982:91).

Only two large samples have been recovered during salvage excavations during the past two decades: the commingled remains of 486 individuals from a fortification trench at the Crow Creek site (39BF11) by the University of South Dakota in 1978 (Willey and Emerson 1993) and 84 burials from the Indian School site (39HU10) by Augustana College in 1989-1990 (F. Winham, personal communication 1994). Both collections have been buried, the latter without study. Current policy of the Omaha District of the U.S. Army Corps of Engineers in regard to lands along Lakes Oahe, Bowman/Haley, and Sakakawea in South Dakota and the Pipestem Reservoir in North Dakota is strict avoidance of all human burials, marked or unmarked, whenever possible.

Data obtained from the RBS samples were published during the 1960s and 1970s, usually as descriptive appendices to archeological reports. Qualified and well-trained students continued work on the Plains collections. As a result, the Plains "progressed from one of the least known to one of the better known regions as far as skeletal studies are concerned" (Bass 1981:3). Research from the 1970s to the present has become more relevant to archeological objectives, with greater emphasis on such aspects as population relationships and demography. Bass (1981) illustrated the breadth of this research by citing 29 M.A. theses and Ph.D. dissertations based on Plains collections. An updated list (since 1980) follows.

Master's Theses and Doctoral Dissertations Since 1980

Based on Central and Northern Plains Skeletal Collections

Deitrick, Lynn M. 1980 The Occurrence and Interpretation of Trauma at the Larson Site, 39WW2, Walworth County, South Dakota. M.A. Thesis, University of Tennessee.


Symes, Steven A. 1983 Harris Lines as Indicators of Stress: An Analysis of Tibiae from the Crow Creek Massacre Victims. M.A. Thesis, University of Tennessee.


Skeletal samples from the Central and Northern Plains, and especially those from along the Missouri River, have offered some of the best opportunities in North America for population studies through cross-cultural, regional, and temporal comparisons. With the recovery of larger samples, and with new analytical methods and theoretical approaches, the study of human skeletal remains from archeological contexts changed and expanded dramatically. With regard to craniofacial morphology and population relationships and origins, this transition required a shift from typological thinking to a process-oriented approach.
focused on microevolutionary problems. Computer-aided analyses have provided a better understanding of morphological variation over time and in different geographic regions.

Bioarchaeology, concerned with the study of human skeletons in an archeological context, is a development of the last three decades. Principal emphases are demography, bone and dental pathology, subsistence, adaptation, growth and development, and sociocultural relationships, such as interpersonal violence and warfare. Volumes edited by Jantz and Owsley (1981) and Owsley and Jantz (1994) reflect the incremental advances in the scope and thoroughness of Plains skeletal biology and bioarchaeological research. Investigative procedures and research designs have become more sophisticated and have benefitted from advances in technology and techniques of analysis, as well as from a systematic approach and the development of computerized data bases.

Bioarchaeological Research in Four States in the Central and Northern Plains

This section of the report deals with bioarchaeological research and collections from four states in the Central and Northern Plains: Nebraska, South Dakota, the northern half of Kansas, and the northeastern corner of Colorado. This area represents the Central Plains and part of the Northern Plains of the Central and Northern Great Plains Overview (CNPO), a project designed to assess (a) the extent of the archeological resource base, (b) data that are lacking, and (c) the current state of knowledge as a basis for planning and managing cultural resources. This overview builds on and complements reports compiled during the Southwest Division Overview Project, which provided information about burial sites in the southern half of Kansas and southeastern and south-central Colorado (Hofman et al. 1989; Simmons et al. 1989). The primary research goals of the new initiative were

- To develop a comprehensive inventory of archeological sites with documented mortuary components;
- To present an initial synthesis of the major research themes and specific research findings based on osteological data; and
- To provide a preliminary synthesis of the bioarchaeological data using a comparative framework based on adaptation types.

Human remains represent a key component of the archeological record and are essential for an understanding of trends in population demography, health, origins and migrations, microevolutionary change, sociocultural interaction, subsistence patterns, and mortuary practices through time and in different regions. Thus the unique and varied data derived from human skeletons are crucial to the interpretation of the past.

Native American concern about the recovery, analysis, and curation of human remains has resulted in greater sensitivity on the part of researchers and in special efforts being made to ensure that interested parties are consulted and fully informed about procedures, alternatives, and the information to be gained through osteological analysis. Large numbers of skeletons in museum collections have been reburied, and most construction and development projects and archeological investigations avoid the recovery of human skeletons when possible. Therefore, an irreplaceable osteological resource is rapidly becoming unavailable, and future generations will not have an opportunity to examine such materials firsthand and to apply future, advanced technological and analytical procedures to them.

There is urgent need for the systematic recovery and analysis of osteological data as a foundation for a better understanding of Plains prehistory. The completion of regional syntheses is an essential step in pulling together and interpreting research findings, identifying trends, showing where additional data or improved procedures of data collection and analysis are needed, and recommending productive directions for further study of the samples that are still available.

The development of the required syntheses began with a systematic survey of a wide variety of sources as a basis for identifying sites with mortuary components. This task was a collaborative team effort in which standardized information was compiled for each archeological site in which human remains had been documented in 11 states included in the Central and Northern Plains Overview project (see Owsley and Richardson, Appendix A). The following information was recorded:

- Site name, number, and FIPS code
- Cultural affiliation
- Number of individuals represented by skeletal remains and number of skeletons (partial and complete) that have been analyzed
- Burial context and relevant environmental factors
- Type of field project and organization(s) investigating each site.

Sources of the information for this site inventory included published and unpublished reports, field notes, site files, and computer records maintained by the Colorado Historical Society, Kansas State Historical Society, Nebraska State Historical Society, South Dakota State Archeological Research Center, University of Kansas Museum of Anthropology, Department of Anthropology of the University of Tennessee, and National Museum of Natural History. National, regional, and local anthropological and archeological journals, bulletins, and newsletters were checked for osteological citations. Travel to Kansas, Nebraska, South Dakota, Tennessee, and Wyoming provided access to less widely circulated publications, monographs, miscellaneous contributions, unpublished reports on cultural resource management, survey reports, Master’s theses, and doctoral dissertations, as well as an opportunity to inventory specific collections.

The sections that follow deal with the sites reported and studied in the four states or portions of states comprising the Central Plains and the Northern Plains overview. The organization is based on the traditional cultural/historical framework including archeological period, tradition, variant, and phase, as described in Appendix A. To identify the archeological context of each burial component within a specific cultural category required heavy reliance on publications, unpublished site records, and the assistance of specialists in the archeology of a region. Sites with multiple burial components (i.e., different cultural units in a burial sample) were classified as
multicomponent. (This classification pertains only to the burial features, not to the total archeological site, which may provide evidence for multiple occupations that are not reflected in the burial sample.)

Following this introductory section, which presents the background data on the archeological sites in the four states under consideration, are sections that describe findings and research needs in relation to demography, subsistence patterns, various types of osteological diseases, developmental anomalies, and trauma, dental pathology, and related topics. These sections include tables showing the osteological data available in relation to sites, together with a summary of the current state of knowledge, data needs, and suggested directions for future research. A chapter of the overall report will reorganize the bioarchaeological data from these sections and relate them to adaptation types for the Central Great Plains region.

**Characteristics of Sites**

In Northern Kansas, as Table 34 shows, of 158 archeological sites with human remains, four contained burials representing multiple components. The total number of individuals recovered from these sites was 941, of which slightly more than half (56.5%) have been analyzed.

The distribution of sites among archeological periods is uneven, there being few sites (5, or 3.2% of the 158) from the Paleoeolithic, Archaic, and Late Archaic periods, which yielded few burials (15, or 1.6% of the 941 individuals recovered), and only a third of those few burials have been analyzed. Substantially more Woodland (including Middle and Late Woodland) sites have been studied, constituting 34.8% (N=55) of the 158 sites, and accounting for 56.6% (N=533) of the individuals that were recovered. Although nearly all (92%) of the human remains from the 29 Late Woodland sites have been analyzed, only 51.5% of the 205 individuals representing 17 Woodland sites (specific period undetermined) have been studied. Eleven Plains Village sites yielded 176 individuals of which 93.7% have been analyzed. About one-fourth of the 158 sites studied were Historic (23.4%). They yielded 90 individuals, about half (54.5%) of which have been analyzed. The archeological period of another one-fourth of the sites with burials in Northern Kansas has not been determined, and only 4.5% of the 67 burials from such sites have been analyzed.

In summary, slightly more than half of the 941 burials identified from the northern half of Kansas have received some analysis, which, at a minimum, involved determination of age and sex together with other general observations. More Woodland and Plains Village burials have been discovered and examined. Phenicie's (1969) study of burials from 17 mounds in North Central Kansas represents one of the more comprehensive investigations. Two numerically important Plains Village samples are those from the Calovitch Mound (14WY7), which was analyzed by Barnes (1977), and the Indian Burial Pit site, also known as the Whiteford site (14SA1). The Whiteford site, a prehistoric cemetery complex of the Smoky Hill culture dated ca. A.D. 1300, was excavated between 1936 and 1940 by C.L. Whiteford, an amateur archeologist. More than 146 skeletons were uncovered and left in situ along with associated burial artifacts. A building erected over the cemetery remained open as a commercial operation for more than 40 years, until 1991, when the facility was closed and the remains reburied. This series offered an unusual research opportunity, as indicated by Wedel (1959:523).

Rarely does the archeologist in the Central Plains find such a large series of measurable human remains in unquestioned association with cultural materials that...
can be correlated with defined prehistoric complexes; and the occasion there afforded for identifying the physical type or types represented, for relating these to other native populations in the general region, and for studying the diseases and disabilities which may have afflicted the pre-white populations should not be overlooked.

Unfortunately, the remains were never properly examined and the application of numerous coats of shellac as a means of preservation inhibited the examination conducted by Finnegan (1989) prior to reburial. Only basic observations indicating burial position, age, sex, and stature were possible. It is even more unfortunate that this site is remembered not for its scientific but for its commercial value and the controversy it stimulated, which led to state legislation mandating the reburial of the human remains from this archeological context.

Almost no information is available for the only possible Paleoamerican remains recovered in this region (14WY9003), and until these remains are analyzed and dated, even their assessment as Paleoamerican remains tentative. Only four Archaic sites have been identified, of which the two "Lansing Man" skeletons (14LV515) found at a depth of about 22 feet in a loess bank on the west side of the Missouri River near Kansas City, Kansas, are the oldest (Bass 1973). Their discovery in 1902 caused considerable controversy about the antiquity (possibly glacial) of these skeletons, a debate that received extensive popular press coverage as well as stimulating many scientific publications (e.g., Holmes 1902, Hrdlicka 1903). Only in 1968, following the development of radiocarbon dating, was assignment to the Early Middle Archaic period clearly established. Students of the University of Kansas provided partial funding for the assessment, which resulted in a date of 3579 B.C. The second oldest burial in Kansas, the fragmented skeleton of a young adult female dating to about 1800 B.C., was discovered during a construction project at the Snyder site (14BU9) near El Dorado (Klepinger 1972).

In Northern Colorado, as Table 34 shows, the number of sites is substantially fewer (43) than in northern Kansas; however, these sites yielded a substantial number of individual remains (124), less than half (43.5%) of which have been analyzed. As in Kansas, there were few multicomponent sites—only two of the 43.

The archeological period of half (51.2%) of the sites has not been established. Of those for whom period is identified, one-third (32.6%) are Woodland (including Early and Late Woodland and Archaic-Woodland, see Table 34), and these sites accounted for one-third (32.3%) of the total number of individuals. Most (87.5%) of these Woodland burials have been analyzed. Five sites, yielding the remains of five individuals, have been assigned to the Archaic period. Of these, the fragmentary skeleton of an adult female exposed by erosion along a tributary of Gordon Creek in Roosevelt National Forest was classified as Early Archaic. This burial (5LR99), the oldest from the Western Plains, has a radiocarbon date of 7750 B.C. (Anderson 1966; Breternitz, Swedlund, and Anderson 1971).

In Nebraska, 310 sites, of which 28 (9.0%) are multicomponent, yielded a total of 2,866 individuals. Three-fifths (59.1%) of the burials have been analyzed. One-third (34.2%) of the sites are of undetermined archeological period. Another third, 107 (34.5%) are Plains Village, and they yielded the majority, 1,679 (58.6%), of the burials. Of these Plains Village burials, three-fourths (77.4%) have been analyzed. Table 34 presents the distribution by archeological period of these Nebraska sites and the number of individuals from each that were recovered and analyzed.

Although the number of burial sites identified in South Dakota (201) was less than in Nebraska, the number of individuals found (4,353), and the number of these analyzed (90%) were substantially greater (see Tables 36 and 37). Of the South Dakota sites, 24 (12.0%) were multicomponent, compared to 28 (9.1%) of the 310 Nebraska sites. As in Nebraska, the archeological period of the largest number of sites (74) was Plains Village, and these yielded a majority of the burials 3,556 (82.1%). The cranium of an adult male found at the Medicine Crow site (39BF2) represents the earliest documented human remains from the Northern Plains (Bass 1976). The stratigraphic context indicates a date of 5000-2000 B.C., which falls within the Archaic period.

In Northern Kansas, Nebraska, and South Dakota, not all the burials at some of the sites are Native Americans. At some sites, most frequently those in Kansas, there are individuals who are white, and there are two black individuals from one site in Nebraska (Table 35). In all, 36 non-Native American burials were identified of which 52.8% were from sites in Kansas. Two-fifths (41.7%) of the non-Native American burials were analyzed. Jantz and Owsley's (1994) identification of a Euro-American cranium in a protohistoric Arikara cemetery (39WW7) illustrates the potential of applying forensic techniques to identify ancestry of individual crania. Their study provides evidence for direct contact with Euro-Americans half a century earlier than historical records had indicated. Bibliographic citations and an inventory of historic burials in Kansas that have been examined appear in a report by Finnegan (1989).

Records for the 712 burial sites identified by this survey document the discovery of 8,264 sets of individual remains. However, those of at least 276 individuals from 101 sites were only reported, not collected (Table 36). The skeletal remains of more than 2,300 individuals, 27.9% of the total sample, have been reburied during the past decade, thus are not available for examination (Table 37). The majority (82.3%) of these remains were examined prior to repatriation.

Organizations Reporting and Investigating Sites

A number of different types of organizations were responsible for the recovery and reporting of human remains at sites in the four Northern and Central Plains states considered in this section. Among these were federal, state, university, medical/legal, contract archeological, other organizations, and amateurs as Table 38 shows. Of 43 sites in northeastern Colorado, amateur organizations excavated two-fifths (41.9%) and universities one-third (32.6%), accounting for the recovery of half (54%) and one-third (34.7%), respectively, of the human remains at these sites. In northern Kansas, amateurs were the most frequent excavators (half [48.7%] of the sites and one-third [31.1%] of the individuals), followed by state organizations, which excavated
one-fifth of the sites (20.3%) and one-eighth (12.6%) of the human remains. In Nebraska, state organizations, amateurs, and universities were those most frequently involved in excavation and recovery. Although the number of sites investigated by state organizations was three times that of universities (32 compared to 11), the percentage of human remains recovered was roughly the same for the two types of organizations, 950 (33.1%) of the 2,868 reported, compared to 980 (34.2%). Amateurs excavated 90 (29%) of 320 sites and recovered 570 (19.9%) of 2,868 individuals. In South Dakota, in contrast to the other states, federal organizations accounted for most of the site exploration, 36.5% of 203 sites reported, with equivalent percentages of sites investigated by museums (19.7%) and amateurs (18.7%) and 10.8% by universities. A combination of organizations (category 2 in Table 38) accounted for the greatest number of individual burials that were recovered and reported, 1,815 (41.5%), followed by universities with 1,480 (34.2%).

The pattern of organizational involvement in such research varies from state to state. In regard to total number of sites, amateurs accounted for the largest percentage (31.2%) excavated, followed by state organizations (22.7%) and universities (14.8%); however, in relation to human remains recovered, universities had the highest percentage (50.5%), followed by combinations of organizations (28.2%), state organizations (13.6%), and amateurs (12.6%).

Table 39 presents a slightly different and more specific approach to organizational involvement in such research, showing the approximate number of sites with burials investigated or reported by particular organizations or groups (for example, local residents) in the four states being considered here. Local residents predominated, and by a wide margin, in both Kansas and Colorado. Amateurs have played such a large role in these discoveries in Colorado because most of the counties in the state’s eastern plains have had only tiny fractions of the total area formally surveyed for cultural resources (Office of Archeology and Historic Preservation 1993). The Nebraska State Historical Society was responsible for the investigation of the largest number of sites (132) in that state, with local residents and the University of Nebraska next (90 and 56 sites, respectively). In South Dakota, the River Basin Surveys and the University of South Dakota accounted for roughly equivalent numbers of sites (47 and 41, respectively), followed by the U.S. Army Corps of Engineers, with about half that number (21). The degree of activity of local residents in three of the four states is noteworthy and tends to substantiate anecdotal evidence of long-
Table 38. Approximate Numbers of Burial Sites Investigated (or Reported) by Selected Organizations:

<table>
<thead>
<tr>
<th>State</th>
<th>Organization</th>
<th>Sites with Burials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>Local Residents</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>University of Colorado</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>University of Northern Colorado</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Colorado Archaeological Society</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Law Enforcement Agency</td>
<td>3</td>
</tr>
<tr>
<td>Kansas</td>
<td>Local Residents</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Kansas State Historical Society</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Kansas State University</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>University of Kansas</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Law Enforcement Agency</td>
<td>4</td>
</tr>
<tr>
<td>Nebraska</td>
<td>Nebraska State Historical Society</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Local Residents</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>University of Nebraska</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Law Enforcement Agency</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>River Basin Surveys</td>
<td>7</td>
</tr>
<tr>
<td>South Dakota</td>
<td>River Basin Surveys</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>University of South Dakota</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Corps of Engineers</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>S. D. Archaeological Research Center</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>University of Kansas</td>
<td>5</td>
</tr>
</tbody>
</table>

Standing public interest and participation in archeological investigations in many regions of the United States.

Although nonprofessionals have made many contributions to Plains archeological research as both informants and participants in supervised archeological excavations, the activities of some who are interested only in collecting relics and artifacts has resulted in the looting and destruction of many important archeological sites in the Plains and provoked the dismay and condemnation of professional archeologists. Many examples involving burials can be cited, though few are needed to make this point.

- The continuous digging by local residents at 25DK10, an Omaha cemetery associated with the Big Village (25DK5), necessitated Champ’s excavation in 1940 (Parks 1992).
- According to Gant (1966), all accidental finds reported by engineers engaged in highway salvage projects in Nebraska in the summer of 1966 were either totally destroyed or badly disturbed by souvenir hunters.
- Salvia archeologists often arrived at sites (e.g., Genoa [24NC20]) to find relic hunters gathered around exposed burials “trying to dig out the bones before the other guy could” (Jones 1970:1).
- When Kivett (1969) terminated investigations at the Woodcliff Recreation Area (25SD31) because a local contractor with a crew of young men continued to loot the site, he emphasized the legal and moral reasons that the excavation of burials should be conducted under the direction of trained archeologists from the Nebraska State Historical Society (or other research institutions). None of the amateurs’ discoveries were made available for study.
- Mallam (1971) severely criticized the excavation of a Pawnee burial by two high school students, which was reported in Nebraskaland under the title “We Dig Herby” (Batte 1970), as an irresponsible act unworthy of publication. Mallam noted that the article “conveys to the general reader the impression that the cultural antiquities of Nebraska may be freely plundered for personal and private pleasure” (1971:3), and that the article was “a sad testimony to the ever-increasing amateur destruction that threatens to eliminate our prehistoric heritage” (1971:12).

As a final example, when farmhands working on the walls of an old pit silo in Weld county, Colorado, discovered bones, they cut rapidly into the bank and uncovered the skeletons of at least 27 individuals. “Word quickly got out to the local residents who brought in electric lights to illuminate the mass destruction that became a frenzy during the night following the discovery. Farmer Garcia’s pit silo disappeared, then other structures, until angered by the wanton destruction, he ran everybody off his property” (Greenway 1961:42). Pillage of the Garcia site (5WL1986) prompted the Department of Anthropology of the University of Colorado to announce that it would provide competent investigators to landowners of Colorado sites to direct or advise on excavations: “Their interests will be scrupulously protected, and they can be assured ... their name will be associated with a contribution to knowledge and not a destruction of it” (Greenway 1961:42).

In contrast, four self-trained, nonprofessional archeologists are noteworthy for their contributions to Plains bioarchaeology because they excavated burials using methods that were reasonably systematic (for the time), which included keeping field notes, cataloging excavated material, and publishing some of their findings. During the 1930s, Floyd Schultz excavated 32 burial mounds in the Lower Republican River valley in Clay and Geary counties of northeastern Kansas (Phenice 1969; Schultz and Spaulding 1948). Schultz’s collection was donated to the University of Kansas in 1948. In Nebraska, the early investigations by A. T. Hill, initially as an amateur and after 1933 as a museum curator and Society Archeologist of the Nebraska State Historical Society, contributed to future Pawnee bioarchaeological research and collections through his excavation of burials at the Pine-Pawnee Village site (25WT1). As a result of the activities of R. F. Gilder, the Museum of the University of Nebraska acquired a collection of more than 100 skulls from burial sites on the bluffs overlooking the Missouri River near Omaha (Gilder 1908, 1909). These materials figured prominently in early discussions of the antiquity and supposed primitive morphology of selected specimens, which were described as “Nebraska Loess Man” (Poynter 1915). The fourth of these nonprofessional archeologists who made significant contributions to bioarchaeological research was William II. Over of the University of South Dakota. As director (1912-1949) of the museum now named in his honor and as a semiretired curator until 1952, he actively surveyed and tested many of the most important sites in South Dakota. His published field notes and reports document more than 200 sites in 43 counties (Over and Meleen 1941; Sigstad and Sigstad 1973). With the assistance of E. E. Meleen, Over excavated human skeletal remains at more than 30 sites (Owsley and Jantz 1994).

Objectives of Archeological Investigations

The types of professional archeological investigations vary, depending on their principal objective(s): for example, survey, testing, salvage, excavation, and instruction (field school). Table 40 presents data on the sites with human remains in relation to
the type of archeological investigation in the four states under consideration. More than half (53.5%) of the sites in northeastern Colorado could not be assigned to one specific objective, but of those that were, excavation was the objective for eight (18.6%), the largest number of the sites investigated, with salvage and survey next (each accounting for five [11.6%] of the sites). (Undefined cases primarily represent those projects that were initiated by amateurs and local residents.) The number of individual burials present at the sites (20, or 16.1%) was the same in both excavation and salvage projects, but only five (4%) in the surveys.

In northern Kansas, excavation and salvage accounted for most of the sites investigated, 26 (16.5%) and 16 (10.1%) respectively, but in regard to the number of individuals, excavation was the predominant objective (18.3% of 172). In this state, more than two-thirds of the sites could not be assigned to one of the “type of project” categories. In contrast to the large percentages of unassigned projects in both Colorado and Kansas, only one-third (32.9%) of the sites in Nebraska and one-fourth (24.6%) of those in South Dakota could not be assigned to one of the archeological categories. As in Colorado and Kansas, excavation was the type of investigation in Nebraska that accounted for 103 (33.2%), the largest number of sites, with by far the greatest number of individuals (2,058, 71.8%); followed by salvage with 47 (15.2%) sites and survey with 41 (13.2%) of the sites. In South Dakota, however, salvage archeology was by far the most frequent type of investigation in relation to both number of sites (104, or 51.2%) and 3,503 (80.8%) of human remains. For all four states taken together, salvage and excavation accounted for most of the sites investigated and the greatest number of human remains reported. In only one state, Kansas, was the investigation of a site a field school activity.

**Burial Context**

Another way of classifying the sites with human remains in Colorado, Kansas, Nebraska, and South Dakota is in relation to burial context. In Colorado, isolated burials and cemetery burials accounted for, respectively, slightly more than one-third (34.9%) and one-fourth (27.9%) of the sites, with the greatest number of individuals (59, or 47.6%) being recovered from cemeteries. In Kansas, burial mounds constituted the most frequent site context (53, or 33.5%, of the sites; 453, or 48.1%, of the individuals). Isolated burials (29, or 18.4% of the sites) and cemeteries (21, or 13.3% of the sites) were the next most frequent contexts, with cemeteries accounting for the next highest number of individual burials (218, or 23.2%). In Nebraska, the pattern was quite different, with sites and burials more evenly distributed among a variety of contexts. Isolated burials (55, or 17.7% of the sites) were the most frequent. Cemetery and ossuary contexts were next most frequent, and roughly equivalent in numbers of sites (46, or 14.8%, and 45, or 14.5%, respectively), and habitation areas and mounds, also equivalent in numbers of sites (35 [11.3%], and 34 [11.1%], respectively), had a somewhat lower frequency. Like Colorado and Kansas, cemeteries accounted for most of the individuals (874, or 34.0%), but unlike these states, ossuaries (840, or 29.3%), had the next highest frequency of individuals. As in Kansas, mounds were also a frequent context in Nebraska, accounting for 612 (21.3%) of the individuals. In South Dakota, mounds (53, or 26.1%) and cemeteries (44, or 21.7%) were the most frequent contexts, and cemeteries were the context of by far the most individual burials with 2,959 (68.3%). Mounds and habitation areas in South Dakota accounted for roughly equivalent numbers of individuals with 608 (14.0%) and 600 (13.8%) respectively, although mounds represented twice the number of sites, 53 (26.1%), compared to habitation areas with 26 (12.8%). Table 41 summarizes these data and shows that, for the four states taken together, mounds (19.9%), cemeteries (17.2%), and isolated burials (16.3%) were the most frequent site contexts, with cemeteries (50.9%), mounds (20.3%), ossuaries (11.3%), and habitation areas (9.2%) having the greatest number of individuals.

**Archeological Traditions and Variants**

The sites, together with the number of individuals represented by each and the number of these individuals that have been studied, can also be grouped in relation to the archeological traditions with which they are associated and, in some instances, with phases, complexes, and variants within particular traditions. In Table 42, Plains Village burials (that is, sites and the number of individuals associated with them) in Kansas, Nebraska, and South Dakota are grouped by archeological tradition. Central Plains tradition sites, 81 in Nebraska and 16 in Kansas, account for a fourth (26.4%) of the 5,871 individuals included in Table 42. Most of these (1,343)
were from Nebraska sites, and 61% of the Nebraska burials have been studied. More than four-fifths (83.3%) of the 210 individuals reported or recovered from Central Plains tradition sites in Kansas have been studied. The Coalescent tradition sites in South Dakota and Nebraska accounted for the highest percentages of individuals (69.5%), and most of these 3,450 (58.8%) were from 52 South Dakota sites. Nearly all (94.1%) of the South Dakota burials have been analyzed, as have 84.7% of the Nebraska burials.

The Middle Missouri tradition is represented by 22 burial sites in South Dakota, with 116 associated human remains, of which 89.7% have been studied. Two possible Oneota (or Central Plains tradition) sites are in Nebraska, and these yielded 94 individuals of which only a third (33%) have been analyzed. One Oneota site in South Dakota contained nine individuals, five of which have been studied, and also present in South Dakota in five undefined Coalescent or Middle Missouri sites were 20 individuals, more than half (60%) of which have been studied.

Table 43 shows the complex, focus, or phase of the sites in Kansas and Nebraska representing the Central Plains tradition. Of the 10 sites in Kansas, most (60.0%) represented the Upper Republican phase; however, most of the individuals came from two Smoky Hill phase sites. Of these 149 burials, 94% have been studied. In Nebraska, many of the sites (33.9% of 59) represented the Nebraska phase, as did most of the individuals (46.9% of 1,031). Five St. Helena phase sites yielded 29.6% of the individuals, and there were small percentages of individuals associated with 12 Itskari phase sites (6.2%) and 21 Upper Republican phase sites (7.2%). One individual came from one Smoky Hill phase site. Three-fourths (73.1%) of the individuals from the Nebraska sites have been studied.

Table 44 presents the number of Coalescent tradition sites and associated individuals in Nebraska and South Dakota in relation to archeological variants. In Nebraska, most sites (63.2% of 36) and individuals (79.5% of 629) represented the Disorganized variant. Nine sites (23.7%) and 115 individuals (18.4%) represented the Postcontact. In South Dakota, sites including both Extended and Postcontact variant burials, though only four of the 52, produced the greatest number of individuals (1,277, 37.0% of 3,450). Nearly half (46.2%) of the South Dakota sites and 1,192 (34.5%) of the individuals represented the Postcontact variant, and three sites and 499 individuals (14.5%) were classified as Initial variant. One site identified with the Disorganized variant contained 344 (10.0%) of the individuals.

High percentages of the individuals from both Nebraska and South Dakota sites (84.7% and 94.1%, respectively) have been studied. As Table 44 shows, the variants represented by the greatest number of individuals at the sites in these two states.
were the Postcontact (32.1%), Extended and Postcontact (31.3%), Disorganized (20.1%), and Initial (12.3%). Nearly all (92.7%) of the individuals from these sites have been studied.

In Table 45, South Dakota sites are further examined in relation to variants of the Middle Missouri tradition. Most sites (54.5% of 52) represent the Initial variant, as do most of the individuals remains associated with sites (49.1% or 116). The Southern Extended variant was represented by three sites (15.6%) and 27 individuals (23.3%). All 27 have been studied, as have 86% of the 34 Initial variant individuals.

In Table 46, several important South Dakota sites are grouped by variant and are shown in chronological order within each variant. The means by which these sites were established and the presence of burials with trade beads are also indicated. The chronological sequencing of these Coalescent tradition Ariska sites has provided the framework for a number of comparative studies (described in later sections) that have evaluated temporal patterning and variations in demography and skeletal traits. Extensive osteological research has focused on the skeletal collections from these seven cemeteries, which date from A.D. 1600 to 1832. The earliest sites (Mobridge, Rygh, Sully, and Swan Creek) represent late prehistoric or early protohistoric populations and contain few or no trade beads. In contrast, burials at later sites (Four Bear, Larson, and Leavenworth) that date well into the Contact period contain large quantities of European trade materials. Research has dealt with population-environmental relations and the developmental forces affecting the human skeleton.

During the Postcontact period, interdependent forces significantly affected Ariska health, demography, nutrition, and sociocultural structure. These forces included the introduction of infectious diseases such as measles and smallpox, acquisition of the horse, increased European presence, tribal migrations, and intertribal warfare. During the same time period, the Ariska experienced increased, as well as differential, morbidity and depopulation from disease, malnutrition, and warfare, changes in settlement and subsistence patterns, and changes in sociocultural deterioration. Thus, these collections provide samples with genetic continuity that show an increase in environmental stress as the Contact period proceeded.

Comparative analyses of skeletons from four archeological time periods (i.e., Late Prehistoric, Early Protohistoric, Late Protohistoric, and Historic) have produced data on rates of long bone growth, prenatal development, cortical bone thickness, pathology, and other variables. The ethnohistorical and archeological context of the samples provided a basis for hypotheses in relation to which the observed data could be interpreted. In addition, the sensitivity of specific osteological indicators of biological and cultural stress could be assessed as applied to the study of archeological populations.

Skeletal samples from South Dakota have provided one of the best opportunities in North America for osteological studies of the biological responses to stress during the Postcontact period. The Ariska collections represented by the seven sites listed in Table 46, together with others, include most of the early Postcontact period and were recovered during surveys of sites threatened by inundation following construction of dams along the Missouri River. Large-scale excavations of burials representing other ethnic tribes of the Plains were not conducted, although smaller collections that represent groups such as the Omaha, Ponca, and Pawnee,
provide some comparative data. For example, Reinhard et al. (1994) have conducted intensive osteological research on collections from two Omaha cemeteries in northeastern Nebraska (25DK2 and 25DK10) that were associated with the Big Village site (25DK5). The two cemeteries date to a period around 1811, as indicated by the abundance of introduced manufactured goods and the occurrence of datable silver ornaments (Table 47) (O’Shea 1984; O’Shea and Ludwickson 1992a).

Table 47. Burial Artifacts in Two Omaha Indian Cemeteries (from O’Shea and Ludwickson 1992:247).

<table>
<thead>
<tr>
<th>Class</th>
<th>25DK2 Grav.</th>
<th>%</th>
<th>Artifacts</th>
<th>25DK10 Grav.</th>
<th>%</th>
<th>Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>4</td>
<td>27</td>
<td>20,510</td>
<td>6</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Trade beads</td>
<td>11</td>
<td>73</td>
<td>28</td>
<td>23</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Iron</td>
<td>7</td>
<td>47</td>
<td>6</td>
<td>13</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Copper or brass</td>
<td>7</td>
<td>47</td>
<td>29</td>
<td>22</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Lead or pewter</td>
<td>3</td>
<td>20</td>
<td>8</td>
<td>12</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Silver</td>
<td>8</td>
<td>33</td>
<td>8</td>
<td>15</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Stone</td>
<td>4</td>
<td>27</td>
<td>19</td>
<td>19</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Bone</td>
<td>8</td>
<td>40</td>
<td>29</td>
<td>15</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Shell</td>
<td>4</td>
<td>27</td>
<td>16</td>
<td>19</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Artif. (excluding beads)</td>
<td>11</td>
<td>73</td>
<td>24</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Artif. (including beads)</td>
<td>12</td>
<td>80</td>
<td>33</td>
<td>97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subsistence strategies may have differed among Central Plains tradition populations (e.g., Upper Republican versus the Nebraska phase [Wood ed. 1969]). Furthermore, although the Middle Missouri and the Coalescent traditions relied on both bison hunting and corn horticulture, the extent to which the Mandan, descended culturally from the Middle Missouri tradition, were dependent on horticulture is not clear. The historic Arikara, cultural descendants of the Coalescent tradition, were major suppliers of maize to fur traders (Ewers 1954). Comparative reconstruction of subsistence strategies for the late archeological variants (i.e., Extended, Postcontact, and Disorganized Coalescent) suggest major effects resulting from Euro-American contact and climatic variation. Over the long term, events associated with these two external influences probably profoundly affected nutrition and, consequently, health.

Despite a mixed subsistence pattern, the historic Arikara experienced periods of severe undernutrition and, in fact, actual starvation of some individuals. Natural causes (such as drought, floods, late frost, and grasshoppers) resulted in occasional shortages (Hayden 1862; Will and Hyde 1917; Gilmore 1927; Abel 1939). Tabeau, for example, reported that floods had destroyed nearly all crops in 1860, causing famine (Abel 1939), and Weakly (1971) noted several periods of subnormal tree ring growth that probably reflected drought. Severe drought not only altered the carrying capacity of the prairie grassland, thus affecting the availability of bison (Wedel 1978a), but also reduced agricultural yield.

Although climatic conditions obviously had an impact on the populations of each archeological variant (e.g., the Tabeau example pertains to the Disorganized Coalescent), their results are most evident in the archeological record of Extended Coalescent populations. Small irregular clusters of houses characterized the Extended Coalescent settlement pattern. Cache pits were few and small, and refuse deposits were generally thin and lacking in cultural debris. Apparently, the settlements were occupied for short periods by groups experiencing marginal conditions.

The available evidence suggests that the great majority of the Extended Coalescent people lived a hand-to-mouth existence in typically small communities that had a high degree of geographic mobility. This pattern contrasts sharply with that of the other village complexes of the region, and there seems to be every reason to assume that it represented a response to the unfavorable climatic conditions of the Neo-Boreal episode (Lehmer 1970:128).

The cooler summers of the Neo-Boreal episode moderated somewhat during the first half of the eighteenth century (Baerreis and Bryson 1965). This change may have led to the establishment of larger, more nearly permanent Postcontact Coalescent villages (Lehmer 1970). Other correlations between cultural history and climatic stress could contribute to a better understanding and interpretation of archeological and osteological/dental dietary trends. The relationship is complex, however, and additional background work on climatic reconstruction is needed.
Factors related to initial European contact also affected subsistence, altering and frequently disrupting Postcontact and Disorganized Coalescent lifestyles. Such factors included: the introduction of acute infectious diseases (with particular impact in crowded, unsanitary conditions); the acquisition of horses; the introduction of a variety of trade materials; and the increased intertribal warfare (often a direct or indirect result of European influence and intervention). The semi-sedentary tribes experienced changes in patterns of settlement and subsistence, adverse sociocultural changes, higher levels of morbidity, and a decline in population size as a result of disease, malnutrition, and warfare. However, prior to A.D. 1750, the impact of European influences was not always negative. Archeological materials from this period suggest that Postcontact Coalescent villages in the Northern Plains were prosperous and stable (Lehmer and Jones 1968). With the acquisition of the horse, bison hunting ranges increased, as did the number of animals killed and the amount of meat transported (Holder 1970). The number and size of cache pits also increased, reflecting successful horticultural productivity (Lehmer and Jones 1968).

The village tribes traditionally followed a shifting settlement pattern associated with planting, harvesting, and summer and winter bison hunting (Hurt 1969). The nutritional deficiencies of maize, which is limited in protein, niacin, and the amino acid tryptophan, was offset by the regular use of legumes and heavy emphasis on bison hunting (Wedel 1986).

The ecological adaptation of the Plains Villagers obviously involved heavy dependence on both horticulture and the hunting of big game animals. This makes their ecosystem unique in Native North America. There were sedentary farmers in many other parts of the continent, but there is nothing to suggest a comparable reliance on hunting. Native North America had other big game hunters, but their economies lacked the agricultural aspect which distinguishes the Plains villagers. In terms of the subsistence base, the Plains villages resemble the mixed horticultural and pastoral economies of the Old World more closely than they do other cultures of native America. (Lehmer and Wood 1977:87)

Wedel (1986) describes techniques for processing and preparing food. Fresh meats were broiled, cooked over a spit, buried under a bed of coals, or, most commonly, boiled in pots in thick soups or stews. Dried meats, maize, beans, pumpkins, and other vegetables were also boiled. Maize was made into hominy, roasted in the husk, parched, or ground into meal with a mortar and boiled as mush or made into cakes and baked in the ashes or on hot stones.

Nomadic tribes like the Cheyenne and Sioux of the eighteenth and nineteenth centuries were hunters and gatherers who relied primarily on bison, although not to the exclusion of elk, antelope, deer, and a variety of small game (Wedel 1986). The prairie turnip, which was eaten raw or dried for later use in stews and soups along with meat, was the most important wild vegetable food. Maize was obtained through barter or by raiding the horticultural tribes. Other foods included ground nuts, roots, wild fruits and berries, Jerusalem artichoke, and sunflower seeds. This subsistence pattern, although often bountiful, included lean times as well.

To an even greater extent than with the seasonal bison hunters, these nomadic tribes underwent periods of plenty and scarcity, of adequate and inadequate nutrition, of more or less balanced and unbalanced diets. Lacking the food reserves stored underground used among the permanent villages to the east, the hunters had to adjust to even greater extremes in subsistence. The hardships arising from such a routine of living must have exacted a heavy toll in child mortality and among the women during the long hard winters and the rigorous 'starving time' of late spring. With the dried meat and stored vegetable reserves dwindling or used up, the game was still lean and scarce from the winter, the grass was not yet greening to feed the herds, and few spring shoots and roots were available for the people to gather to eke out the most meager survival diet. (Wedel 1986:200)

Seasonal migration and subsistence patterns were disrupted during the historic period, with food shortages becoming increasingly common in Disorganized Coalescent villages in spite of the greater mobility provided by the horse.

The food resources of the horticulturalists [sic] also reflected the changing conditions. There was the direct demand of the products themselves. In addition, the labor of the women was diverted into channels of hide working and the production of other commodities for the trade. The failure of food crops, any unusual demands on the stored surpluses, such as raids by nomads, would empty the storage cists of their irreparable surplus. The horticulturalists [sic] themselves now operated close to the subsistence minimum for their own needs (Holder 1970:117).

Interrtribal conflict caused food shortages. Wedel (1978b) described the problems experienced by the Pawnee under conditions of constant harassment. Villages were repeatedly burned during the absence of the tribe on bison hunts; women working fields at a distance were killed, molested, or abducted; and the crops were neglected as a result. Recurrent is the theme that fear of the raiders hampered cultivation, resulting in short crops or none at all. When village hunts were started early to make up with meats the food thus lost, improperly processed maize and beans moulded in the caches. The hunting parties were under frequent heavy attack, returning to the villages with limited meat and supplies and robés or none at all. In 40 years of reporting there is repeated mention of insufficient food in prospect for the winter (Wedel 1976:11).

The difficulties of the Arikara paralleled the situation of the Pawnee, as statements among the earliest documents (ca. 1795, see Beauregard 1912) indicate. Tabeau (Abel 1939) called the Leavenworth (39CO9) Arikara the serfs of the Sioux, as they had to endure the presence of the Sioux with little or no benefit therefrom. Throughout the trade period, the Sioux set trade prices to their own advantage, looted gardens, stole horses, and beat the women. After leaving, they wandered about keeping...
the buffalo away from the villages. Fear of the Sioux also inhibited the Arikara gathering of prairie turnips (Wedel 1978c).

Increased mobility, facilitated by the horse, occurred during the Historic period, which in the case of the Arikara was especially during the last quarter of the eighteenth century following the smallpox pandemic of 1781-1782 (Wedel 1955). Villages, which were normally occupied for 15 to 30 years (Holder 1970), changed location more frequently. Lehner and Jones (1968) and Wedel (1955) outline Arikara migration from one locality to another during the late 1700s and early 1800s. Some semblance of semipermanence was reestablished with the founding of the Leavenworth and Ashley Island villages in 1803: "Thirty-five years of wandering came to a halt" (Lehner and Jones 1968:94). However, Ashley Island was abandoned before 1811, and both Leavenworth villages were unoccupied for part of 1823-1824. Furthermore, the Arikara, numerically reduced by smallpox and hemmed in by the Sioux, had to give up tribal hunts as a regular practice by 1815 (Will and Hyde 1917). Previously, bison hunting had provided a substantial proportion of their food.

Studies by Bass and Phenice (1975), Palkovich (1978a), Williams (1994), and Owsley (1985-1989) are the sources of the demographic data used in the analysis of trends in mortality over time. To minimize interobserver error, broad age categories are used, and comparisons in the following analyses are of preadults (i.e., age < 15 years) and adults (> 15 years of age) representing the various regions and time intervals.

As Figure 51 shows, mortality among preadults was approximately 15% greater at Coalescent tradition sites in the Northern Plains than among the Archaic and Woodland samples of the Northern and Northeastern Plains. The two Central and Southern Plains sites had equivalent rates of preadult mortality, both being slightly higher than that of the Northern Plains Coalescent tradition samples. The differences between the Woodland and Coalescent tradition population samples were statistically significant ($X^2 = 53.3, df = 4, P = 0.0000$) and reflected mainly the difference in subsistence patterns, although increasing Euro-American contact and trade played a part. The high rate of preadult mortality at the pre-Columbian Southern Plains site suggests that increasing population density and the accompanying deterioration of sanitary conditions in a sedentary village over time also contributed to high preadult mortality. More data on both precontact and later populations are needed to clarify and substantiate the trends suggested in Figure 51.

The highest rates of preadult mortality occurred during the eighteenth century, with infant deaths accounting for much of the childhood mortality. There was an especially high mortality rate for perinatal infants at Larson, with 40.9% of the total sample dying between birth and one year (Owsley and Bass 1979).

Adult mortality also changed over time, as Figure 52 shows. The Northern Plains Woodland and Southern Plains prehistoric samples showed approximately equivalent rates of death for 15-

![Figure 51. Percent of individuals less than 15 years of age in Woodland and Plains Village mortality distributions.](image-url)
Sex Differences in Mortality

Mortality profiles of Coalescent tradition villagers from South Dakota are characterized by high percentages of deaths during the first year of life. Such phenomenal losses coincide with large numbers of fatalities of young adult females. At Larson (39WW2), for example, the mortality curve shows a slightly higher percentage of female deaths relative to males during the adolescent years (Owsley and Bass 1979). At age 15-19 years, both sexes experienced increased numbers of deaths, but the rise was especially marked for females. In fact, the actual peak in female mortality occurred during this interval, and the percentage remained higher than that of males through the early twenties. In a combined sample totaling nearly 1,500 individuals (Figure 53), 31.5% of the deaths occurred during the first year of life (Owsley and Bradtmiller 1983). The number of adult female deaths was greater than that of males between the ages of 15 and 30 years, especially during the teenage years (Figure 54).

This difference in sex-related mortality could be due to complications in pregnancy and childbirth, an association supported by analysis of the Larson burial configuration. In cases of multiple interments within graves, the only consistent pattern involves the pairing of infants with "young to middle-aged females, probably childbirth mortalities" (Bass and Rucker 1976). On a case by case basis, however, the presence of a newborn in the grave of an adult female does not necessarily reflect a maternal-infant relationship. Without genetic testing, definite familial association is confirmed only when fetal remains are found in utero. Such an event is rarely documented in archeological context on a worldwide basis, and this is also true in the Great Plains.

For the Arikara, Owsley and Bradtmiller (1983) have reported only two cases out of 221 females (0.9%) with fetal skeletal remains in the abdomen or pelvis. One individual from Larson was aged 17-19 years. The other, aged 30-34 years, from Mobridge (39WW1) was pregnant with twins. The femur lengths of the fetuses measure 31 and 33 mm, indicating that one twin was slightly larger than the other, a common occurrence in twins, and that the gestational age was about 24 weeks. An Omaha female, aged 15.5 to 17.5 years, from Big Village (25DK5) also died while pregnant (Reinhardt et al. 1994). Except for the increased risk incurred with a multiple pregnancy, examination of the skeletons did not provide conclusive evidence that these deaths were caused by the hazards of childbirth. However,
A review of the ethnographic literature for the Omaha, a group heavily involved in the fur trade, suggests that this commitment increased workloads for women (Reinhard et al. 1994). Females were largely responsible for household construction and maintenance, farming and gathering wild foods, raising children, cooking, processing foods and jerky for later use, preparation of hides and animal skins, making clothing, collecting firewood, and bead and quill work. Garden crops were raised for local consumption and for trading. Females were kept especially busy processing hides and skins. As noted by Fletcher and LaFlesche (1911:615), “one woman could scarcely give proper attention to all the skins secured by a good hunter; still less could she do the additional work occasioned by the pressure of trade.”

Reinhard et al. (1994) have demonstrated the effects of higher activity levels and physical strain on historic period villagers. Comparisons of small numbers of precontact St. Helena and postcontact Omaha and Ponca skeletons from northeastern Nebraska show more severe vertebral lipping (osteoophyosis), even in a younger aged sample, and higher frequencies of Schmorl’s depressions and spondylolisthesis in the later period. Moreover, vertebral pathology was more severe in Omaha and Ponca females than in males and spondylolisthesis was more common. Separate neural arches represent fatigue fractures in the spinal column, a condition partially triggered by stooped-over postures employed while scraping hides. Differences were also detected in dental attrition. Omaha females show increased anterior tooth wear relative to the prehistoric period and to contemporaneous males, a trait probably due to softening hides by chewing. “Such tasks placed women at greater risk to other dental diseases and hence, lowered the quality of their lives” (Reinhard et al. 1994:74). Traditional female tasks combined with labors associated with the fur trade led to more pronounced degenerative disease and dental pathology. Heavy work loads contributed to early deaths and perinatal mortality.

Perinatal Infant Mortality

Village populations experienced increased rates of morbidity and mortality during the Postcontact period. Prenatal growth was also adversely affected. Figure 55 shows the distribution of femur diaphysis lengths of 375 perinatal infant skeletons in four Arikara cemeteries (Owsley and Bradmiller 1983). Long bone lengths are linearly correlated with gestational age (from the last menstrual period) and can be used to estimate the age of the fetus or neonate. In this series, mortality was greatest for babies with femur lengths measuring 75 to 79 mm, the size of most term infants at birth, and the time of greatest neonatal mortality. Smaller infants, not found in utero, represent premature births or infants that were small for gestational age (SGA).

Comparative analysis of age-at-death distributions based on long bone lengths of nearly 500 Arikara infants dating from A.D. 1600-1733 and 1760-1835 shows a significant change during the Postcontact period (Owsley and Janz 1985). Differences in the cumulative proportions reflect higher percentages of smaller sized infants in the later period (Figure 56). The age frequency distribution for the earlier sample has its mode at 39 weeks, which compares favorably with the mean gestational age of live-
to delineate small age categories in order to test for microdemographic variation. The distributions for the three variants show significant heterogeneity along with some features in common. Following birth, secondary modes are seen in all samples between the age of 7 to 12 months. This period possibly indicates the introduction of whole foods, which could have resulted in gastrointestinal infections and increased mortality from weaning diarrhea. Mortality from one to two and a half years represents a period of generally declining mortality.

One of the most puzzling differences concerns rates of mortality at birth. Although both the Extended and Postcontact Coalescent samples show high mortality peaks at birth, the Disorganized Coalescent does not; but otherwise, it shows fairly high mortality throughout infancy. The small number of deaths at birth in the Disorganized variant, where one would expect high mortality, is of particular concern. This inconsistency could be a sampling effect, however, Disorganized Coalescent samples from Nebraska show a similar pattern. Perhaps this effect relates to the deaths of so many young adult females with concomitant loss of their potential fecundity.

**Longevity**

The adult mortality profiles for this region pertain primarily to young to middle-aged adults, as there are relatively few older individuals represented in the cemetery collections. Undoubtedly, elderly individuals were present, although their numbers may be slightly underrepresented either as a result of cultural practices involving burial in other locations or differential preservation of fragile (e.g., osteoporotic) remains. More likely, perhaps, is that the use of standard osteological criteria for age determination resulted in underestimation of the age of some older individuals in these population samples. (Underestimation can be a problem because the older an individual is, the more difficult the accurate determination of chronological age.)

Underenumeration of the older portion of a population could result from preferential mortuary treatment and special burial. However, there is little archeological or ethnohistorical evidence of alternative burial practices or locations (i.e., away from village cemeteries) for elderly individuals. Furthermore, bone preservation at many archeological sites in the Plains is quite good, permitting recovery of remains of both infants and the elderly.

The skeleton of one especially old individual is that of a woman recovered from a small mound near the Crow Creek village (39BF11) (Willey and Mann 1986). The burial dates to the Plains Village period, but it could represent either the Middle Missouri or Coalescent occupations of the site. Age was determined by using standard morphological criteria such as degenerative features in the pubic symphysis, nearly complete fusion of endocranial sutures, an obtuse (120°) gonial angle of the mandible, thin cranial vault, loss of trabecular bone and open medullary cavities in the humeri, and arthritic lipping of the right femoral head. The skeleton showed several pathological conditions in the spinal column that are related to advanced age, including anterior osteophytosis, severe osteoporosis, and marked spinal kyphosis. The bodies of the scapulae are thin,

![Figure 55. Femur lengths and gestational ages of perinatal infants from four Coalescent tradition sites: Larson, Leavenworth, Mobridge, and Sully.](image)

![Figure 56. Temporal comparison of gestational age frequency distributions of perinatal infant skeletons from Prehistoric and Historic Arikara sites in South Dakota.](image)

born infants. The mode for the later period is 38 weeks, and there is a higher percentage of individuals aged 34 to 38 weeks. In other words, perinatal infant skeletons show temporally patterned size differences with increased numbers of premature and SGA infants, as indicated by younger age assignments, in the later series. Mothers had a harder time carrying babies to term and full size. Overwork, malnutrition, and maternal illness are important factors in the etiology of premature deliveries and SGA infants.

While it is valid to expect that these samples might also show differences in older infant and childhood mortality rates, relatively little work has been done in this regard. Jantz and Owsley (1985) have examined mortality differences during the first two and a half years of life among Extended, Postcontact, and Disorganized Coalescent villagers from South Dakota. Dental calcification ratings for the deciduous teeth were used
pleated, and distorted, and the glenoid cavities show arthritic lipping. Other degenerative conditions attributable to old age occur in the distal ulnae and radii, which are bilaterally erubrated, and the navicular and first cuneiform of each foot, which are ankylosed. The ribs have a distorted "shepherd's crook" form as a result of severe osteoporosis and spinal kyphosis. Based on these traits, estimated age at death was well over 70 years. After Owsley examined more than 2,000 skeletons from Plains Village sites in South Dakota and Nebraska, he found no others, with the exception of one incomplete Crow Indian skeleton from Montana, that showed evidence of such an advanced age as this one from Crow Creek.

Determination of trends in population longevity through time and in different geographical regions in the Central and Northern Plains should receive a high priority in future research. At present, there is little information available on average life span, longevity, or number of elderly individuals in early populations. Few individuals of advanced age have been identified, and, in spite of the aforementioned caveats, this assessment probably represents reality for many Plains groups.

Epidemic Diseases, Tuberculosis, and Treponemal Infection

Epidemics

In the eighteenth and nineteenth centuries, epidemic diseases led to marked changes in the demographic and cultural patterns of Central and Northern Plains populations (Deetz 1965; Lehmer 1971, 1977; Oliver 1962; Ray 1974, 1976; Sharrock 1974). However, only recently have studies begun in the Plains on the effects of epidemic diseases on, for example, the size of Native American populations and the resulting cultural changes. The combined use of epidemic disease models, ethnohistorical literature, and archeological and osteological data are leading to a better understanding of the impacts of such epidemics. Historical circumstances associated with the more recent epidemics provide a foundation for analysis of osteologically derived demographic data.

In crowded living conditions, acute infections, specifically measles, smallpox, influenza, whooping cough, and cholera, had a generally devastating effect on Plains tribes, although rates of morbidity and mortality differed among them. These diseases are typically restricted to one species, produce immunity in survivors, and are not viable for an extended time outside the host, thus a large population is necessary for their maintenance and spread (Black 1966, 1975; Burnet and White 1972). In addition, for a disease to continue at full strength in a given community requires an ongoing influx of previously unexposed persons, such as newborns and migrants. Typically, there is initially a low incidence of such diseases, which is succeeded by periodic epidemics in which morbidity and mortality are high among those who are susceptible. In a small population under acutely crowded conditions, the infections will run their course and die out. However, with the addition of susceptible individuals, the same disease may begin anew. In communities such as those on the Plains, in which all individuals initially lacked immunity (so-called "virgin soil" populations), infectious diseases decimated tribal populations.

The episodic pattern is apparent in the incomplete ethnohistorical records for the eighteenth and nineteenth centuries. At least eight major epidemics of smallpox or measles are documented between the early eighteenth and mid nineteenth centuries, in 1735, 1750, 1780-1782, 1801-1802, 1831-1832, 1837-1838, 1845-1846, and 1856 (Deetz 1965; Truteau 1952; Spalding and Smith 1958; Teit 1903; Thompson 1915; Hyde 1959; Mitchell 1842; Stearn and Stearn 1945; Denig 1961; Chardon 1932; Moore 1846). Trimble (1989) compiled an extensive list of historically documented epidemics among Plains Indians and other North American groups. The lack of disease resistance and consequent high mortality during the smallpox pandemic of 1780-1782 suggest that many groups such as the Arikara, Mandan, and Hidatsa were "virgin soil" populations. This pandemic apparently originated in New Mexico and moved north among migratory hunters and villagers along the intertribal trade route (Lehmer 1977). A drastic reduction in population size of the affected tribes followed, with an accompanying decrease in the number of villages and amount of territory controlled. For example, estimates based on number of villages, number of houses per village, and average number of individuals per household suggest a pre-epidemic population amounting to roughly 19,000 (7,500 Arikara, 6,000 Mandan, and 5,500 Hidatsa). The postepidemic estimate for the three tribes is 5,950, a loss of 13,000 (68%) (Lehmer 1977). As Lehmer (1977) notes, these estimates are consistent with the data on mortality in the subsequent 1837-1838 epidemic. Prior to it, the estimated combined population of the three tribes was about 7,000, of whom 5,000 died (a mortality rate of 70%), with the greatest loss of life among the Mandan.

As an example of the consequent drastic reduction in the number of villages and amount of territory controlled, of 24 large, late-eighteenth-century Mandan and Hidatsa towns in a 60-mile area along the Heart and Knife rivers, only five small villages remained by the early 1800s, and none of these was more than 4 miles from the mouth of the Knife River (Lehmer 1977). The cultural impact, that is, the loss of specialists in crafts such as pottery and of tribal leaders, resulted in intratribal and intertribal disorganization and conflict, thereby affecting physical well-being, as reflected in osteological data.

An outbreak of smallpox that swept through the Central Plains in 1831 primarily affected the Pawnee of south-central Nebraska but did not reach the Northern Plains (Trimble 1992). More than 3,000 Pawnee (roughly 50% of the population) died. The subsequent passage of the Vaccination Act of 1832 resulted in inoculation of some 3,500 Iowa, Otoe, Pawnee, Teton, Yankton, and Yanktonai individuals (Trimble 1992, 1994). However, none of the groups along the Missouri River north of Fort Pierre (in mid South Dakota) were vaccinated.

The diffusion of epidemics of smallpox, measles, whooping cough, and other such infectious diseases along the Missouri River trench was directly related to patterns of social interaction, as only humans can carry and transmit the so-called "acute crowd infections." The ethnohistorical record shows three time periods associated with the introduction of such diseases. The first began
with European contact in the Southwest (ca. A.D. 1650) and ended about 1800. During this interval, the only acute infectious diseases to reach the Middle Missouri trench were smallpox and, possibly, measles (Stearn and Stearn 1945). The 1780-1782 epidemic was the most widespread and severe. The Northern Plains groups had relatively little contact with Euro-Americans at this time, although there was probably contact with the Arikara as early as 1714 (Berry 1978; Holder 1970). The first recorded visit to them by Euro-Americans was in 1738 (Lehmer 1971), and contact during the La Verendrye expeditions of 1742 and 1743 is well documented (Wood and Thiessen 1985). Osteological evidence shows that direct contact (i.e., Euro-Americans living in Arikara villages) with the Arikara occurred several decades earlier than the archival sources indicate, specifically at the Swan Creek site (39WW7) near the Grand River (Jantz and Owsley 1994).

Historical accounts also indicate that French traders were living among the Pawnee as early as 1700 and that a Frenchman lived in the Middle Missouri area in 1742 (Lehmer 1971; Nasarre 1952; Beauregard 1912; Wedel 1979a). Between 1742 and 1800, direct links were well-established, and many European traders resided in tribal villages (Lehmer 1971). Such contact undoubtedly facilitated the introduction of disease pathogens into the susceptible native population.

A second era of contact resulting from the extension of the Canadian fur trade into the Upper Missouri River Valley began in the late 1790s and ended about 1820. During this period, contact between Europeans and the horticulturists in the area increased. Wishart (1975) estimates that in 1807 there were fewer than 50 traders on the Upper Missouri but that by the 1820s there were nearly 1,000. (See Holder [1970] and Deetz [1965] for chronological reviews of the major expeditions into the Missouri Valley.) As a result, infectious diseases thus introduced devastated the non-immune populations.

The creation of permanent trading posts along the Upper Missouri in the 1830s marks the third period in which the transmission of epidemic diseases followed frequent contacts between the traders and the Native Americans who settled near these outposts. The smallpox epidemic of 1837-1838, which was spread along the Missouri River by personnel on the steamboat St. Peters, was catastrophic. In a seven-week interval, the disease was transmitted to nearly every tribe living in or near the Missouri Valley and, through intertribal contacts, became pandemic across the Plains (Trimble 1992). The more northern populations, which had been little affected by the epidemic in 1831, were especially hard-hit. Estimates of eyewitnesses suggest that 50% of the Arikara, Assiniboine, and Hidatsa, two-thirds of the Blackfeet, and 87% of the Mandan succumbed to the disease.

Using archival data on the 1837-1838 epidemic, Trimble (1979) developed an epidemiological paradigm incorporating such variables as disease ecology, human biology, culture, and environment to explain the spread of the disease and differential morbidity and mortality among tribes (Trimble 1992, 1994). Transmission of the disease was greater among the large, densely populated, semisedentary, horticultural communities, in which an infectious disease could sweep through an entire village in a matter of days, than it was among small, fragmentary, nomadic groups. The disruption of planting and harvesting schedules in a horticultural community led to nutritional stress and further mortality (Trimble 1992). In nomadic bands, the group dispersed into scattered family units (in effect, a kind of quarantine) to avoid the disease. Though not entirely preventing transmission, this strategy diminished the impact and often prevented the spread to other nomadic groups. The loss of all specialists in a craft vital to the well-being of a tribe was one of the most devastating impacts in sedentary communities, but was virtually unknown among nomadic tribes (Trimble 1992).

The substantial decrease in Plains populations, such as the Mandan, Hidatsa, and Arikara, changed the balance of power, with shifts in tribal allegiances and boundaries. Reduction in manpower resulted in inability to defend traditional territories. Villages became isolated garrisons that could not effectively defend themselves and their crops from the nomadic Sioux, who increasingly raided the horticultural settlements (Trimble 1994). The few surviving Mandan had to join with the Hidatsa and later the Arikara. Further, as the Mandan and Hidatsa were the principal brokers of the intertribal trading system on the Upper Missouri River, with their decline the system deteriorated and dependence on white traders and their goods increased.

From the ethnohistorical record and Trimble's (1979, 1992, 1994) epidemiological analysis of the 1837-1838 epidemic, it is evident that:

- Native Americans of the Plains had little or no immunity to smallpox and other such infectious diseases, thus exposure to these diseases resulted in massive epidemics and a drastic increase in morbidity and mortality among tribes of the Central and Northern Plains.
- Periodic outbreaks of disease occurred as individuals entered an affected group (though birth and migration).
- The greatest impact of infectious diseases occurred in densely populated horticultural centers, with small, scattered nomadic groups having higher rates of survival and less cultural disruption.
- The Vaccination Act of 1832 benefitted both sedentary and nomadic tribes in the lower Missouri River Valley, but the Arikara, Assiniboine, Blackfeet, Cree, Hidatsa, and Mandan were not vaccinated and were decimated by the epidemic of 1837-1838, with a consequent shift in the balance of power to nomadic tribes such as the Sioux, as well as increased intertribal strife and loss of cultural heritage.

Nineteenth century records on epidemics can contribute to the interpretation of osteologically derived demographic data on, for example, Arikara, Omaha, and Pawnee villages such as Leavenworth (39CO9), Big Village (25DK5, 25DK2, and 25DK10), and Pike Pawnee Village (25WT1). These communities experienced epidemics, and the mortality distributions undoubtedly include fatalities resulting from infectious diseases. Demographic evidence of these episodes should be reflected in high crude death rates, a large number of deaths during infancy, increased numbers of deaths during adolescence (a time in life when death was relatively uncommon), and short life spans. Leavenworth, for example, had a much higher crude death rate (65 per 1,000) than that (33 per 1,000) estimated for the earlier Extended/Postcontact Coalescent Sully site (39SL4) (Bass et al. 1971). Relative to Sully, the mortality distribution of a late eighteenth and early nineteenth century series (39CO9, 39DW2,
and 39ST215) shows higher percentages of deaths for all ages less than 20 years and proportionally fewer individuals older than 40 years (Table 48; OsWley 1992).

To assess the effects of earlier (seventeenth and eighteenth centuries) epidemics on Plains populations will require the combined approaches of archeology, skeletal biology, and historical demography. A central question yet to be resolved is whether the dramatic change in population size began—even in remote areas like the Plains—immediately after European settlement of the New World and far in advance of direct contact.

Ramenofsky (1987) used number and area of settlements and amount of roofed area to document changes in the population size in the Middle Missouri subarea. She argues that disease-induced depopulation began as early as the 1600s. Archeological evidence suggests a succession of early outbreaks of infectious disease during the seventeenth century. Thereafter, historical records provide evidence of epidemics in the late eighteenth and early nineteenth centuries.

Paleodemographic data exhibit particularly high mortality rates early in the seventeenth century, thus suggesting the early impact of epidemics on Extended and Postcontact Coalescent populations like Mobridge and Sully (OsWley 1992). These sites have multiple cemeteries, and those that date to the last half of the century have fewer subadults. These internal differences in demographic profiles are probably linked to early introductions of communicable diseases such as measles and smallpox. Individuals who survived the high mortality experienced by the first generation exposed to the disease were immune to subsequent outbreaks, leaving a smaller pool of susceptible hosts and, in effect, less mortality, at least in relation to a particular disease. In spite of these early epidemics, the Arikara population increased until late in the seventeenth century when disease pressure intensified again, accompanied by an escalation in the level of warfare. Irreversible population decline began about A.D. 1700, as evidenced in sites like Larson (39WW2) (OsWley and Bass 1979). Larson had an extremely high infant death rate and high rates of childhood mortality. The peak age of adult female mortality was between the ages of 15 and 19 years.

Archeological excavation of the Larson village produced evidence of depopulation. Successive rebuilding of earth lodges showed that the later structures had smaller perimeters and were reduced in size. In addition, the site had two fortification ditches, of which the inner one was stratigraphically more recent, thus reflecting a marked contraction in the size of the village. Larson eventually reached a threshold below which defense was no longer possible. It was destroyed by intertribal warfare and its inhabitants massacred (OsWley et al. 1977). For the Arikara, population decline continued through the eighteenth and nineteenth centuries, as illustrated by changes in age-specific mortality rates.

Efforts to identify and model the effects of infectious diseases, as manifested in the mortality distributions derived from Plains skeletal collections, have just begun. The well-documented, relatively large, Plains Village samples spanning the Prehistoric and Postcontact periods offer demographers one of the best available opportunities in North America for this type of analysis. Accumulating the data for these samples is a formidable task, and analysis will require sophisticated demographic models, simulations, and collaboration with paleodemographers to interpret distributions of age at death over time. The potential contribution of an osteological approach to the understanding of Plains paleodemography is yet to be realized, although the initial steps have been taken by Moorhead (1982), OsWley and Bass (1979), OsWley (1992), and Palkovich (1981).

Tuberculosis and Treponemal Infection

Although the existence of pre-Columbian tuberculosis has been documented for the Americas, this disease was probably relatively uncommon among early Plains populations. Examination of a large number of commingled skeletons from Crow Creek (39BF11) revealed no indications of skeletal tuberculosis in this Initial Coalescent village (Gregg and Gregg 1987; Zimmerman et al. 1980). Williams (1993, 1994) has identified six cases of probable tuberculosis from Woodland sites in the Northern Plains, including the DeSpigler site (39RO23) in South Dakota.

Tuberculosis was a major health problem during the Postcontact period. Palkovich (1978b) identified two individuals of 246 (0.5%) at Mobridge (39WW1) and eight individuals of 621 (1.3%) at Larson (39WW2) with skeletal lesions suggesting tuberculosis. The effect on morbidity and mortality would have been pronounced, as clinical studies reveal that only a small percentage of tuberculosis cases exhibit skeletal lesions (Morse 1969; Steinbock 1976). Palkovich (1978b) estimates that these counts represent only 2-3% of all cases. If relative numbers of diagnosed cases are a guide, and as Mobridge predates Larson, tuberculosis became more prevalent during the Postcontact period.

Cases of tuberculosis involving the skeleton show various loci of bone destruction—the spinal column, hip, knee, sacroiliac joint, and ankle. A case from the Larson cemetery, a young woman 16 to 18 years old, displays diffuse osteolytic lesions in the lower thoracic and lumbar vertebral bodies, the medial surface of the left innominate, one rib, both distal radii, and a proximal tibia (Gregg and Gregg 1987). The authors describe the case as follows (Gregg and Gregg 1987:60):

The extensive involvement of more distant parts of the skeleton indicates hematogenous dissemination of the infection throughout the victim's body. Death in this instance was from overwhelming general sepsis, with pulmonary or central nervous system complications being its most likely cause. Had this individual survived, the affected vertebrae would have collapsed with the resultant hunchback deformity. In addition, after vertebral collapse, she would very likely have been paralyzed in the lower part of her body due to spinal cord compression.

Burial 33a from Mobridge, Feature 302, provides a classic example of Pott's disease (spinal tuberculosis). This skeleton of a female, 18 to 22 years old, shows destruction of the bodies of lumbar vertebrae 2-5, which resulted in kyphosis of the spine. Bone lesions are also present on the left and right radii, one lower left and two lower right ribs, the proximal metaphyseal
regions of the right and left tibiae, and the left calcaneus and talus. Bony growths occur on the left innominate above the acetabulum. Changes in the pelvic area reflect the spread of the infection from the vertebral bodies through formation of an abscess that ruptured through the anterior longitudinal ligament of the spine into the psoas muscle, allowing migration of infection into the pelvis. Additional examples of psoas abscess infection of pelvic structures were found at Mobridge (Rose, Marks, and Kay 1984) and Leavenvor (39ST215) (Cleaves 1994) (Figure 57).

In 62.8% of the skeletons examined from the cemeteries of Mobridge, Sully (39SLA), Larson, and Leavenvor (39CO9), Kelley et al. (1994) reported periostal reactions on the visceral surfaces of the ribs as a result of pulmonary disease (Table 49). Site comparisons did not show a statistically significant difference in the percentages of individuals with rib lesions; however, there was a slight decrease in the number of ribs affected per individual in the Postcontact Coalescent samples. Most cases (87%) exhibited unilateral involvement and tended to be localized in the middle and upper ribs. Adolescents were most often affected, with a subsequent decline in incidence among young adults, followed by an increase among middle aged to older individuals. A majority of these cases can be attributed to pulmonary tuberculosis, as indicated by the relative ages of the individuals affected, the location, frequency, and appearance of the rib lesions, and the correlation of these results with current medical literature and the pathogenesis of tuberculosis versus other respiratory illnesses such as pneumonia.

Village density and close quarters inside an earth lodge facilitated the spread of tuberculosis among the semisedentary horticulturists. However, the equestrian nomads of the nineteenth century also suffered from this disease, as paleopathology cases found among the Crow from Montana (Figure 58) and the Sioux of South Dakota show. For example, skeletons of two males (NMMH 380272, 380273), 20-24 years of age, found on the Crow Creek Sioux Reservation (when exposed by erosion) show rib pathology caused by periostal inflammation. Although the frequency of pulmonary tuberculosis has decreased markedly during the twentieth century, it continued to be a serious health problem for some Native American groups in the Northern Plains (Gregg and Gregg 1987).

Yaws, pinta, venereal syphilis, and endemic syphilis (beja) are syndromes of the infectious disease known as treponematosis. The presence of treponematosis in prehistory has been widely debated, with the argument centering on whether the condition (primarily venereal syphilis) existed in the New World prior to European contact. However, advances in paleopathological analyses, resulting in criteria for identification of the skeletal changes related to the onset of the disease (Hackett 1976), and chemical testing have led to documentation of treponemal infection in the Americas prior to European contact (Baker and Armelagos 1988), thus resolving the controversy.

Reports of treponemal disease in the paleopathological literature are relatively rare for Plains groups despite historic accounts frequently mentioning the presence of venereal disease in tribes such as the Arikara (Abel 1939; Beauregard 1912).

<table>
<thead>
<tr>
<th>Site</th>
<th>Ribs Affected Mean N (SD)</th>
<th>Ribs Lesions /Individuals</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobridge F1</td>
<td>2.8 (0.82)</td>
<td>9/76</td>
<td>6.6</td>
</tr>
<tr>
<td>Mobridge F2</td>
<td>5.4 (3.40)</td>
<td>10/152</td>
<td>6.6</td>
</tr>
<tr>
<td>Sully A, D</td>
<td>3.4 (1.67)</td>
<td>9/128</td>
<td>7.0</td>
</tr>
<tr>
<td>Sully B, E</td>
<td>5.7 (4.46)</td>
<td>6/70</td>
<td>8.6</td>
</tr>
<tr>
<td>Larson</td>
<td>6.0 (2.73)</td>
<td>12/244</td>
<td>4.9</td>
</tr>
<tr>
<td>Leavenvor</td>
<td>4.0 (1.00)</td>
<td>3/70</td>
<td>4.3</td>
</tr>
<tr>
<td>All Sites</td>
<td>4.6</td>
<td>46/740</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Palkovich (1978b) reports treponemal-like infection in skeletons from Mobridge, thus offering support for the historic accounts of disease in the region following European contact. In their analysis of frontal bone lesions and the presence of treponemal disease in Native North Americans, Stewart and Quade (1969) report a relatively low frequency of frontal lesions in Plains skeletons. Only eight cases of cranial lesions were found in the six Postcontact Arikara sites included in their analysis (Mobridge [39WW1], Nortvold sites 1, 2, and 3 [39CO31, 32, and 33], Leavenvor [39CO9], and Sully [39SL4]), and of these most were single, small depressions of probable traumatic, rather than infectious, origin.

Several studies suggest that treponemal disease was present in prehistoric Plains groups. Bass and Phenice (1975) describe a possible case of acquired syphilis in an adult female from the Middle Woodland Period site of Swift Bird. The skeleton displayed osteomyelitis on both tibiae, the left fibula and ulna, the distal ends of both radii, and the left malar. Schermer et al. (1994) describe several examples of periostitis and osteitis resulting from probable treponemal infection in Woodland period sites in western Iowa, and Gregg and Gregg (1987) report possible evidence of syphilis in Initial Coalescent skeletons from Crow Creek. Tuross and Owsley (unpublished data) tested for treponemal antigens in a study of molecular preservation in ancient North American human bone. Their positive results confirmed the presence of treponemal infection in prehistoric South Dakota skeletons of the Woodland period.

The inability of anthropologists to recognize and report treponemal infection may have contributed to the apparently relatively low incidence in Plains samples. As techniques for identification of diseases in prehistoric populations develop, for example, chemical analysis of bone, there may be clearer evidence of treponemal disease among Plains Native Americans. Such has been the case in regard to the presence of other diseases in prehistoric samples.

Periostitis, Osteomyelitis, and Cranial Infections and Tumors

Skeletons from the Central and Northern Plains show low to moderate frequencies of periostitis and osteomyelitis. Periostitis involves inflammation of the periosteum as evidenced by the deposition of new bone on the outer surface of the affected element (Mann and Murphy 1990). Osteomyelitis, which results from an acute or chronic infection, affects both the marrow and the bone cortex. Inflammation accompanies the infection and
Figure 57. Osteolytic destruction of the acetabulum suggestive of tuberculosis (39ST215, NMNH 382742).

Figure 58. Localized, mild periosteal reaction on the visceral surface of a left rib consistent with pulmonary tuberculosis (Crow, HF5341).
causes bone remodeling and expansion (thickening of the cortex), often with a draining sinus (cloaca) (Mann and Murphy 1990).

The primary causes of these conditions are difficult to determine. Especially in the case of periostitis, many factors (for example, trauma, blood-borne infection, venous insufficiency, and scurvy) contribute to localized or widespread dissemination throughout the skeleton. The severity of the response offers clues to the origin, and data on frequency of occurrence provide a basis for generalizations about the health status of past populations.

Localized periostitis is a response to an injury (traumatic or infectious) or to a hematogenous infection originating in another part of the body. It is the most commonly recorded form of the condition in human skeletons from the Plains and is usually found on the diaphyses of the tibiae or fibulae, as indicated by the specific examples shown in Table 50. Bilateral, or widespread, periostitis, which reflects a systemic hematogenous infection or other systemic disease, has also been documented in skeletons from the Central and Northern Plains, although at a lower frequency than for localized periostitis. A characteristic of treponemal infection is periostitis accompanied by saber-shin morphology, and periostitis on the visceral surface of ribs is consistent with pulmonary tuberculosis.

Although routinely recorded in Central and Northern Plains skeletal series, rarely have researchers conducted systematic studies of periostitis and osteomyelitis to discover possible relationships to regional patterns of nutrition, types of trauma, or diseases. In one of the few analyses of this type, Zimmerman et al. (1981) dealt with Crow Creek skeletons and found an association of osteomyelitis and periostitis with trauma and nutrition. The authors attributed two cases of secondary osteomyelitis to nonlethal scarring. Two cases of pyogenic osteomyelitis, both in tibiae and fibulae of subadults, were also present in the Crow Creek series. In all, 148 cases of periostitis and accentuated periostial markings were noted (Zimmerman et al. 1981). These cases were widely disseminated throughout the skeletons, ranged from mild to severe, and were both generalized and localized. Some were associated with skeletal trauma. The most frequent sites were the proximal tibia, the distal and proximal femur, and the proximal humerus. Both children and adults suffered from the condition, and Zimmerman et al. (1981) indicate that the frequency and severity of periostitis among Crow Creek subadults were greater than in other Northern Plains skeletal series. They suggest that the relatively high rate resulted from disturbances in the nutrition or metabolism of these children.

Palkovich (1981) conducted an intrasite analysis of pathological conditions and noted differing levels of periostitis in earlier and later occupations of Mobridge. In skeletons from the earlier occupation (Feature 1), 1.2% of the individuals studied displayed localized periostitis. For Feature 2, the frequency was 6.1%, indicating a marked increase. Palkovich does not associate these cases with major systemic disease processes affecting the population but suggests instead that periostitis resulted primarily from localized infections.

Other studies, such as one conducted by Shermis (1969) on Leavenworth (39CO9) skeletal remains, found that a large number of the pathological conditions recorded (affecting 10.1% of the sample) were inflammatory, and half of these cases were osteomyelitis. However, Shermis failed to differentiate between cases of otitis media, mastoiditis, infections from intrusion of foreign bodies (such as gunshots), and localized periostitis. Thus, it is difficult to generalize with regard to causation or frequency of these conditions.

A major focus in paleopathology research on skeletons from South Dakota has been cranial pathology and anomaies. The biomedical research value of the William H. Over skeletal collection was first recognized by investigators from the Medical School and Speech and Hearing Clinic of the University of South Dakota. They examined crania in the Over collection for evidence of ear pathology, with special emphasis on otosclerosis and stapedial footplate fixation (Holzhuetter et al. 1965; Steele et al. 1965; Gregg et al. 1965; Gregg, Steele, and Holzhuetter 1965). Radiographic examination of the temporal bones showed high frequencies of abnormalities in mastoid air cell patterns, indicating significant amounts of infectious middle ear disease during childhood. Other studies reported on external auditory canal exostoses (Gregg and Bass 1970; Gregg and McGrew 1970), unusual osteolytic defects (Gregg, Steele, and Bass 1982), and tumors of the lacrimal gland (Gregg and Bass 1994).

Extreme cases of otitis media and mastoiditis have also been found in children from the Central and Southern Plains (Mann et al. 1994). One case, involving an Omaha child, 5 to 6 years old, from 25DK10, showed intramedullary lytic lesions in the ribs and long bones, resorptive lesions in the spine and both temporals, and porotic hyperostosis. Gross and radiographic examination of the lesions suggested that the child suffered from histiocytosis X, accompanied by otitis media and mastoiditis.

To adequately document the frequencies of specific types of bone pathology and corresponding changes in disease patterns over time and in different areas of the Great Plains will require much additional work. Although the studies mentioned have suggested patterns and relationships, many questions remain unanswered. A major limitation is the lack of standardization in data collection procedures and protocols, which would facilitate comparative analysis. Another problem is the lack of temporal depth, as most of the published reports concern Extended and early Postcontact Coalescent sites. In Circumcontact and Postcontact periods, shifts in the nature and incidence of disease often occurred, yet evidence of this transitional era and its disease impact as reflected in bone pathology has not been adequately examined through comparative studies of population samples from the Late Prehistoric through the Historic periods. Knowledge of prehistoric sites is especially limited. John Gregg initiated several studies that included prehistoric samples from the William H. Over series, with emphasis on cranial pathology and anomalies. The Initial Coalescent ossuary sample from Crow Creek (A.D. 1325) is the only large prehistoric collection that has been examined for cranial and postcranial pathology. For many of the Archaic, Woodland, Central Plains, and Middle Missouri tradition groups of this region, frequency data for periostitis and
<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>5AH244†</td>
<td>B2, Male, age 35-39</td>
<td>Mild periostitis on all major long bones</td>
</tr>
<tr>
<td>Middle Woodland/Central Plains</td>
<td>250D02†</td>
<td>S50, Adult</td>
<td>Possible healed infection on humerus &amp; femur</td>
</tr>
<tr>
<td>Middle Woodland</td>
<td>25DW233†</td>
<td>Mdl. F2, Bl. #122, Adult male</td>
<td>Periostitis on both tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mdl. F2, Bl. #123, Child</td>
<td>Periostitis on distal right humerus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mdl. #169 &amp; 170, Child, age 6-10</td>
<td>Periostitis covering shaft of humerus &amp; vertical border of scapula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, Bl. #169, Adolescent</td>
<td>Periostitis on anterior shafts of both tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, B2, #168, Adult female</td>
<td>Periostitis on anterior shafts of both tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, B3, #169, Adolescent</td>
<td>Osteomyelitis on both tibia, left fibula, distal ends of both radi, left ulna, &amp; left malar (possible acquired syphilis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, B3, Adult female</td>
<td>Periostitis on shafts of left tibia &amp; fibula, inner &amp; outer surfaces of left ilium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, B4, #171(1), Adolescent</td>
<td>Severe periostitis covering tibia, metatarsals, paraspinous, lateral border of left scapula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Md2, B5, #172, Adolescent</td>
<td>Periostitis on 2 left fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mdl. B2</td>
<td>Periostitis on right femur &amp; left fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mdl. B8</td>
<td>Localized periostitis on right fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mdl. B9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39DW240†</td>
<td>Adult</td>
<td>Large area of periostitis along anterior edge of midshaft of right tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diffuse osteitis over the midshaft of left fibula</td>
</tr>
<tr>
<td></td>
<td>140B401†</td>
<td>Female, age 25-30</td>
<td>Moderate to severe periostitis on posterior shaft on right femur along linea aspera</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periostitis on midshaft of right tibia</td>
</tr>
<tr>
<td></td>
<td>14PH4†</td>
<td>Exhibi T, #20b</td>
<td>Pinpoint osteitis at midshaft of right tibia; both femora also show reaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periostitis on right tibia</td>
</tr>
<tr>
<td></td>
<td>39LMS57†</td>
<td>Individ. 11, Adult male</td>
<td>Healed periostitis on right femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Osteitis on left fibula</td>
</tr>
<tr>
<td></td>
<td>39CH210†</td>
<td>Individ. 13, Subadult, age 14-17</td>
<td>Active thickened periostal bone on anterior medial surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individ. 15, Adult male</td>
<td>covering two-thirds of shaft of left tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individ. 37, Adult female</td>
<td>Nonspecific periostis on distal third of diaphysis of fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Distal half of right tibia symmetrically thickened with anterior bowing (saber shin); mild midshaft periostitis on left tibia with slight bowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scrofulous scar on posterior distal surface of right femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>above medial condyle (Inflammatory response to injury of medial head of gastrocnemius muscle)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scrofulous scar, same area as above but on left femur</td>
</tr>
<tr>
<td></td>
<td>39CA102†</td>
<td>Individ. 1, Male, age 21-46</td>
<td>Bilateral periostitis on posterior distal surface of both tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3 B1-112-4, Individ. 1, Male, age 21-46</td>
<td>Swelling osteitis of midshaft of right tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3 B1-112-182, Adult</td>
<td>Periostitis on both tibia (mild infectious response, well remodeled)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3 B1-112-370, Individ. 5, Male</td>
<td>Active periostitis on both tibia (possible treponema infection)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3 B1-112-4, Individ. 2, Male, age &gt;23</td>
<td>Mild periostitis on popliteal area of left femur &amp; on both tibia</td>
</tr>
<tr>
<td></td>
<td>39BR13†</td>
<td>Individ. 5</td>
<td>Subacute osteomyelitis on femur &amp; sequestrum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.3 B1-112-165, Individ. 5</td>
<td>Elliptical swelling on anterior crest of right tibia</td>
</tr>
<tr>
<td></td>
<td>39LM227†</td>
<td>B1, Male, age 25-35</td>
<td>Periostitis &amp; sequestron on right fibula, periostitis on both tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mild periostitis (hematoma) on right tibia</td>
</tr>
<tr>
<td></td>
<td>25CU287†</td>
<td>Adult male</td>
<td>Periostitis on proximal end of right tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periostitis on proximal femur</td>
</tr>
<tr>
<td></td>
<td>39WW203†</td>
<td>Bunal 1, Male, age 40-50</td>
<td>Severe periostitis on tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible osteitis on pubis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periostitis on tibia</td>
</tr>
<tr>
<td></td>
<td>39LA4†</td>
<td>F211, Bl. #25, Female, age 35+</td>
<td>Periostitis on distal right femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F320, B13a, #3300, Female, age 40+</td>
<td>Periostitis on midshaft of left fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F320, B11b, #342, Female, age 35+</td>
<td>Periostitis on humerus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F420, B1, #422, Female, age 50+</td>
<td>Small inflammatory lesion on posterior distal left femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F421, B23d, #5607, Child, age 4-5</td>
<td>Periostitis on right tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F421, B23h, #5612, Male, age 30</td>
<td>Mild periostitis on fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F421, B24, #5618, Female, age 40+</td>
<td>Mild periostitis on tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F421, B28, Child, age 2-3</td>
<td>Periostitis on proximal tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F101, B8a, Female, age 23-28</td>
<td>Scrofulous scar on posterior distal right tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F101, B12b, Adult male</td>
<td>Subperiostal thickening on right humerus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F101, B12b, Infant, age 1-5.2-5</td>
<td>Periostitis on tibia fragment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F201, Biegshka, Male, age 35+</td>
<td>Periostitis on long bones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F201, B28a, Male, age 45+</td>
<td>Periostitis on left tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F201, B28a, Female, age 45+</td>
<td>Periostitis on tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, B21a, Male, age 20-22</td>
<td>Mild periostitis on fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, B21d, Male, age 20-24</td>
<td>Mild periostitis on tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, B21d, Female, age 40+</td>
<td>Mild periostitis on fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, B27e, Female, age 19-21</td>
<td>Severe fracture of right rib 4 with scapular periostitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, B28e, Female, age 19-21</td>
<td>Mild periostitis on proximal tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F302, C33b, Female, age 19-21</td>
<td>Moderate periostitis on left tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F39WW1†</td>
<td>Osteomyelitis on right femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F39WW7†</td>
<td>Periostitis (2 small patches) on midshaft of left fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F39CO34†</td>
<td>Localized area of healed periostitis on medial aspect of distal tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed periostitis on left tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periostitis on tibia &amp; fibula; osteomyelitis on dorsal left pubic symphysis, ramus, dorsal sacrum, &amp; transverse processes of L5, T11-12, &amp; neural spines of T10-11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderate periostitis on popliteal area of posterior femur; mild periostitis on right tibial tuberosity</td>
</tr>
</tbody>
</table>
Table 50, cont.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postcontact Coalescent, cont.</td>
<td>39ST216a</td>
<td>NMNH #381162, Adult female</td>
<td>Severe periostitis on distal femur (possible septic arthritis)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NMNH #381176, Male, age 23</td>
<td>Periosteal inflammation of the distal third of humerus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NMNH #211158B, Female, age 20-23</td>
<td>Superoistelial hematoma on femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NMNH #211158F, Female, age 19-21</td>
<td>Possible osteomyelitis on distal third of first metatarsal</td>
</tr>
<tr>
<td>Disorganized Coalescent</td>
<td>36CO86</td>
<td>Child, age 2-5</td>
<td>Extensive reactive bone on left humerus, right scapula, left clavicle, &amp; left scapula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sk. 92, Subadult, age 12</td>
<td>Pyogenic activity on right ilium &amp; proximal femur; large areas of reactive bone with several cloaca (involution) on anterior surface of femur (i.e., new bone created during repair following acute inflammatory disease)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sk. 202, Subadult, age 12-17</td>
<td>Osteomyelitis of the tarsal bones (2 calcanei, 1 talus) Healed osteomyelitis on distal third of right femur; active osteomyelitis on distal right fibula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sk. 228, Male, age 18-30</td>
<td>Osteomyelitis of ribs with swelling &amp; perforations; pathologic fracture &amp; dissemination to spine of right scapula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sk. 87, Female, age 16-30</td>
<td>Active periostitis on both femora, tibiae, humeri, ulnae, &amp; radii</td>
</tr>
<tr>
<td>Unknown</td>
<td>5MR32</td>
<td>BI, Female, age 45-55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39BK9001a</td>
<td>indiv. 1, 54:01, Male, age 25-30</td>
<td></td>
</tr>
</tbody>
</table>

Hummert (1982)  
3 Parker (unpublished data)  
3 Bass and Phenece (1975)  
4 Bass (1987)  
6 Bass (n.d.)  
6 Williams (1988)  
6 Wicklund (n.d.)  
6 Williams (1988)  
6 O'Shea and Bridges (1989)  
6 Owley (unpublished data)  
6 Greg (unpublished data)  
6 Smith and Jantz (1972)  
6 Kelley (unpublished data)  
6 Rose et al. (1984)  
6 Willey et al. (1987)  
6 Bellande and White (n.d.)  
6 Cleaves (1994)  
6 Sharps (1969)  
6 Scott and Birkedal (1972)

Osteomyelitis are not available. The compilation of these data should be based on detailed skeletal inventories so that precise counts can be generated by age, sex, and cultural context for comparative analysis.

Cribra Orbitalia and Porotic Hyperostosis

Dietary disorders can result in pathological changes in the skeleton. Such changes often are limited to the skull and are characterized by lesions affecting the outer and inner tables of the parietal, occipital, and frontal bones and the superior orbital plates. Porotic hyperostosis appears as osteoporotic pitting and thinning of the outer table of the frontal, occipital, and/or parietals, accompanied by hypertrophy, or expansion of the cranial diploe ("hair on end" effect). Cribra orbitalia is osteoporotic pitting on the superior orbital plates and often occurs in combination with porotic hyperostosis (Mann and Murphy 1990; Orttner and Putschar 1981). Although iron deficiency anemia is most often cited as a cause of porotic hyperostosis and cribra orbitalia (Steinbock 1976; Stuart-Macadam 1985, 1987), the etiology of the two conditions is not yet fully understood. Diseases other than anemia that have been associated with this pathology include rickets, toxic disorders, and infection (Lallo et al. 1977; Mensforth et al. 1978; Orttner and Putschar 1981). In general, any condition leading to a vitamin or mineral deficiency, and in turn causing nutrient loss, could be a cause.

Evidence of cribra orbitalia in Central and Northern Plains skeletons is limited. Individual descriptions of the condition for skeletons dating from the Woodland through the Disorganized Coalescent periods appear in Table 51, and frequency data compiled for a few sites in South Dakota are presented in Table 52. Variation in scoring methods and interobserver error complicate assessment of the frequency of the condition in Plains samples. For example, in frequency data compiled for Mobridge (39WW1 F01, F02, F03), three researchers each reported different frequencies of cribra orbitalia for a single site (Table 51).

Table 51. Frequencies of Cribra Orbitalia in Central and Northern Plains Skeletal Series.

<table>
<thead>
<tr>
<th>Site</th>
<th>With Cribra Orbitalia</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Woodland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39RO23</td>
<td></td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>39CL2</td>
<td></td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Late-Late Woodland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39BF11</td>
<td></td>
<td>392</td>
<td>4.8</td>
</tr>
<tr>
<td>39WW1</td>
<td></td>
<td>55</td>
<td>2</td>
</tr>
<tr>
<td>39WW1 F01</td>
<td></td>
<td>122</td>
<td>7</td>
</tr>
<tr>
<td>-F02</td>
<td></td>
<td>33</td>
<td>1</td>
</tr>
<tr>
<td>-F03</td>
<td></td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>39WW1 F01</td>
<td></td>
<td>163</td>
<td>0</td>
</tr>
<tr>
<td>-F02</td>
<td></td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>Postcontact</td>
<td></td>
<td>62</td>
<td>1.2</td>
</tr>
<tr>
<td>39DW2</td>
<td></td>
<td>41</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Greg and Greg (1987)  
3 Rodriguez (n.d.)  
3 Palkovich (1981)

Although the data are limited, some patterns are evident. Reported data concur with previous findings on the prevalence of cribra orbitalia in young individuals (Mann and Murphy 1990). As Table 53 shows, in Plains skeletons cribra orbitalia occurs most frequently in children or young adults, which is consistent with iron deficiency being most common in children and women of child-bearing age.

The frequencies of cribra orbitalia in Central and Northern Plains skeletal series also suggest a temporal trend from rare examples of the condition in early Woodland peoples to increasing frequencies in Initial and Postcontact Coalescent periods in South Dakota. In an analysis of Archaic and Woodland skeletons from the Northern Plains, Williams (1994) reports low frequencies of cribra orbitalia in the early series and proposes a correlation of the condition with the emergence of horticulture in the region. The transition from a hunter-gatherer mode of subsistence, affording a varied diet, to horticulture and the consumption of corn, would be conducive to an increase in nutritional stress, manifested, for example, in iron deficiency anemia, as corn, with its high phytic acid content, inhibits the absorption of iron (Mollgaard et al. 1946). To correlate the incidence of cribra orbitalia with subsistence patterns and...
Table 52. Selected Cases of Cribra Orbitalia in Central and Northern Plains Skeletal Series.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>39LN109</td>
<td>Ind. 1, B6, 9-20-60, Child, 10-12 years</td>
<td>Bilateral cribra orbitalia (slight)</td>
</tr>
<tr>
<td>Late Woodland</td>
<td>39RO233</td>
<td>Juvenile</td>
<td>Slight cribra orbitalia</td>
</tr>
<tr>
<td>Central Plains</td>
<td>14WY7</td>
<td>Lab. 10, Child, age 9 mos.</td>
<td>Cribra orbitalia with beginning porotic hyperostosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 11, Child, age 3 years</td>
<td>Cribra orbitalia with probable porotic hyperostosis (hydrocephalus?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 12, Child, age 4 years</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 21, Child, age 6 mos.</td>
<td>Beginning cribra orbitalia and porotic hyperostosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 31, Child, age 3-7 years</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 47, Child, age 4 years</td>
<td>Severe cribra orbitalia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 48, Child, age 5-6 years</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 53, Child, age 3 years</td>
<td>Beginning cribra orbitalia with slight cranial osteoporosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab. 54, Child, age 18 mos.</td>
<td>Cribra orbitalia with beginning porotic hyperostosis</td>
</tr>
<tr>
<td>Extended Coalescent</td>
<td>39WW203</td>
<td>Lab. 61, Child, age 7 years</td>
<td>Small area of healed cribra orbitalia</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39SL48</td>
<td>Exhibit 2 #29</td>
<td>Bilateral cribra orbitalia (healed)</td>
</tr>
<tr>
<td>Coalescent</td>
<td>39WW109</td>
<td>F20B B21 #9346, Subadult, age 12-14</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td>Postcontact Coalescent</td>
<td>28PT1</td>
<td>F20B B11b, Child, age 3-4 years</td>
<td>Mild cribra orbitalia</td>
</tr>
<tr>
<td>Disorganized Coalescent</td>
<td>28PK17</td>
<td>Oc 12W, Infant, age 6 mos.</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td>Unknown</td>
<td>14RW310</td>
<td>Sk. 19, Child, age 2-3 years</td>
<td>Cribra orbitalia</td>
</tr>
<tr>
<td></td>
<td>26CC62</td>
<td>UBS 1669-03, Female, age 36-44 years</td>
<td>Cribra orbitalia (healing)</td>
</tr>
</tbody>
</table>

Nutritional health of Plains groups from the Archaic through the Historic periods will require additional data and systematic analyses. These conditions are less prevalent in Plains Indians than is the case for many groups in the Americas.

Congenital and Developmental Anomalies

The types of anomalies present in Plains Native American skeletons are similar to those found in other skeletal series and contemporary populations. The incidence of such abnormalities has probably not changed appreciably over the past millennium (Gregg and Gregg 1987). In their overview of congenital and developmental disorders, Gregg and Gregg (1987) list the common loci for human skeletal abnormalities, viz: the skull, spine, sacrum, hip, hands, and feet. Congenital or developmental anomalies recorded in Plains skeletons at these and other loci included macrocephaly, microcephaly (and various degrees of craniostenosis), abnormalities of the basioccipital and craniovertebral junction, facial maldevelopment, and disorders of the axial skeleton (some of which [e.g., spondylolisthesis] are discussed in other sections of this report). Anomalies of the hands and feet are rarely documented as a result of circumstances of field recovery, mortuary practices, and poor preservation.

Cranial Abnormalities

The most fully described of the congenital and developmental abnormalities documented in Plains skeletons are those of the cranium. Such abnormalities (not including facial maldevelopment or basioccipital anomalies), although rare, occur in both prehistoric and historic series (Table 54). Gregg and Gregg (1987) report five cases (two adults and three children) of macrocephaly (abnormally large skull) among 2,500 crania from the Dakota Territory, all of which displayed supranormal intracranial capacity. One of the two adults showed evidence of gigantism, which would have resulted in a larger than normal cranial capacity consistent with enlarged elements of the postcranial skeleton. The provenance of neither of the adult skeletons is known, thus their ethnic affiliation is also unknown.

The archeological context of the three children with forms of macrocephaly, reported by Gregg and Gregg (1987), is known. One child is classified as hydrocephalic, a condition that can be congenital or can result from, for example, brain tumor, meningitis, or injury with a subsequent buildup of cerebrospinal fluid and intracranial pressure (Gregg and Gregg 1987). The specific cause in this child and the other two children with macrocephaly could not be determined, but severe forms of the condition prevent survival beyond early childhood. The hydrocephalic child did not survive past seven years of age.

Macrocephaly, or premature closure of the cranial sutures resulting in an abnormally small skull, also occurs in Plains skeletons. A child 1.5-2.5 years old from the Sully Site (39SL4) in South Dakota shows a severe form of microcephaly (Figure 59), with near complete closure of all cranial sutures. This child undoubtedly died from complications related to the condition.

Less severe forms of craniostenosis (premature suture closure) reported for the region include a clear case of scaphocephaly (Eiseley and Asling 1944) in an adult female who was approximately 30 years old at death. Unlike the microcephalic child, or instances of oxycephaly (premature closure of both the coronal and occipital sutures), scaphocephaly results from premature closure of only the sagittal suture, which leads to an antero-posterior rather than transverse increase in the size of the skull. The subsequent narrowing of the skull results in a lack of parietal tuberosities. In spite of these changes, a scaphocephalic skull is bilaterally symmetrical and shows less extensive deformation than do oxycephalic skulls.

Postcranial Abnormalities

Among other congenital and developmental deformities that are not life-threatening and that have been found in Central and
Northern Plains skeletons are bifurcated ribs and synostoses of the proximal radius and ulna and the distal tibia and fibula. Gregg and Gregg (1987) describe a number of these conditions.

In general, of the postcrania1 anomalies recorded in Central and Northern Plains skeletons, few were life-threatening. Some would have been accompanied by cosmetic defects or minor physical disabilities. Individuals with these kinds of disorders survived well into childhood and even to adulthood. Babies with serious birth defects did not survive, either because of intrinsic complications or the practice of infanticide when infants were born with physical deformities (see, for example, Morton 1839).

**Spina Bifida**

Spina bifida is an anomalous condition of the lower spine involving incomplete closure of the neural canal. The condition is most common in the sacrum and occurs in varying degrees ranging from incomplete fusion of several spinous processes (spina bifida occulta) to complete division of the spinous processes resulting in the absence of the vertebral arch (complete spina bifida or spina bifida cystica) (Ortner and Putschar 1981). Severe forms of the condition are noticeable at birth and result in the protrusion of the spinal cord or meninges through the vertebral defect. The occult form of spina bifida is not visible at birth and has minimal to no effect on the individual, allowing normal survival into adulthood. It is this form of the condition that is usually scored in analyses of skeletal pathology in archeological series.

Numerous studies of skeletal material from archeological contexts report the presence of spina bifida. There is, however, no consensus about what constitutes spina bifida occulta versus a sacral hiatus (Barnes 1994). Because of the lack of consensus on the scoring criteria for spina bifida occulta, comparisons of

| Table 53. Selected Cases of Ectocranial Porosis/Porotic Hyperostosis in Central and Northern Plains Skeletal Series. |
|---|---|
| **Variant** | **Site** | **Specimen** | **Description** |
| Woodland (7) | 39HL4 | 6.6 82-13, Individual 1 | Mild ectocranial porosis on occipital, right parietal, & posterior frontal |
| Late Woodland | 39RO23 | Juvenile | Mild ectocranial porosis on parietals & occipital; slight bossing and "hair on end" effect |
| Late Woodland or Initial Middle Missouri | 39BK20 | 6.4 92-10, Individual 1 | Porotic hyperostosis |
| Woodland or Plains Village | 39HU205 | Adult female | Moderate to severe ectocranial porosis on occipital, parietals, & frontal |
| Central Plains | 14WY7 | Lab. 8, Child, age 5 years | Bilateral porotic pitting on cranium |
| | | | Severe ectocranial hyperostosis with premature synostosis of coronal, sagittal & occipital sutures |
| | | | Beginning porotic hyperostosis |
| Plains Village | 39BR13 | | Porotic hyperostosis with cribra orbitalia (probable hydrocephalus) |
| | | | Varying degrees of porotic hyperostosis on several skull fragments |
| Extended Coalescent | 39HU5 | | Slight, healed ectocranial porosis on occipital & frontal |
| Extended/Postcontact | 39WW203 | | Porotic hyperostosis and beginning cribra orbitalia |
| | 39SL4 | | Healed porotic hyperostosis |
| | | | Porotic hyperostosis |
| | | | Healed ectocranial porosis |
| | | | Healed porotic hyperostosis |
| | | | Beginning porotic hyperostosis |
| | | | Small area of healed porotic hyperostosis on occipital |
| | | | Ectocranial hyperostosis along midline on parietals & frontal |
| | | | Ectocranial porosis along midline on parietals & frontal |
| | | | Porotic hyperostosis on parietals near bregma |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Cranial porosity, "hair on end" effect |
| | | | Healed porotic hyperostosis on parietals with endocranial reaction |
| | | | Mild porotic hyperostosis on parietal |
| | | | Extensive porotic pitting on frontal, parietals, & occipitalis |
| | | | Porotic hyperostosis on parietals & occipitalis |
| | | | Porotic pitting on parietals |
| | | | Ectocranial porosis along posterior midline of cranium |
| | | | Ectocranial porosis on frontal at glabella |
| | | | Ectocranial porosis |
| | | | Healed ectocranial porosis |
| | | | Healed ectocranial porosis |
| | | | Beginning porotic hyperostosis |
| | | | Porotic hyperostosis on parietals near bregma & on frontal |
| | | | Spongiform reaction along midline of parietals and frontal |

---

1 Williams (1993)
2 Williams (1994)
3 Gregg and Gregg (unpublished data)
4 Rose et al. (1984)
5 Barnes (1995)
6 Williams (1985)
7 Willey et al. (1987)
8 Kelley (unpublished data)
9 Owsley (unpublished data)
10 Sherwin (1989)
Table 54. Macrocephaly and Craniosynostosis in Central and Northern Plains Skeletal Series.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>14DP9003</td>
<td>Skull #3934, Female, age 30 years</td>
<td>Complete synostosis of sagittal suture; characteristic of scaphocephaly</td>
</tr>
<tr>
<td>Late Woodland</td>
<td>39HT2</td>
<td>Child, age 3-4 years</td>
<td>Possible macrocephaly with cranial capacity of 1335 cc</td>
</tr>
<tr>
<td>Central Plains-Middle Ceramic</td>
<td>39RO23</td>
<td>Pit-40, Child</td>
<td>Skull vary thin with premature closure of sagittal suture</td>
</tr>
<tr>
<td></td>
<td>14WY7</td>
<td>Lab 8, Child, age 5 years</td>
<td>Premature synostosis of coronal, sagittal, and occipital sutures;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 11, Child, age 3 years</td>
<td>Probable case of hydrocephaly with cribra orbitalia and porotic</td>
</tr>
<tr>
<td>Plains Village</td>
<td>39HU5</td>
<td>Ind. 3, 10.71.5, Spec. 20, 21, Young adult</td>
<td>Hydrocephalic</td>
</tr>
<tr>
<td>Extended/Postcontact Coalescent</td>
<td>39SLA2</td>
<td>F421 B119e, #9928, Child, age 6-7 years</td>
<td>Craniosynostosis of posterior portion of right squamosal suture</td>
</tr>
<tr>
<td></td>
<td>39SLA1</td>
<td>RBS #5683, NMNH #381373, Child, 1.5-2.5 yrs</td>
<td>Hydrocephalic; complete closure of all cranial sutures</td>
</tr>
<tr>
<td>Postcontact Coalescent</td>
<td>39ST215</td>
<td>NMNH #382744, Child, age 10 years</td>
<td>Premature closure of sagittal suture; scaphocephaly</td>
</tr>
<tr>
<td></td>
<td>39WW2</td>
<td>F201 B100, Child, age 4 years</td>
<td>Macrocephaly with cranial capacity of 1335 cc</td>
</tr>
<tr>
<td>Disorganized Coalescent</td>
<td>29HW1</td>
<td>B185, Child, age 2-3 years</td>
<td>Craniosynostosis of posterior right squamosal, parietal, mastoid,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and occipito-mastoid sutures</td>
</tr>
</tbody>
</table>


Figure 59. Superior view of cranial vault of a child (39SLA4, NMNH 381373) aged 1.5-2.5 years, with premature closure of the coronal, sagittal, and lambdoidal sutures (craniolength = 125 mm; cranial breadth = 102 mm; cranial circumference = 375 mm)

Table 55. Spina Bifida Occulta in Plains Village Skeletal Series.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Individuals</th>
<th>with SBO</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Plains Tradition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebraska Phase</td>
<td>25DK13</td>
<td>44</td>
<td>22</td>
<td>50.0</td>
</tr>
<tr>
<td>Initial Coalescent</td>
<td>39BF11</td>
<td>396</td>
<td>42</td>
<td>10.6</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39SLA4</td>
<td>100</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>Coalescent</td>
<td>36WW1</td>
<td>161</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Postcontact Coalescent</td>
<td>39WW2</td>
<td>75</td>
<td>7</td>
<td>9.3</td>
</tr>
</tbody>
</table>


The frequency of the condition in archeological samples are difficult at best and can lead to extreme variation in the frequency of occurrence among samples and erroneous interpretations. The wide variation in the incidence of spina bifida occulta recorded for Central and Northern Plains skeletal series shown in Table 55 provides an example. Although some degree of variation in frequency is expected as a result of a combination of genetic and developmental factors, the extremely high incidence shown for 25DK13 (50%) probably results from interobserver differences in the identification of the condition.
Wolley (1988) sought consistency with previously conducted studies of spina bifida in Plains skeletons by following the criteria outlined by Bradtmiller (1984), which specified that failure of closure above the union of the third and fourth sacral vertebrae is scored as spina bifida occulta. Wolley interpreted this criterion as including cases of failure of closure among three even when closure was complete at segments four or below. Bradtmiller’s definition did not mention failure of closure of the superior sacral segments and probably limited his samples to those exhibiting an open spinal canal from the inferior segments of the sacrum upward.

Frequencies of spina bifida occulta in different groups as determined by a single observer are useful for comparative studies, for example, Bradtmiller’s (1984) analysis of this defect in Arikara skeletons from the Larson (39WW2) and Sully (39SL4) sites in South Dakota. The results of his analysis show that individuals from Larson have a 7.3% greater incidence of the condition than those from Sully. In addition to the difference in the frequency of spina bifida occulta in the two skeletal series, Bradtmiller also records differences in the incidence by age: all Larson cases occurred in individuals under 39 years of age, and the two cases from Sully were in individuals in the third and sixth decades. Bradtmiller cites these differences in frequency and in age as evidence that the populations of Sully and Larson are biologically distinct (assuming that these samples accurately represent actual population frequencies and that spina bifida is a congenital anomaly, with a genetic/biological factor playing a large part in the frequency of occurrence).

Other studies (e.g., Wolley 1988, 1992) have attempted to equal the condition with nutritional deficiencies. Wolley (1988) examined the frequency of spina bifida and its relationship to diet and subsistence strategies in skeletal series from Nebraska and South Dakota. Her study, based on evidence that suggests spina bifida is a congenital anomaly resulting from maternal zinc deficiency, uses chemical, archeological, and ethnographic evidence to reconstruct the diets of groups from sites 25DK13, 39BF11, 39SL4, and 39WW1. She calculated the risk of zinc deficiency in hunter-gatherers versus horticultural populations. As the protein consumption in hunter gatherers is higher than that of horticulturists, the former groups tend to have a lower risk for zinc deficiency and a correspondingly low risk for spina bifida. Samples from mixed economies are moderately at risk for zinc deficiency, and groups engaged in intensive agriculture show the highest risk. The results of Wolley’s study supported her theory that groups with a higher risk of zinc deficiency display a higher incidence of spina bifida; however, the study is inconclusive because of the differences in scoring criteria, which resulted in a frequency of 50% at site 25DK13. Further study of the possible relationship between nutritional deficiencies and spina bifida in archaeological populations is required.

Trauma

Analysis of osseous defects and their frequency by age, sex, and location on the skeleton provides evidence of the physical trauma experienced by a population. Such data, in turn, lead to a better understanding of cultural and social developments throughout a geographic region and over time.

A review of the current literature on Native American skeletons from South Dakota, Nebraska, and portions of Colorado and Kansas showed low frequencies of traumatic defects in nearly all Plains series. However, there are but few systematic studies of antemortem injury for this region, and even fewer attempts to combine the collected data for a holistic approach to trauma in Plains populations. In one of the few such analyses, Deitrick (1983) examined the occurrence of antemortem and perimortem injury in skeletons from the Larson village and cemetery site (39WW2). Gregg and Gregg (1987) also discussed examples of trauma, mainly at the Crow Creek site (39BF11) in South Dakota. The authors of both studies attempted to integrate their observations into the broader context of trauma in Native Americans of the Plains, but were limited by not only a general lack of published data for the region, but by differences in the documentation and reporting of the few available data.

In spite of the lack of systematic studies, some inferences can be drawn in regard to trauma for the Central and Northern Plains by analyzing the data on three types of osseous defects—fractures, heterotopic ossifications (i.e., bone spurs or enthesophytes), and dislocations—in relation to age, sex, and site (Table 56).

Table 56. Comparisons of Antemortem Trauma in Three Northern Plains Skeletal Series

<table>
<thead>
<tr>
<th>Variant(Site)</th>
<th>Individuals</th>
<th>Fr</th>
<th>Dis</th>
<th>Enth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extended(39WW1 Feature 1)</td>
<td>162</td>
<td>1</td>
<td>0.6</td>
<td>0</td>
</tr>
<tr>
<td>Extended/Postcontact (39WW1 Feature 2)</td>
<td>230</td>
<td>5</td>
<td>2.2</td>
<td>1</td>
</tr>
<tr>
<td>Postcontact(39WW2 Cemetery)</td>
<td>628</td>
<td>124</td>
<td>20.1</td>
<td>9</td>
</tr>
<tr>
<td>Disorganized (39C09)</td>
<td>281</td>
<td>16</td>
<td>8.1</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Fr = Fractures; Dis = Dislocations, Enth = Enthesophytes


Fractures

Excluding perimortem trauma associated with massacre sites or directly related to the cause of death of an individual, the most common type of trauma recorded for the Central and Northern Plains is fracture. Given the relative ease with which fractures can be identified and the extensive remodeling characterizing repair of such an injury, this result is not surprising. The types of fractures identified in Plains skeletons include depressed lesions on the cranial vault, facial bone fractures, postcranial bone fractures, and vertebral compression fractures. Fractures of the cranial (vault and face) were not only the most commonly recorded in individual descriptions (Table 57), but in studies of trauma in South Dakota skeletal series (Deitrick 1980; Zimmerman et al., 1980), skull fractures (especially nasal bone fractures) also had the highest frequency (Table 56). The second most common type was fracture of an upper limb, usually of the ulna and radius, with fracture of the humerus and clavicle also having a relatively high frequency.
Table 57. Selected Central and Northern Plains Sites with Reported Cases of Fracture.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>5JF959</td>
<td>Male, age 30-35</td>
<td>Healed fracture of left ulna; small healed depression fracture on frontal</td>
</tr>
<tr>
<td></td>
<td>39L256</td>
<td></td>
<td>Healed Colles’ fracture with severe osteoarthritis</td>
</tr>
<tr>
<td></td>
<td>39D233</td>
<td>Adult male</td>
<td>Healed fracture of left rib</td>
</tr>
<tr>
<td>Middle Woodland</td>
<td>39D240</td>
<td>Adult</td>
<td>Healed depression fracture on skull</td>
</tr>
<tr>
<td></td>
<td>3D.U.</td>
<td>Adult</td>
<td>Partially healed depression fracture on left parietal</td>
</tr>
<tr>
<td>Late/Middle Woodland</td>
<td>14PH4</td>
<td>Adult</td>
<td>Left radius with area of roughening &amp; slight deformation</td>
</tr>
<tr>
<td>Central Plains</td>
<td>29XX12</td>
<td>Adult male</td>
<td>(possible healed fracture)</td>
</tr>
<tr>
<td></td>
<td>14WW77</td>
<td>Adult</td>
<td>Possible fracture of distal radius with articular area deformed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Child</td>
<td>Healed fracture of three left ribs (3, 4, 117)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible healed fracture or trauma resulting in fusion of proximal ulna &amp; radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right proximal femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on left supraclavicular arch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right rib &amp; fibula with chronic osteomyelitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Small healed depression fracture over left supraclavicular arch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of left humerus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture; healed depression fracture on left parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of proximal radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible healed fracture of distal third of right radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible fracture of distal humerus resulting in malformed articular surfaces of humerus, ulna, &amp; radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Compression fracture of second lumbar vertebra</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of ribs with possible perimortem fractures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed overriding fracture of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Large healed depression fracture on left frontal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Probable healed fracture of right parietal resulting in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>evacuar necrosis of bone (incomplete repair &amp; cyst formation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible fractured left clavicle resulting in scierous reactive bone on scapular articular surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Compression fracture of first lumbar vertebra</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right rib; healed fracture of left proximal femur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pseuodarthrosis on acromial process of right clavlicp with</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>failure to unite due to fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed greenstick fracture of right rib, about 75% healed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on left parietal; fractured left ulna</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on left parietal; healed left clavicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right radius with lateral development</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture; healed depression fractures on right supraorbital margin &amp; left parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Depression fracture on right frontal with osteitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Compression fracture of fourth lumbar vertebra</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Compression fracture of first lumbar vertebra</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fracture of right rib (8 or 9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Severe fracture of right rib &amp; with spicular periostitis; severe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>fracture of right clavicle</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Colles’ fracture of left radius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible healed fracture of right rib</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of left ulna</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on left supraclavicular arch</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on right parietal</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture on left clavicle, scapula, &amp; ulna</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of proximal leftibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trauma resulting in fusion of right knee (tibia/femur); fused</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sacroiliac joint; healed fracture of right radius; avulsion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>fracture of left transverse process of second lumbar vertebra</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fracture of right parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trauma to right frontal resulting in well-healed groove</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed depression fracture on right frontal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Three small depression fractures on right parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Small healed depression fracture on right frontal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed nasal fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Overriding fracture of blade of scapula</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Healed fractures of left &amp; right clavicles; healed Colles’ fracture;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>possible fracture of acromion</td>
</tr>
</tbody>
</table>
Lower limbs (femur, tibia, and fibula) were less frequently fractured, and flat bones (innominate, scapula, sternum) had the lowest incidence of injury.

The proportionately high rate of craniofacial fractures suggests participation in violent activities conducive to head injury. Although fractures of the skull and facial bones can occur as a result of a fall, a blow to the head, for example, a fist or a club, is more often the cause. Fractures of the forearm, which were relatively frequent in Plains samples, also suggest violence, as such injuries in the distal ulna (referred to as parry fractures) are typically defensive, being sustained when attempting to shield the body from a blow (Mann and Murphy 1990). Violent games, warfare, and horseback riding are documented in the ethnohistoric literature on Native Americans of the Plains, and all would be consistent with the types of fractures most frequently occurring in this region.

Although fractures were found in all age groups, there was a correlation between increasing rates of fracture with age in Plains skeletons. Deitrick (1980) reported that a majority (65.2%) of the fractures in remains from the Larson cemetery occurred in individuals over 30 years of age. Young adults (15-29 years) had the second highest frequency (22.8%), and children a relatively low rate (12%). Shermis (1969) reported a similar increase in rate of fracture by age for the Leavenworth site (39CO9). The incidence of fractures in individuals 31-plus years old in this sample was nearly double (63.3%) that of individuals in the 12-30 year age range (36.4%). A higher fracture rate among older individuals could be expected as a result of increased exposure to traumatic episodes with increasing age and the more rapid healing of fractures in children and subadults.

Differential rates of fracture for males and females have been little studied in Central and Northern Plains samples; therefore, only limited conclusions are possible. In his Leavenworth study, Shermis (1984) noted that males had a slightly higher incidence of fractures than females. He also found that fractures in females generally occurred on facial and upper limb bones and on the upper ventral aspect of the body, whereas in males, fractures were more generally distributed throughout the body. He suggested that the data on differential fracturing by sex was consistent with patterns of domestic violence and assault. Deitrick (1980), who also examined the incidence of fractures by bone and sex, observed a similar pattern of injury in the Larson cemetery sample, with adult males having a majority of the fractures (52%), which were widely distributed, and females having slightly higher frequencies of forearm fractures. In both studies, sample sizes were small. Further systematic analyses are needed to validate a difference in the incidence and location of fractures in males and females.

Changes in fracture rates and patterns over time are poorly documented for the Central and Northern Plains. Deitrick (1980) provides one of the few intersite comparisons of fracturing and reports an increase over time for the Missouri River region of South Dakota, with the highest incidence in the Postcontact Coalescent period site of Larson (Table 58). The frequency for Larson was substantially higher than that reported for the Initial Coalescent period Crow Creek site, for which the overall fracture rate was 6.2% (Zimmerman et al. 1980). The fracture rate at Crow Creek was comparable to the later Disorganized Coalescent site of Leavenworth. Fracture incidence at Mobridge (F1 and F2) was somewhat lower than at either the earlier or later sites in this region (Palkovich 1978a).

Data on regional differences in the incidence of fractures, and on trauma more generally, are lacking for the Plains. The virtual absence of fractures in Pawnee skeletons from central Nebraska (broken bones were found in only four individuals) and the relatively widespread incidence of fractures in contemporaneous South Dakota series (Deitrick 1980; Gregg and Gregg 1987; Palkovich 1978a; Shermis 1969; Zimmerman et al. 1980) suggest that regional differences are likely. Burgess (1994) reported a relatively high rate of aggressive trauma (12% of the skeletal sample) in Ponca remains from northeastern Nebraska and noted a statistically significant difference between the Ponca and the neighboring Omaha of east central Nebraska (Reinhard et al. 1994), who had a lower rate.
Table 58. Frequencies of Cranial and Postcranial Fractures in Skeletal from Crow Creek (38BF11) and Larson Cemetery (39WW2).

<table>
<thead>
<tr>
<th>Variant Initial</th>
<th>Site</th>
<th>Bone</th>
<th>N Fractured</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coalescent</td>
<td>38BF11</td>
<td>Frontal</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parietal</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nasal</td>
<td>129</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rib</td>
<td>233</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clavicle</td>
<td>413</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Humerus</td>
<td>734</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ulna</td>
<td>338</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Femur</td>
<td>299</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>676</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fibula</td>
<td>902</td>
<td>6</td>
</tr>
</tbody>
</table>

Postcontact Coalescent

<table>
<thead>
<tr>
<th>Bone</th>
<th>N Fractured</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial vault</td>
<td>540</td>
<td>19</td>
</tr>
<tr>
<td>Facial bones</td>
<td>540</td>
<td>21</td>
</tr>
<tr>
<td>Sternum</td>
<td>540</td>
<td>21</td>
</tr>
<tr>
<td>Scapula</td>
<td>786</td>
<td>6</td>
</tr>
<tr>
<td>Rib</td>
<td>1002</td>
<td>22</td>
</tr>
<tr>
<td>Clavicle</td>
<td>746</td>
<td>8</td>
</tr>
<tr>
<td>Humerus</td>
<td>892</td>
<td>6</td>
</tr>
<tr>
<td>Radius</td>
<td>779</td>
<td>10</td>
</tr>
<tr>
<td>Ulna</td>
<td>768</td>
<td>6</td>
</tr>
<tr>
<td>Femur</td>
<td>882</td>
<td>2</td>
</tr>
<tr>
<td>Tibia</td>
<td>246</td>
<td>1</td>
</tr>
<tr>
<td>Fibula</td>
<td>975</td>
<td>0</td>
</tr>
<tr>
<td>Tibia</td>
<td>921</td>
<td>0</td>
</tr>
</tbody>
</table>

1 Antemortem fractures only
2 Zimmerman, Gregg, and Gregg (1980)
3 Deitrick (1980)

Future in-depth analyses relating data on skeletal trauma to archeological and ethnohistoric data on warfare, trade, and social discontinuity for the various Native American groups of the Plains are needed to permit geographic and temporal comparisons of intensity of conflict and levels of interpersonal violence in Plains populations.

Enthesophytes

Enthesophytes (including bone spurs, heterotopic bone formations, myositis ossificans) form in response to torn ligaments or muscles and other types of injury and biomechanical stress and result in calcification of the inflamed tissue. They are the second most common skeletal indicator of trauma recorded for Central and Northern Plains samples. They are typically present on the appendicular skeleton and commonly result from such trauma as blows or sprains—any injury involving extravasated blood and fibrous tissues undergoing ossification and calcification. The most usual sites are the fibula and tibia.

Selected descriptions of enthesophyosis in Plains skeletons (Table 59) and a list of sites of enthesophytes in skeletons from Crow Creek (Table 60) and Larson (Table 61) document their occurrence throughout the postcranial skeleton. The tibia and fibula show the highest rate of occurrence, with lower rates characterizing the radius, ulna, humerus, femur, patella, innominate, scapula, and clavicle.

Few data on the frequency of occurrence of enthesophytes have been collected for Plains samples. The majority of the documented instances occurred in males. In Deitrick's study (1980) of the Larson skeletal series, 19 males and 10 females more than 20 years of age from the cemetery sample showed

Table 59. Selected Central and Northern Plains Sites with Reported Cases of Enthesophyosis.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Specimen</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Woodland</td>
<td>39DW240</td>
<td>Mdl B2, Male, adult</td>
<td>Exostosis on femur, myositis ossificans (*)</td>
</tr>
<tr>
<td>Central Plains</td>
<td>14WW7</td>
<td>Lab 52, Female, age 30-35</td>
<td>Osteophyte on anterior crest of greater trochanter of left femur</td>
</tr>
<tr>
<td>Middle Missouri</td>
<td>39CA 102</td>
<td>6.3 91-112-285</td>
<td>Enthesophytes on medial margin of rhomboid fossa of left clavicle</td>
</tr>
<tr>
<td></td>
<td>39HS1</td>
<td>Indiv. 1 880, Female, age 20-34</td>
<td>Enthesophytes along proximal surface of linea aspera and greater trochanter</td>
</tr>
<tr>
<td></td>
<td>39CA 4</td>
<td>Indiv. 3, Male, adult</td>
<td>Slight enthesophyosis along linea aspera</td>
</tr>
<tr>
<td>Extended Coalescent</td>
<td>39SL4</td>
<td>Exhibit B 92A</td>
<td>Ossified ligament on popliteal line of right tibia</td>
</tr>
<tr>
<td>Extended/Postcontact Coalescent</td>
<td>39SL4</td>
<td>F320 B9 #9239, Female, age 35</td>
<td>Proximal bone spur on left fibula</td>
</tr>
<tr>
<td></td>
<td>39SL4</td>
<td>F320 B10 #9225, Female, age 22-25</td>
<td>Small bone spur on proximal left tibia</td>
</tr>
<tr>
<td></td>
<td>39SL4</td>
<td>F461 B6C #9415, Male, age 35-40</td>
<td>Bone spur on proximal left fibula</td>
</tr>
<tr>
<td></td>
<td>39WW1</td>
<td>Indiv. 3, Male, adult</td>
<td>Acromial spur on left &amp; right scapulae</td>
</tr>
<tr>
<td></td>
<td></td>
<td>188</td>
<td>Lateral spur on left tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39HS1</td>
<td>B162, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, House 2, F4, B1, Female, age 25-35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39HS2B</td>
<td>B23 B2, Male, age 22-28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39HS2B</td>
<td>B23 B, Male, age 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39HS2B</td>
<td>Indiv. 1, Male, age 50-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 35-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 2, Female, age 45-50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 50-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 50-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 50-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39WW7</td>
<td>Indiv. 1, Male, age 50-60</td>
</tr>
</tbody>
</table>

* Bass & Pfenice (1975)
* Barnes (1977)
* Willey et al. (1987)
* Owlesy et al. (Unpublished data)
* Williams (1988)
* Gregg (unpublished data)
* Cleaves (1994)
* Owlesy et al. (Unpublished data)
* Shainis (1989)
heterotopic bone development. In the village sample, six males from 10 to 40-plus years of age and one individual whose sex could not be determined had enthesophytes. Sherman (1969) records four individuals, all males, with enthesophyte development in the Leavenworth skeletal series and notes the absence of the condition in females from this site.

Gender-based activities in Plains populations favor the more frequent development of enthesophytes in males than in females. For example, horseback riding, hunting, violent games, and raiding would predispose males to a higher incidence of trauma involving torn muscles and other biomechanical stress conducive to the development of enthesophytes.

A lack of systematic analysis of the incidence of enthesophytosis in Plains samples limits inferences about occurrence over time and in different geographic regions. Although enthesophytes are routinely recorded in skeletal inventories, variation in occurrence over time has not been considered, except minimally by Dietrich (1980:68), who noted a decrease in frequency of occurrence from the Postcontact Coalescent site of Larson (6.1%) to the Disorganized Coalescent site of Leavenworth (2.1%). This decrease corresponds to a similar decrease in the occurrence of fractures at these two sites and suggests a relationship of the two conditions to similar traumatic episodes. However, many more data and their systematic analysis will be necessary for a better understanding of patterns of traumatic injury in populations of the Plains.

The association between metacarpal entheses and specific activity patterns has been systematically studied using a Plains Indian sample. Goldsmith (1990) compared development of entheses on metacarpals of nonagricultural Archaic samples from Tennessee and Kentucky and agriculturists from Tennessee and South Dakota. The South Dakota sample was from Larson (39WW2) and included 18 females and 18 males. The agricultural sample had larger metacarpal entheses for seven of eight muscle insertion points. Cross-sectional dimensions also differed and showed increased length of the fourth and fifth metacarpals in the agriculturists. Goldsmith attributes these differences to subsistence-related activity patterns with larger hands and enthesophytes associated with power-grip types of activity.

### Dislocations

Dislocations, involving joints out of articulation or alignment as a result of force, are relatively rare in Central and Northern Plains samples. As bone remodeling and repair can occur when the dislocation is relatively minor, the few cases recorded could reflect either a lack of skeletal evidence or low incidence of the condition in Plains populations.

Although numerous joints can suffer dislocation, it is most commonly noted for the articulation of the femoral head and acetabulum. Current literature on the Central and Northern Plains shows five cases of hip dislocation (Table 62). Of these, two appear to be the direct result of trauma. Both cases occur in adult males with other pathological indicators of injury. Of the other three, one is a child, 7-9 years of age, with a deformity of the femoral neck and marked attrition of the femoral head and acetabulum. Because of the young age and apparently abnormal bone development, Gregg and Gregg (1987) describe the child as having congenital hip dislocation rather than having experienced trauma. Meadows (1988) classifies the other two cases of hip dislocation, both found in young adults 15-21 years of age, as probably resulting from congenital dislocation as the acetabula were markedly more shallow than those of other individuals in the skeletal series.

### Spondylolysis

Spondylolysis occurs as a vertebral fracture, typically in the region of the pars interarticularis. Although the presence of certain anatomical variations in individuals affected by the condition suggests a genetic predisposition to it (Jyrven et al. 1976; Roche and Rowe 1952; Stewart 1956), a "triggering mechanism" in the form of sustained stress or trauma is usually required for fracturing to occur (Merbs 1983, 1989). Table 63 shows a fairly wide variation in the occurrence of spondylolysis in Central and Northern Plains skeletons. With the exception of the single male from 25XX12, sites dated to the Precontact and early Contact periods display relatively low frequencies of the defect. In their analysis of the remains from the Precontact Initial Coalescent site, Crow Creek (39BF11), Zimmerman et al. (1981) reported 40 instances of spondylolysis in a total of 1,694 lumbar vertebrae examined. The frequency of the condition for the population sample could not be determined because the bones were recovered from an ossuary; however,
the recovery of 396 partial and complete sacra suggests a minimum of at least that many individuals. The number of individuals represented by lumbar vertebrae is unknown. Consequently, only an approximate frequency of occurrence of 10.1% in the Crow Creek sample can be estimated. One elderly man from the Calovich Mound site (Ng-Wy7), a Central Plains tradition Steed-Kisker site in eastern Kansas, had spondylolysis of the fifth lumbar vertebra (Barnes 1977).

The incidence of spondylolysis increased over time for Plains groups. Bradtmiller (1984) reports an increase of more than 100% between the Extended/Postcontact Coalescent site of Sully (39SL4) and the later Postcontact site of Larson (39WW2), that is, from 11.7% to 25.8%. Sandness and Reinhard (1992) report similar frequencies of 27.3, 20.0, and 33.3% for the historic Omaha and Ponca skeletal collections from northeastern Nebraska, although prehistoric skeletal series from this region (25DK13 and 25DK9) showed no instances of spondylolysis. In addition, continuing surveys of pathology in prehistoric Nebraska skeletons (sites 25CD7, 25DX4, and 25KX12) revealed only one case of spondylolysis (at 25KX12) (K. Reinhard, personal communication 1992), suggesting that the condition was not a problem for the prehistoric peoples of Nebraska, though it was for the Historic period groups in this region (Sandness 1992).

In his comparison of the Sully and Larson skeletal remains, Bradtmiller (1984) not only demonstrates that individuals from the later Larson site (39WW2) more frequently had separated
neural arches than did the earlier population from Sully (39SL4) but that spondylosis occurred in younger adults (Table 64) and was related to vertebral arthritic changes (Table 65). This finding suggests that the Larson individuals were experiencing increased biomechanical stress, leading to vertebral fractures, compared to the Sully individuals who had lower frequencies of spondylosis, a lower correlation with spinal arthritis, and an absence of the condition in younger adults. Spondylosis continued to be a common problem for the Arikara during the last quarter of the eighteenth century. Several individuals from the Leavitt site (39ST215), including a seven-year-old with unilateral separation of the left pars interarticularis, had this condition (unpublished data). The fifth lumbar vertebra of an adult female from the Doniphan site (14DP2), a Historic Kansa village, has a similar arch defect on the right side (Stewart 1959).

As in the samples from South Dakota, the incidence of spondylosis in Historic Nebraska skeletons appears to be associated with increased physical stress and trauma. Sandness and Reinhard (1992) recorded spondylosis in four females under 25 years of age. In addition, they noted higher frequencies of Schmorl’s nodes (disc herniation associated with heavy labor or trauma) in the Historic skeletal series, as well as the early onset of spinal osteophytosis and arthritic changes. The presence of these types of spinal pathology in Historic period skeletons and the absence of spondylosis in prehistoric Nebraska samples further suggest increased biomechanical stress as a cause of this defect.

Several activities could have led to increased biomechanical stress and incidence of trauma in Historic Plains peoples. For women, such activities might include the arduous task of tanning and dressing skins, which required hours of scraping in a bent posture, similar to the 90° stance Merbs (1983) cites as a factor in the development of spondylosis in Arctic peoples. In addition, with increased trade and the resulting increase in hunting, the labor of women in preparing skins for the market would have become much greater. Women also were responsible for many of the duties associated with lodge construction and with farming and would have suffered disproportionately for increased horticultural production for trading purposes. For men, the introduction of the horse and activities fostered by increased trade would have increased the incidence of vertebral pathology, including spondylosis. Further study of this pathology should include testing for differences in frequency of occurrence between the sexes.

The differing frequencies for the Prehistoric and Historic period skeletal samples have been cited as support for claims of the biological distinctness of the earlier and later Native American groups in the Plains (Bradtmiller 1984). However, the relationship of spondylosis to spinal arthritic changes and trauma in later Historic samples from South Dakota and Nebraska, as well as its presence in young adults in these samples, would seem to provide strong support for theories of increased levels of physical stress and different patterns of activity for Native Americans of the Plains after contact.

Evidence of Warfare

Warfare occurred in the Great Plains from the Prehistoric through the Historic eras, with the nature and prevalence of conflict varying over time (Owsley 1994). Culturally patterned violent conflict among different social groups extends back in time for at least a thousand years. Except for a few examples (Tiffany et al. 1988; J. A. Williams 1991), there is little evidence of warfare during the Archaic and Woodland periods. The dispersed and unfortified Central Plains tradition settlements also suggest that group conflict was not a pervasive concern. However, the osteological findings indicate that small-scale feuding and raiding occurred and resulted in fatalities.

Early large-scale conflicts resulted from migration and competition for territory and scarce resources as Central Plains tradition villagers moved northward into the Middle Missouri Valley onto lands held by people of the Middle Missouri tradition. Warfare that resulted in the destruction of entire villages and the massacre of the inhabitants occasionally occurred. Ultimately, representatives of the Middle Missouri tradition retreated into North Dakota.

Small-scale warfare was common during all variants of the Coalescent tradition, and this pattern, which included raiding, scalping, and the taking of other physical trophies, continued into the Historic period. Conflict during the Protohistoric and Historic periods continued as the Sioux and other groups migrated into the Plains from the east. The ethnohistoric record contains numerous accounts of intertribal conflict that involved small-scale raiding for horses, scalps, captives, trade goods, and agricultural products.

Patterns of warfare varied geographically as well. Most of the physical evidence derives from sites in present-day South Dakota, and to a lesser extent from Nebraska and North Dakota. Within South Dakota, the frequency and intensity of warfare (based on evidence of scalping, as well as settlement patterns and the presence or absence of fortifications) differed between the Grand Mound region, extending northward toward the North Dakota/South Dakota border, and the more southern Bad-Cheyenne region where the effect of the Pax La Roche was apparent (Owsley 1994). The more northern Arikara faced greater risk of violent death than those who lived farther south.

As Tables 66 and 67 show, the data on warfare and trophy taking in the Central and Northern Plains from the Late Woodland through the Central Plains tradition was widespread geographically but sparse. Most examples come from Coalescent and Middle Missouri tradition sites. The osteological evidence for warfare includes:

- cuts around the cranial vault with associated scaling;
- exfoliation of the outer table and diploe, infection of the outer table, and increased vascularity characterizing survival of scaling (see, for example, Miller 1994);
- blunt force trauma to the cranium apparent in depressed fractures, both unhealed (perimortem) and healed (antemortem);
- cranial trauma caused by sharp instruments (e.g., ax or hatchet);
- traumatically induced dental evulsions;
Table 66. Plains Village Sites in Nebraska and South Dakota with Evidence of Warfare.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Osteological Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Woodland</td>
<td>25DXA</td>
<td>1 healed &amp; 2 partially healed scalpings</td>
</tr>
<tr>
<td>Central Plains</td>
<td>25CU28</td>
<td>Multiple scalpings; cut around 1 foramen magnum</td>
</tr>
<tr>
<td>Itaski</td>
<td>25HW2</td>
<td>Scapling</td>
</tr>
<tr>
<td></td>
<td>25HW3</td>
<td>Scapling</td>
</tr>
<tr>
<td></td>
<td>25HW8</td>
<td>Scapling</td>
</tr>
<tr>
<td>Nebraska</td>
<td>25DKS</td>
<td>Partially healed scalping</td>
</tr>
<tr>
<td></td>
<td>25SY67</td>
<td>Partially healed scalping</td>
</tr>
<tr>
<td>Upper Republican</td>
<td>25FT13</td>
<td>Multiple (+1) scalpings</td>
</tr>
<tr>
<td>Oenota</td>
<td>25RH1</td>
<td>Multiple scalpings</td>
</tr>
<tr>
<td>Coalescent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>39BF11</td>
<td>Commingled remains in mass grave in fortification trench; village burned; massacre of at least 486 people; periodontal trauma; mutilations, including scalpings (2 healed); dismemberment, and decapitation Multiple scalpings (1 healed); periodontal trauma; knife and arrow wounds; disarticulation</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39CA5</td>
<td>Multiple scalpings</td>
</tr>
<tr>
<td></td>
<td>39SL4</td>
<td>Partially healed scalping</td>
</tr>
<tr>
<td></td>
<td>39WW1</td>
<td>Multiple scalpings; periodontal trauma</td>
</tr>
<tr>
<td></td>
<td>39WW2</td>
<td>Multiple scalpings; 1 partially healed; decapitation; periodontal trauma; knife or arrow wounds; (Cemetery) disarticulation</td>
</tr>
<tr>
<td></td>
<td>39WW23</td>
<td>Village burned; commingled remains of 61 individuals in 3 lodges; 10 found in village perimeter; scalpings, decapitation, and dismemberment, 39WW23 Village burned; commingled remains of 61 individuals in 3 lodges; 10 found in village perimeter; scalpings, decapitation, and dismemberment</td>
</tr>
<tr>
<td></td>
<td>39WW3</td>
<td>Healed scalping</td>
</tr>
<tr>
<td></td>
<td>39WW7</td>
<td>Multiple scalpings; knife or arrow wound; disarticulation</td>
</tr>
<tr>
<td></td>
<td>25KX12</td>
<td>Scapling; periodontal trauma</td>
</tr>
<tr>
<td></td>
<td>25KX5</td>
<td>Scapling</td>
</tr>
<tr>
<td></td>
<td>39COB</td>
<td>Multiple scalpings; arrow and gunshot wounds; disarticulation</td>
</tr>
<tr>
<td>Disorganized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Missouri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>39ST11</td>
<td>Village burned; 5 skeletons in 2 lodges; decapitation; projectile injury; probable dismemberment; partially healed scalping</td>
</tr>
<tr>
<td>Southern Extended</td>
<td>38AR201</td>
<td>Dismemberment and mutilation of 10 individuals; intentional fragmentation</td>
</tr>
<tr>
<td>Unknown</td>
<td>14PA</td>
<td>Scapling</td>
</tr>
</tbody>
</table>

1 Miller (1994)  
2 D'Shane and Bridges (1989)  
3 Hollimon and Owsley (1994)  
4 Bubniak and Verano (1993)  
5 Willey (1990)  
6 Olsen and Shipman (1994); Owsley (1994); Owsley, Mann, and Baugh (1994)  
7 Montgomery (1968)  
8 Rose et al. (1994)  
9 Bass (1984)  
10 Owsley, Barryman, and Bass (1977)  
11 Hamperl and Laughlin (1959)  
12 Burgess (1994)  
13 Shermis (1969)  
14 Willey and Bass (1978)

Table 67. Central and Northern Plains Sites with Trophy Skulls and Intentionally Modified Crania.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Woodland, Schultz Focus</td>
<td>14CY32</td>
<td>Openings with polished edges cut into the occipitals of 4 crania, possibly for mounting</td>
</tr>
<tr>
<td>Schultz Focus</td>
<td>14GE4</td>
<td>Openings with polished edges cut into the occipitals of 4 crania, possibly for mounting</td>
</tr>
<tr>
<td>Central Plains, Itaski</td>
<td>25CU7</td>
<td>Incised skull fragment with 5 perforations</td>
</tr>
<tr>
<td>Upper Republican</td>
<td>25FT13</td>
<td>Partially prepared skull bowl</td>
</tr>
<tr>
<td>Upper Republican</td>
<td>25HN36</td>
<td>Gut and drilled calvarium</td>
</tr>
<tr>
<td>Coalescent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>39BF11</td>
<td>4 skull bowls</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39SL4</td>
<td>Trophy skull with 2 drilled perforations</td>
</tr>
<tr>
<td>Postcontact</td>
<td>25CX18</td>
<td>Etched cranial fragment with a human figure on the endocranial surface</td>
</tr>
<tr>
<td>Disorganized</td>
<td>39WW3</td>
<td>Trophy skull</td>
</tr>
<tr>
<td></td>
<td>25DK2</td>
<td>Trophy skulls</td>
</tr>
<tr>
<td></td>
<td>25WT1</td>
<td>Trophy skull</td>
</tr>
</tbody>
</table>

1 Phenice (1969)  
2 Phillips (1986)  
3 Carlson, G. (1989, personal communication)  
4 Willey (1990)

* trauma resulting from projectiles (arrows or gunshots), found in association with human remains or in some instances embedded in bone (Figures 60a, b, and c);  
* decapitation;  
* dismemberment and green bone fractures; and  
* trophy taking (e.g., skulls, hands, and other postcranial bones), sometimes with intentional modifications such as a cranial vault made into a bowl (Wedel 1986; Owsley et al. 1994).

Osteological evidence has revealed the destruction of entire villages and the massacre of inhabitants, as at the Initial Coalescent site (A.D. 1325) of Crow Creek (39BF11) (Willey 1990) and the Extended Middle Missouri site of Fay Tolton (39ST11) (Hollimon and Owsley 1994). Approximately 500 people were killed at Crow Creek and their bodies mutilated and scalped. At Larson (39WW2) (Owsley et al. 1977), a Postcontact Coalescent site inhabited until about A.D. 1733, commingled and partially disarticulated human skeletons were found inside earth lodges.
that had collapsed when burned. There were musket balls and copper arrow points in association with some remains; others showed evidence of scalping, depressed fractures, dental evulsions, and mutilation. Victims of scalping included men, women, and children (the youngest about five years old), and several males had been decapitated.

Though the data are often compelling, as at Crow Creek, they are often less than clear-cut. For example, were the burials in the Sargent Ossuary (O'Shea and Bridges 1989) victims of a raid, persons who died a violent death away from the village, or examples of a particular type of mortuary practice? One site (Fremont I [2SY1]) that was long interpreted as evidence of violence and cannibalism may have been a charnel house in which remains were processed for burial according to cultural rites and practices (Cook 1977).

Examples from many prehistoric sites show the antiquity of scalping in the Central and Northern Plains, and scalping was also a common practice among Plains Indians during the Historic period. Scalps were taken as trophies and regarded as emblems of victory. The process often resulted in cuts on the frontal, parietal, and occipital bones that can be detected through close examination under high illumination. A number of reports
provide detailed information about the number, patterning, and distribution of cuts on scalped skulls (Owsley 1994; Owsley et al. 1977; Owsley et al. 1994; Willey 1990). A systematic survey of adult crania from 15 Coalescent tradition sites in South Dakota (A.D. 1600-1832) showed evidence of scalping in 3.5% of the sample (Owsley 1994). The risk of being scalped was about the same for males and females, although the age distribution of scalped individuals differed in relation to sex. One-fifth of the deceased males between the ages of 20 and 29 years showed cuts resulting from scalping, thus illustrating the negative impact of warfare on this segment of the population. Further, the risk of being scalped increased for males during the early Historic period.

Willey (1990) described and compared the kinds of mutilations observed in massacre victims of prehistoric Crow Creek and protohistoric Larson village. Although the same types of modifications (e.g., burning, depressed fractures, dental evulsion, scalping, dismemberment, and decapitation) were present, the frequencies of specific mutilations differed, with all types of mutilations occurring more frequently in the Crow Creek sample. The majority (>90%) of the Crow Creek crania were scalped; only 37.5% of the Larson sample had cuts on the cranium indicating scalping. The difference might be related to the use of metal knives at Larson, compared to the less efficient stone knives used at Crow Creek. Many of the Crow Creek skulls showed cuts on the occipital bone from decapitation (14.3%), and a few had cuts on the maxillae from removal of the nose (4.5%). Decapitations in the Larson sample involved separation through the cervical vertebrae, thereby avoiding damage to the basilar portion of the occipital. Although not observed in the Larson village series, Owsley is aware of skulls from Extended and Postcontact Coalescent cemeteries with cuts indicating removal of the nose (e.g., at Mobridge).

Olsen and Shipman (1994), working from cast molds of bones and using scanning electron microscopy, have investigated distinctions between evidence of conflict and characteristics of secondary burial practices and have also distinguished among the variety of weapons and implements with which cuts, scraps, and fractures were inflicted. In research on evidence of warfare, they emphasize the need for careful recording of the presence or absence of all skeletal elements and whether these are in
articulation, the identification of fractures as antemortem, perimortem, or postmortem, and the recording of any natural or artificially induced alterations of bone that are present.

Systematic research on evidence of warfare in the Central and Northern Plains is a paramount need. The questions are many and varied, and the lack of adequate data to answer them is apparent. Among the highest priority needs are the following:

- Documentation of temporal trends and geographic patterns of warfare, including comparisons of areas both within a state and among states;
- Systematic investigation of skeletal trauma: lethal and nonlethal, perimortem and healed or partially healed; nature of the weapon (e.g., spiked club, arrow, gunshot) or tool (stone or metal knife) that inflicted the injury; and evidence of skeletal modification (e.g., killing and trophy taking, dismemberment and defleshing for secondary burial or cannibalism);
- Determination of the relationship, if any, of mortuary treatment to particular circumstances of death;
- Examination of cemetery samples to discover any additional evidence of traumatic injury resulting from violence;
- Documentation of the sex, age, and geographical distribution of victims of warfare;
- Comparisons of patterns of warfare between eras and geographic areas within a state and among states; and
- Collection of data on warfare in states such as Kansas where at present none have been reported or described, or where such data are as yet sparse, as in Nebraska (Burgess 1994; Montgomery 1986).

Indicators of Physiological and Environmental Stress

Cortical Bone Thickness

In bioarchaeological investigations of subsistence patterns, cortical bone growth and thickness have been used as indicators of nutritional status (Cook 1979; Hummert 1983; Pfeiffer and King 1983). The rationale for this approach derives from research showing that the sex, age, and diet of an individual influence the amount of cortical bone mass (Frisancho et al. 1970; Garn 1970, 1972). The effects of mild to severe malnutrition on the subperiosteal and endosteal surfaces of tubular bone have been demonstrated in controlled feeding studies of laboratory animals and in longitudinal and cross-sectional comparisons of a large number of poorly nourished and well nourished children in the United States and Central America (Garn 1966, 1970, 1972; McCance 1960; Platt and Stewart 1962; Platt and McCance 1964; Fleagle et al. 1975; Garn et al. 1969; Himes et al. 1975; Himes 1978). Garn (1972:503-504) indicates:

Bone growth in undernutrition and simple malnutrition is somewhat like normal growth, but slower, with less bone formed. Bone growth in protein-calorie malnutrition (like bone growth in some malabsorption states and in some disorders of oxygen transport) is slower growth, subperiosteally, but with excessive bone loss at the endosteal surface.

Kwashiorkor (a severe protein-deficiency type of malnutrition) and marasmus cause excessive endosteal resorption in which as much as 40% of the bone can be lost (Garn 1970; Garn et al. 1969; Garn et al. 1964). Endosteal loss reduces the bony cortical wall to a thin shell with a greatly enlarged marrow cavity. This loss occurs even though the external bone size, or even the time of ossification, remains relatively unaffected. Catch-up growth by bone replacement during the period of recovery from kwashiorkor or marasmus is minimal (Garn 1966). Medullary enlargement and decreased cortical thickness also occur in a variety of malabsorption states, in the osteopenias, in hyperparathyroidism, and at ages greater than 40 years (Garn 1970). To compare age-related variation requires that the age distribution of the samples be controlled, with older adults excluded. The femur has been used in most studies of archeological samples, including systematic surveys of a number of village samples from the Central and Northern Plains (Cashion 1967; Owsley 1985, 1991; Tiffany et al. 1988). Two basic midshaft cross-sectional measurements, total subperiosteal diameter (T) and width of the medullary cavity (M), were obtained from high-resolution radiographs of the femur, which was x-rayed in a standardized posterior-anterior position. From these measurements, other variables can be obtained, including mediolateral cortical thickness (C), Nordin's Index (N), and cortical area (CA). Cortical thickness, calculated as $C = T - M$, represents the combined or net thickness of the medial and lateral walls of the bone at the midshaft. Nordin's Index, $N = C / T$, represents the proportion of the total width attributed to the cortex. Cross-sectional area indicates the potential calcium reserve and absolute bone mass, calculated as $CA = 0.785(T^2 - M^2)$ (Garn 1970). The underlying assumption for this formula is an approximately circular cross-sectional geometry of both the endosteal and subperiosteal surfaces, which seems to be valid for the femora of subadults and is also reasonable for many adults from the Northern Plains. However, the cylindrical model is less applicable in some Southern Plains groups that show extreme anterior-posterior elongation of the femur cross-section (Owsley and Jantz 1989; Ruff 1994). In his study, Ruff (1994) determined tubular bone shape, cortical thickness, and related biomechanical characteristics of the long bone diaphysis from transverse sections of the femur.

Cortical bone thickness is a sensitive indicator of changes in Arikara nutritional status during the Postcontact period. Owsley (1985) compared measurements of femoral cortical thickness in Extended, Postcontact, and Disorganized Coalescent samples of males and females, 18-30 years of age, from South Dakota. The age range was restricted to avoid the inclusion of individuals with age-related endosteal resorption. Because the samples were from Arikara villages along the Missouri River, they represented genetically related populations from a limited geographical area over a time interval of 230 years (A.D. 1600 to 1832), a period of rapid change.

The femora were x-rayed in a standardized posterior-anterior projection, using a special film and a single lanex, fine screen cassette. Table 68 presents the resulting means and standard deviations for the variable C (i.e., cortical thickness). The means,
ranging between 11.9 and 14.6 mm, were larger for males than females, and statistically significant temporal differences were present. Cortical thickness values were larger for the Postcontact Coalescent samples than for the Extended and Disorganized Coalescent samples. Values for M and T showed that the differences in cortical thickness resulted primarily from variations in the diameter of the medullary cavity. Femora of the Postcontact Coalescent samples had smaller medullary cavity diameters than did those of the Extended and Disorganized Coalescent samples. Although the general pattern was the same for both sexes, females showed the largest amount of endosteal cortical thinning during the Disorganized Coalescent time period.

<table>
<thead>
<tr>
<th>Sex and Variant</th>
<th>Bone Cortex</th>
<th>Diaphyseal Length</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended</td>
<td>18</td>
<td>13.49</td>
<td>18</td>
<td>433.22</td>
<td>20.33</td>
<td>28</td>
<td>401.82</td>
<td>20.46</td>
</tr>
<tr>
<td>Postcontact</td>
<td>41</td>
<td>14.55</td>
<td>41</td>
<td>431.73</td>
<td>23.15</td>
<td>65</td>
<td>401.41</td>
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<td>439.64</td>
<td>22.26</td>
<td>65</td>
<td>401.41</td>
<td>15.19</td>
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<td>Female</td>
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</tbody>
</table>

Table 68. Mean Cortical Thickness and Diaphyseal Lengths of Femora of Young Adults from Three Coalescent Tradition Variants in South Dakota (from Owsley 1985:203).

These data suggest an improvement in the nutritional status of the Arikara during the Protohistoric period, as reflected by an increased amount of cortical bone and relatively narrow diameters of medullary cavities in Postcontact Coalescent young adults. Reduced cortical thickness in the Disorganized Coalescent samples is evidence of nutritional problems after A.D. 1780. Dietary stress and undernutrition became more common with the spread of infectious diseases, internal and external strife, and crowding, which strained available resources in the few remaining horticultural villages. These shortages especially affected females. The reasons for a differential effect on the two sexes are complex. Their clarification will require a better understanding of various biocultural factors such as sex differences in diet, differential access to food, effects of pregnancy and lactation, and different types and amounts of work.

Increased cortical bone among Postcontact villagers indicates relative success in meeting nutritional needs. An improved climate conducive to farming and the introduction of the horse, which facilitated bison hunting, are likely causes. A follow-up study that compared samples representing specific periods of short duration examined patterns and the timing of changes in cortical bone thickness (Owsley 1991). Table 69 shows the measurements of cortical thickness and maximum lengths of femora for samples representing Late Prehistoric (A.D. 1600-1650), Early Protohistoric (1650-1740), Late Protohistoric (1740-1795), and Historic (1795-1832) periods. Differences among the samples showed fairly similar patterning for both sexes and were statistically significant for all cortical bone measurements. (In contrast, comparison of the diaphyseal and maximum lengths of the femora of these same groups showed no significant differences [Tables 68 and 69].)

The increase in the means of C, N1, and CA during the early Protohistoric period indicates more cortical bone. In females, a reduction in the width of the medullary cavity was the cause. After 1740, Late Protohistoric and Historic period females showed incremental increases in the diameter of the medullary cavity (Figure 61). The diameters of medullary cavities of males during the Late Protohistoric and Historic periods were larger than those representing the Early Protohistoric period. Thus, cortical thickness increased in both males and females during the transition from the Late Prehistoric to the Early Protohistoric period (Figure 61). However, this increase was transient, with midshaft cortical thickness beginning to decrease in the Historic period, and the reduction was particularly apparent in females.

Nutrition in late seventeenth and early eighteenth century populations was good, with a positive change in nutritional status characterizing the transition from the Late Prehistoric to the Early Protohistoric periods. The improvement resulted in part from increased emphasis on horticulture to acquire surpluses for trade (and/or environmental conditions leading to increased productivity). Greater reserves of food provided a buffer against lean times. Although acquisition of the horse (ca. 1740) facilitated the hunting of wild game and the transport of larger quantities of meat to a village, this factor apparently had little effect, the greatest impact being on the post-1750 economy of the Arikara.

Little has been published on cortical bone thickness of subadult samples from archeological sites, although such data would provide a sensitive indicator of health and nutritional

<table>
<thead>
<tr>
<th>Variable</th>
<th>Late Prehistoric</th>
<th>Early Prehistoric</th>
<th>Late Prehistoric</th>
<th>Early Prehistoric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>Medullary cavity diameter</td>
<td>11</td>
<td>11.79</td>
<td>1.57</td>
<td>76</td>
</tr>
<tr>
<td>Total subperiosteal diameter</td>
<td>11</td>
<td>25.29</td>
<td>2.12</td>
<td>76</td>
</tr>
<tr>
<td>Cortical thickness</td>
<td>11</td>
<td>13.50</td>
<td>2.15</td>
<td>76</td>
</tr>
<tr>
<td>Nordin's index</td>
<td>11</td>
<td>0.53</td>
<td>0.66</td>
<td>76</td>
</tr>
<tr>
<td>Cortical area</td>
<td>11</td>
<td>394.84</td>
<td>76.92</td>
<td>76</td>
</tr>
<tr>
<td>Maximum length</td>
<td>8</td>
<td>466.13</td>
<td>13.93</td>
<td>60</td>
</tr>
</tbody>
</table>

status. One study (Mann et al. 1994) used plain-film radiography, computerized tomography, and quantitative densitometry to assess the level of osteoporosis evident in an Omaha child (from 25DK10) with histiocytosis X and otitis media. Relative to nine other children of the same age with femora of similar lengths, the child showed marked osteopenia as a result of cortical thinning accompanying expansion of the medullary cavity. Photon absorption densitometry was used to quantify the degree of loss of mineral content, as measured at the midshaft and neck of the femur. The density of the child’s femur was nearly two standard deviations less than the average of the reference sample. Using computerized tomography, the investigators evaluated the magnitude of this difference through individual variations in the cross-sectional areas of the cortical bone and the medullary cavity. The 25DK10 femur had a thinner cortex, sparse cancellous bone trabeculae, and diminished mineral content relative to the other children. As a result of limited muscular exertion and inactivity, the child’s femur was virtually circular, there being a lack of development of the linea aspera (normally a prominent muscle attachment site on the posterior surface). Progression of the disease affecting the child caused a loss of appetite, thus reduced food intake, undernutrition, and immobilization, resulting in muscle atrophy and osteoporosis.

That cortical bone thickness is responsive to changes in nutritional status has been demonstrated in the Postcontact Arikara. Osteological examinations should include systematic x-raying of the femora and tibiae of both young adults and children to augment the database and make comparisons with other population samples possible.

Harris Lines

Among the indicators of stress and morbidity in the human skeleton are transverse lines or bands of increased opacity (called Harris lines) that occur on the diaphyses of long bones when longitudinal growth of epiphyseal cartilage is stunted during episodes of disease or malnutrition in the first 18 years of life (Martin et al. 1985; Steinbock 1976; Wells 1967). A period of delayed growth results in a thin layer of bone called the primary stratum. When growth resumes, this stratum thickens, producing a dense layer of horizontally arranged trabeculae that is visible in sectioned bone and roentgenograms (radiographs).

Most Harris lines develop during early childhood, when susceptibility to illness is greatest (Garn and Schwager 1967; Gindhart 1969), and many of these lines persist into adulthood, making analysis based on mature populations possible. Because of the noninvasive nature of such analyses, Harris line studies have been very useful in providing insights into health and morbidity in archeological populations (Allison et al. 1974; Goodman and Clark 1981; McHenry 1968; Wells 1967; Woodall 1968). Among the factors cited as likely causes of the development of Harris lines are shifts in subsistence strategy (McHenry 1968) and contact with European settlers, which led to social change and economic upheaval (Woodall 1968), as well as to disease (Allison et al. 1974).

Few systematic studies of Harris lines have been conducted on Central and Northern Plains skeletons. Sandness and Green (1993) recorded Harris lines in four skeletal collections from northeastern Nebraska spanning a period of approximately 800 years and incorporating Woodland to Disorganized Coalescent populations. Symes (1983) conducted a detailed evaluation of Harris lines in individuals from the Initial Coalescent site of Crow Creek (39BF11), South Dakota. Owlsley (1983) and Cashon (1987) documented the occurrence of Harris lines in Extended, Postcontact, and Disorganized Coalescent Arikara skeletons from the Middle Missouri Valley in South Dakota and a small number of Pawnee from Nebraska. Others (Langdon, Willey, and Cummins 1993; Nickens 1977; Scott and Birksdal 1972; Wanner and Brunswig 1992) studied Harris lines in isolated skeletons collected from the Plains region but offered no conclusions about the causes of these lines other than their representing an episode of childhood nutritional stress or disease.

To evaluate the presence of Harris lines in Plains Native Americans prior to and after European contact, the findings from these various studies are brought together in Table 70. The sites are arranged by temporal context and archeological variant, and the data for specific sites are combined based on their temporal, cultural, and regional similarities.

The percentages of males and females having at least one Harris line are about equal in studies by Cashon (1987), Owlsley (1983), Sandness and Green (1993), and Symes (1983), with no statistically significant differences found. However, these analyses show that males have higher numbers of Harris lines, with a majority of lines developing in early childhood, compared...
Table 70. Lines of Arrested Growth in Tibiae from the Central and Northern Plains.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Sites</th>
<th>Indiv.</th>
<th>NL</th>
<th>%NL</th>
<th>ML</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaic</td>
<td>SWL2055</td>
<td>1</td>
<td>1</td>
<td>100.0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Woodland</td>
<td>5MR378</td>
<td>1</td>
<td>1</td>
<td>100.0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JF995</td>
<td>1</td>
<td>1</td>
<td>100.0</td>
<td>14</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>25DK13</td>
<td>13</td>
<td>11</td>
<td>84.8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Plains Village</td>
<td>Central Plains</td>
<td>25DK13</td>
<td>60</td>
<td>32</td>
<td>53.3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Initial Coalescent</td>
<td>39BF11</td>
<td>122</td>
<td>92</td>
<td>75.0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Extended Coalescent</td>
<td>39BF208</td>
<td>1</td>
<td>100.0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39CA</td>
<td>9</td>
<td>28</td>
<td>88.7</td>
<td>7</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Postcontact Co.</td>
<td>39DW2</td>
<td>39WW2</td>
<td>39WW7</td>
<td>67</td>
<td>71.3</td>
</tr>
<tr>
<td></td>
<td>Disorganized Co.</td>
<td>39CO9</td>
<td>39ST215</td>
<td>24</td>
<td>16</td>
<td>68.7</td>
</tr>
<tr>
<td></td>
<td>25DK2</td>
<td>25DK10</td>
<td>24</td>
<td>11</td>
<td>45.8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>25BU1</td>
<td>14</td>
<td>12</td>
<td>85.7</td>
<td>12</td>
<td>3.0</td>
</tr>
<tr>
<td>Historic</td>
<td>Crow</td>
<td>20</td>
<td>13</td>
<td>65.0</td>
<td>3</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>417</td>
<td>286</td>
<td>88.6</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Note: NL = number of individuals with lines of arrested growth; ML = maximum number of lines observed.

1 Wanner and Brunswig (1992) 2 Langdon, Willey, and Cummings (1993)
3 Scott and Birkedal (1972) 4 Owsley (1983)
5 Nickens (1977) 6 Cashon (1987)
7 Sandness and Green (1993) 8 Sandness (1994)
9 Symes (1983)

arrested growth would be expected over time, as shown in the data on the Postcontact and Disorganized Coalescent skeletal series.

Childhood disease has also been cited as a factor in the development of Harris lines (Caffey 1967; Harris 1933; Gindhart 1969). Increased trade and interaction with European explorers and traders brought an influx of epidemic diseases throughout the Historic period. Lowie (1954) and Trimble (1994) document several epidemics during the Postcontact and Disorganized Coalescent periods. Repeated episodes of disease would be expected to increase the incidence of lines of arrested growth in Historic period samples, yet the data do not reflect such a trend. However, such lines would be evident only if the victims of disease survived their illness. High infant and subadult mortality reported in demographic studies (Moorhead 1992; Owsley 1983) and in ethnohistoric documentation suggest that epidemic diseases had a devastating effect on Historic Plains Native Americans, greatly reducing population size. Those individuals who survived probably were the hardiest and healthiest. As a result, the data on incidence of Harris lines are not good indicators of the frequency and severity of acute infectious disease stress in Central and Northern Plains Historic period populations.

To summarize, differences in Harris line counts for males and females are small and generally show no patterns that provide clues to factors or events differentially affecting line formation in the two sexes. However, they do suggest that line formation occurred somewhat earlier in males than females. More research comparing Harris line formation in males and females representing different populations and time periods is needed.

That the average number of Harris lines is higher in Archaic and Woodland populations than in later Plains Village horticulturists and Plains nomad bison hunters (i.e., the Crow) is probably the result of nutritional factors, such as the greater likelihood of seasonal shortages (winter/spring) among Archaic and Woodland populations. Village horticulturists could rely on stored crops supplemented by bison hunting to get them through seasonal shortages. Further, Historic period nomadic groups—mounted hunters—could follow the food sources, moving when necessary as food in one location was depleted or affected by seasonal climate.

The Historic Pueblo site (25BU1) does show a higher frequency of Harris lines than do contemporaneous Arikara and Omaha sites. Thus, there is an indication of possible differences in stress leading to arrested growth among populations of late Historic period sites—a finding that calls for further investigation.

More notable in research on Harris lines is the general lack of a difference in numbers of lines counted in relation to archeological variant of the Coalescent tradition. If Harris lines accurately reflect childhood morbidity levels, differences should appear. Disorganized Coalescent samples should have higher average numbers of lines, but the data do not support this expectation. Harris lines observed on adult tibiae only marginally reflect actual stress levels affecting temporally sequential samples. The Protohistoric and Historic populations (i.e., Postcontact Coalescent, Disorganized Coalescent, and Crow) do
not show an increase in line frequency that can be linked to the introduction of infectious diseases (e.g., measles and smallpox). The mortality rate was probably high, with lines indicating arrested growth found only in individuals who recovered and resumed normal growth. Thus, Harris lines do not provide a reliable indication of the level of disease stress affecting these populations.

The most pressing research needs are systematic studies to document temporal trends and population differences and, especially, more data on Archaic and Woodland samples. Both femora and tibiae should be used in such studies, with routine x-rays made in a standardized format. When Owsley (1983) investigated transverse line formation on the proximal and distal sections of tibiae, he found a low correlation between proximal and distal counts and locations of lines. Further research should explore these differences and their implications; for example, are sex differences in proximal tibial values indicators of male/female stress differences, or do they merely reflect differential rates of growth and remodeling?

**Enamel Hypoplasia and Fluctuating Dental Asymmetry**

Hypoplastic lines are transverse bands or pits in the enamel of deciduous or permanent teeth resulting from malnutrition and diseases with high fever occurring in early childhood during enamel apposition. Diseases such as tuberculosis, rickets, and congenital syphilis have been associated with enamel hypoplasia (Ortner and Putschar 1981). Unlike Harris lines, hypoplastic lines are not obscured by remodeling in adulthood, thus providing a better indication of physiological or environmental stress. However, they are subject to loss as a result of dental attrition, and teeth with defective enamel (e.g., hypocalcification and severe hypoplasia) are more likely to become carious and to be lost ante-mortem as a result of tooth decay.

Data on the occurrence of enamel hypoplasia in samples from the Great Plains are limited. For example, there are no systematic studies of enamel hypoplasia in skeletal samples from Kansas or northeastern Colorado. Although several reports on skeletal samples from South Dakota (Rose, Marks, Kay and Riddick 1984; Willey and Swegle 1980) indicate the presence of hypoplastic lines, they fail to identify the teeth in which these occurred or to relate the data on hypoplasia to other data representing different time periods or geographic areas. Without knowledge of the teeth affected, the results of these studies are difficult to interpret or to integrate into the Plains skeletal data base. An urgent need, therefore, is to record data on enamel hypoplasia in relation to specific teeth and to indicate the age at which the stress episode(s) occurred. Only one study of samples in this region (Cashon 1987) fulfills this requirement.

Cashon's study deals with Harris lines, hypoplastic lines, and cortical bone thickness as indicators of stress in skeletons from seven archeological sites in South Dakota, Oklahoma, and Nebraska. Table 71 presents the data on hypoplastic lines in one mandibular and three maxillary teeth for samples collected at four archeological sites in South Dakota and Nebraska. These data pertain to Plains Village, Coalescent tradition Arikara and Pawnee sites dating from A.D. 1600-1850.

The data on enamel hypoplasia provide evidence of temporal and regional patterning. For example, Arikara males show a decrease in the mean number of hypoplastic lines over time from the Extended to the Disorganized Coalescent variants. Females in the Arikara sample, however, show a slight increase in enamel hypoplasia during the Postcontact period (39WW2), followed by a decrease in line frequency in the Disorganized Coalescent skeletal series from Leavenworth (39CO9). In general, line frequencies for both males and females decrease over time, with the Extended and Postcontact Coalescent sites having relatively similar values that are significantly higher than those of the Disorganized Coalescent sample. The same trends are apparent in the data on Harris lines. The decrease in frequency of enamel hypoplastic lines suggests that health improved during the Disorganized Coalescent variant relative to the preceding 150 years.

The reduction in enamel hypoplasia is difficult to reconcile with the historic context of the Leavenworth site (39CO9). Leavenworth represented an amalgamation of the remnants of previously autonomous villages following the 1781-1782 smallpox epidemic. Based on the historical record, the Leavenworth population was in decline, with a high mortality rate that has been attributed to diseases resulting from European contact, warfare, and periodic food shortages.

The frequency of enamel hypoplasia at the Linwood site (25BU1) in Nebraska, which corresponds temporally to the Leavenworth skeletal series, is the highest among these samples. Cashon (1987) proposes two hypotheses to account for the

<table>
<thead>
<tr>
<th>Table 71. Enamel Hypoplasia in Coalescent Tradition Samples from Nebraska and South Dakota (from Cashon 1987).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variant, Site, Sex</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Extended (39WW1)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Postcontact</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Disorganized (39CO9)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>(25BU1)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>
discrepancy between these two temporally corresponding samples: (a) a difference in the height of enamel (as a result of wear) between the Leavenworth and Linwood samples; and (b) differences in the level of European contact experienced by different Disorganized Coalescent groups. The Leavenworth samples have greater wear and lower enamel height than those at Linwood. Thus, the possibility of detecting hypoplastic defects is greater for the Linwood than the Leavenworth samples. In regard to European contact, as Linwood was farther south, sustained European contact could have occurred earlier there than at Leavenworth, and the resulting stress reached a higher level than at the more northern contemporary site. Yet the Pawnee, being distant from the Missouri River "superhighway," were more isolated and insular; therefore, they should have experienced a lower level of stress than the population at Leavenworth. Numerically, the Pawnee remained intact longer than the Arickara.

The similarity between the high frequencies of enamel hypoplasia in the Linwood series and those of the Extended and Postcontact variants in South Dakota (e.g., Mobridge [39WW1]) suggests that these populations may have experienced somewhat comparable types of stress (e.g., seasonal food shortages, levels of childhood illnesses, or other events conducive to hypoplasia) even though they represent different time periods.

Types of stress, for example, nutritional or disease-related, might result in different frequencies of hypoplastic lines (and other indicators), a possibility that should be explored. Cashion's (1987) findings show how difficult it is to interpret temporal and geographic differences in indicators of stress. The problem is complex and cannot be solved without larger samples and more comprehensive analyses (e.g., line frequency by type of tooth, sex, site, and other variables) of these samples.

Nongenetic environmental factors can affect tooth enamel in other ways than hypoplasia, for example, by increasing bilateral fluctuating asymmetry in the size of corresponding antimeres. Perzigan (1977a, 1977b) included a Plains Indian sample in a comparison of the levels of fluctuating asymmetry among hunter-gatherers, horticulturists, and twentieth century whites. His results showed a significant difference between an Archaic hunter-gatherer sample from Indian Knoll and a horticulturist sample from Campbell and Larson, as well as between Indian Knoll and the twentieth century Hammon-Todd collection. The difference between the Campbell-Larson sample and the Hammon-Todd groups was not significant. These results are consistent with other evidence suggesting that some Archaic groups suffered greater levels of stress because of their precarious mode of subsistence than did later groups (e.g., Larson) who subsisted on horticulture as well as hunting.

Dental Caries and Antemortem Tooth Loss

Dental Caries

The relationship between diet and dental disease, particularly caries, is a central research issue in dental anthropology and oral biology. Caries, although a multifactor disease process, is predominantly influenced by the form and frequency of carbohydrate ingestion. Dental health and subsistence base are correlated; for example, a low frequency of caries has been found for groups that engage in hunting/fishing and gathering, and a high frequency among horticulturists (Turner 1979; Perzigan et al. 1984). This difference results from the larger proportion of carbohydrates in the diet of the horticulturists. Starches and sugars provide from 45 to 80% of the calorie intake of nonindustrialized horticultural societies (Guthrie 1979). Readily fermentable carbohydrates are characteristic of horticultural foodstuffs (e.g., maize), and their presence stimulates bacterial growth (Lactobacillus acidophilus and Streptococcus mutans) and plaque formation. Bacterial acids promote the decay of dental enamel (Gray et al. 1962). In contrast, meat protein has a cariostatic effect caused by raising the pH and by the relatively brief clearance time in the mouth, which limits use by plaque bacteria (Alfano 1980).

Food processing techniques, which affect texture, adhesiveness, rate of flow of saliva, and amount of grit in the diet, are also related to the frequency of dental pathology. Minimal processing and grit (introduced while cooking or from the use of grinding stones) cause attrition, which has a cleansing effect that limits the accumulation of plaque and bacteria and removes incipient caries. Diets rich in carbohydrates are typically soft and do not require extensive mastication. Boiling softens foods and removes grit. "Detergent" foods that help to cleanse the oral cavity of the foodstuffs that promote dental decay are often lacking (Guthrie 1979).

Several studies have examined the occurrence of dental caries, abscesses, and premortem tooth loss in Plains Indians. These studies provide information about patterns of dental disease in relation to age, sex, dental morphology, attrition, and subsistence pattern (e.g., Leigh 1925; Phenice 1969; Toth and Peterson 1992; Ubelaker 1971).

The pattern of dental disease can be used as an indicator of the shift from hunting and gathering to horticulture (Turner 1979). A few studies of Plains Indian dentitions have focused on the correlation of dental pathology with archeologically defined subsistence base and inferred diet (notably M.A. theses by Masters [1987] and Zitt [1992]). Zitt compared data on dental pathology for the Central (Lower Loup phase and Historic Pawnee) and the Northwestern Plains (Archaic, Late Prehistoric, Protohistoric, and Historic). Rates of caries for horticulturists were only slightly higher than for hunter-gatherers, a finding that suggests a mixed economy with heavy emphasis on hunting. Masters (1987) also found rates of caries in Central Plains and Middle Missouri populations that were surprisingly low for horticultural groups.

The frequency of dental caries in permanent dentitions varies geographically and temporally in the Great Plains. Tables 72, 73, and 74 give the incidence of dental caries by tooth type reported (or calculated from Owsley's data files) for Late Woodland, Southern Plains Village, Central Plains tradition, and Coalescent samples representing the Arikara, Pawnee, Omaha, and Ponca from Nebraska and South Dakota. Table 75 provides additional data and summarizes the findings in regard to caries.
Table 72. Dental Caries in Late Woodland and Southern and Central Plains Tradition Samples.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Southern Plains Village</th>
<th>Late Woodland</th>
<th>Central Plains Tradition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Washita River Phase)</td>
<td>(Schultz Focus)</td>
<td>(Itaskari Phase)</td>
</tr>
<tr>
<td></td>
<td>[34G2, 34WAS]</td>
<td></td>
<td>[25HW3]</td>
</tr>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>37</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Canines</td>
<td>21</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Premolars</td>
<td>36</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Molars</td>
<td>28</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>41</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Canines</td>
<td>28</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Premolars</td>
<td>51</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Molars</td>
<td>52</td>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>294</td>
<td>62</td>
<td>142</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth C = Number with caries % = Percent carious

1 Owsley and Jantz (1989:150)

Table 73. Dental Caries in Extended, Postcontact, and Disorganized Coalescent Tradition Samples from South Dakota.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Extended/Postcontact</th>
<th>Postcontact</th>
<th>Disorganized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>[38SSL4]</td>
<td>[39D12]</td>
<td>[39CC9]</td>
</tr>
<tr>
<td>Incisors</td>
<td>594</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Canines</td>
<td>307</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>Premolars</td>
<td>810</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>Molars</td>
<td>888</td>
<td>52</td>
<td>27</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>579</td>
<td>41</td>
<td>14</td>
</tr>
<tr>
<td>Canines</td>
<td>298</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Premolars</td>
<td>592</td>
<td>41</td>
<td>20</td>
</tr>
<tr>
<td>Molars</td>
<td>875</td>
<td>61</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>4743</td>
<td>313</td>
<td>144</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth C = Number with caries % = Percent carious

1 Phenice (1969:92)

Table 74. Dental Caries in Coalescent Tradition Samples from Nebraska.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Protohistoric Pawnee</th>
<th>Historic Pawnee</th>
<th>Historic Omaha</th>
<th>Historic Ponca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>98</td>
<td>0</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>Canines</td>
<td>51</td>
<td>0</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>Premolars</td>
<td>102</td>
<td>0</td>
<td>56</td>
<td>40</td>
</tr>
<tr>
<td>Molars</td>
<td>150</td>
<td>8</td>
<td>90</td>
<td>68</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>188</td>
<td>0</td>
<td>43</td>
<td>16</td>
</tr>
<tr>
<td>Canines</td>
<td>93</td>
<td>0</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>Premolars</td>
<td>199</td>
<td>5</td>
<td>53</td>
<td>34</td>
</tr>
<tr>
<td>Molars</td>
<td>293</td>
<td>23</td>
<td>88</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td>1184</td>
<td>36</td>
<td>408</td>
<td>298</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth C = Number with caries % = Percent carious

1 Zitt (1992:96)

(As several investigators compiled the data, and for different purposes, there is some overlap or duplication of individuals represented by a few samples.)

Specific information for the Archaic period is lacking, and data for Woodland populations of the Central Plains are sparse. Caries were present, although the percentage of teeth affected was only around 5% or less. The frequency of caries in late Woodland Schultz focus samples from north central Kansas was slightly higher and comparable to that of some of the later Central Plains tradition groups.

Overall oral health was better among Northern Plains Woodland period hunter-gatherers than among the later Plains Village horticulturists (Willey and Hoffman 1994; Williams 1994). Southern and Central Plains tradition populations from Oklahoma, Kansas, and Nebraska show a similar trend, with frequency values for caries higher in later periods than during the Archaic and Woodland periods.

Most of the available data represent Plains Village populations that relied on mixed economies, emphasizing a subsistence pattern based on both hunting and farming. These samples show some heterogeneity, but there is consistency among comparable groups (e.g., Disorganized Coalescent samples). Variations among populations suggest differences in the relative contributions of these two activities to the diet.
The frequency of caries in Southern Plains horticulturists was considerably higher than in the Central and Northern Plains (Owlsley and Jantz 1989). The highest value (21.1%) for caries occurred in Southern Plains villagers from Oklahoma, with an Iskari phase Central Plains tradition sample from Nebraska next (14.8%). Caries affected all types of teeth (including incisors and canines). This regional difference indicates greater reliance on maize in the Southern Plains. Although precise data on frequency are lacking, carious lesions were common in Steed-Kisker (e.g., 14WY7) from Kansas and Missouri (Barnes 1977; Stewart 1943).

Coalescent tradition samples show a lower rate of dental caries than the Central Plains tradition samples; however, there was heterogeneity among these samples. Although there was no change in the frequency of caries between the Protohistoric and Historic Pawnee (Table 74), the Postcontact Coalescent Arikara experienced higher frequencies of caries (suggesting greater dependence on maize) than did the earlier Extended and later Disorganized Coalescent Arikara (Tables 73 and 75). This pattern is consistent with archeological evidence indicating differences in the subsistence base of these variants (i.e., heavier emphasis on horticulture by Postcontact villagers).

Burial samples from the same Omaha village (i.e., 25DK2 and 25DK10) show differences in the frequency of caries (Table 76). Adults from 25DK2 were essentially free of dental caries (0.6%), compared to a much higher frequency of caries (9.0%) in those from 25DK10, a percentage similar to that found among the Postcontact Coalescent Arikara. The meaning of this internal variation is not yet understood: does it reflect dietary differences that are linked to trade (e.g., differential access to sugar), relatively greater dependence on maize among subsets of the same population, or a temporal effect involving a rapidly changing diet as a result of contact?

Among the horticulturists, the lowest frequencies of caries occurred in the Disorganized Coalescent Arikara, Pawnee, and Ponca, as a result, in part, of heavy reliance on bison hunting. No published data are available for late nomadic groups like the Cheyenne and Sioux, with the exception of an early study by Leigh (1925). This study found pronounced differences among the Zuni, Arikara, and Sioux, the latter having the lowest frequency, a difference attributed to the low proportion of carbohydrates and large amounts of animal protein in the Sioux diet.

Most studies tabulate the data without regard for the age or sex distribution of the sample. In the case of the Protohistoric and Historic Pawnee, a group with a low frequency of caries, this approach is valid, as the basic statistics for age-stratified adults and for males and females are comparable (Table 77; Zitt 1992). Sex-specific data for additional samples appear in Table 78. Only the Omaha show a pronounced difference, with nearly all carious lesions found in females (from 25DK10). This observation does not fit a time-based model but is indicative of differential access to certain foods (through trade or by farming) by groups of related (?) females. Because the available information is limited, future evaluations of the data on dental pathology should include tests for differences related to demographic composition.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Ind.</th>
<th>Teeth</th>
<th>Carious</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaic/Woodland</td>
<td>Multiple1,2</td>
<td>21</td>
<td>74</td>
<td>2</td>
<td>5.0</td>
</tr>
<tr>
<td>Late Woodland</td>
<td>14PO14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Plains</td>
<td>Multiple1,2</td>
<td>36</td>
<td>78</td>
<td>10</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>14SA10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25DKX9, 25DK13</td>
<td>35</td>
<td>75</td>
<td>9</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>25DKW1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postcontact</td>
<td>39LH27, 39WY7</td>
<td>94</td>
<td>9</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>39WY22, 39LH4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disorganized</td>
<td>Multiple1,2</td>
<td>32</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Pawnee</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Omaha/Ponca</td>
<td>Multiple1,2</td>
<td>11</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Omaha</td>
<td>25DK2, 25DK10</td>
<td>17</td>
<td>407</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Arikara</td>
<td>39CG6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The percent column refers to the percentages indicated by the investigator(s) and some omitted reporting the data on which the percentage was based.

1 Masters (1987)
2 Curming (1958)
3 Finnegan (1990)
4 Tolley and Peterson (1992)
5 Rose, Marks, and Kay (1984)
8 Pawnee: 25BU1, 25BU2, 25NC20, 25PK1, 25SD2, 25WT1
9 Omaha/Ponca: 25CD7, 25DK2, 25DK10, 25GW7

---

Table 75. Dental Caries in Archaic, Woodland, and Plains Village Dentitions.

Table 76. Dental Caries and Alveolar Bone Pathology in Samples from Two Omaha Cemeteries.

<table>
<thead>
<tr>
<th>Tooth</th>
<th>25DK2</th>
<th>25DK10</th>
<th>25DK2</th>
<th>25DK10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>C</td>
<td>%C</td>
<td>S</td>
</tr>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>10</td>
<td>0</td>
<td>0.0</td>
<td>29</td>
</tr>
<tr>
<td>Canines</td>
<td>9</td>
<td>0</td>
<td>0.0</td>
<td>15</td>
</tr>
<tr>
<td>Premolars</td>
<td>21</td>
<td>0</td>
<td>0.0</td>
<td>33</td>
</tr>
<tr>
<td>Molars</td>
<td>38</td>
<td>0</td>
<td>0.0</td>
<td>44</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>15</td>
<td>0</td>
<td>0.0</td>
<td>24</td>
</tr>
<tr>
<td>Canines</td>
<td>9</td>
<td>0</td>
<td>0.0</td>
<td>14</td>
</tr>
<tr>
<td>Premolars</td>
<td>17</td>
<td>0</td>
<td>0.0</td>
<td>26</td>
</tr>
<tr>
<td>Molars</td>
<td>35</td>
<td>1</td>
<td>2.9</td>
<td>41</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth; C = Number with carious lesions; %C = Percent carious; S = Number of tooth sockets; P = Number with alveolar bone pathology (antemortem loss & perimortem abscesses); %P = % with pathology
Table 77. Number of Carious Teeth in the Protohistoric and Historic Pawnee by Age and Sex (Zitt 1992:91, 93).

<table>
<thead>
<tr>
<th>Tooth</th>
<th>15-29 Years</th>
<th></th>
<th>30+ Years</th>
<th></th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>C</td>
<td>%</td>
<td>N</td>
<td>C</td>
<td>%</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Maxillary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>129</td>
<td>0</td>
<td>0.0</td>
<td>126</td>
<td>0</td>
<td>0.0</td>
<td>118</td>
<td>0</td>
</tr>
<tr>
<td>Canines</td>
<td>66</td>
<td>0</td>
<td>0.0</td>
<td>65</td>
<td>1</td>
<td>1.5</td>
<td>59</td>
<td>0</td>
</tr>
<tr>
<td>Premolars</td>
<td>134</td>
<td>2</td>
<td>1.5</td>
<td>133</td>
<td>4</td>
<td>3.0</td>
<td>119</td>
<td>4</td>
</tr>
<tr>
<td>Molars</td>
<td>197</td>
<td>4</td>
<td>2.0</td>
<td>201</td>
<td>13</td>
<td>6.5</td>
<td>172</td>
<td>8</td>
</tr>
<tr>
<td>Mandibular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>198</td>
<td>0</td>
<td>0.0</td>
<td>146</td>
<td>0</td>
<td>0.0</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>Canines</td>
<td>97</td>
<td>0</td>
<td>0.0</td>
<td>75</td>
<td>0</td>
<td>0.0</td>
<td>84</td>
<td>0</td>
</tr>
<tr>
<td>Premolars</td>
<td>192</td>
<td>9</td>
<td>4.7</td>
<td>154</td>
<td>5</td>
<td>3.2</td>
<td>133</td>
<td>5</td>
</tr>
<tr>
<td>Molars</td>
<td>301</td>
<td>14</td>
<td>4.7</td>
<td>229</td>
<td>13</td>
<td>5.7</td>
<td>202</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>1314</td>
<td>29</td>
<td>2.2</td>
<td>1129</td>
<td>38</td>
<td>3.2</td>
<td>997</td>
<td>28</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth; C = Number with caries; % = Percent carious.

Table 78. Frequency of Dental Caries in Plains Village Adults by Gender.

<table>
<thead>
<tr>
<th>Variant, and Site</th>
<th>Males N</th>
<th>Males C</th>
<th>%</th>
<th>Females N</th>
<th>Females C</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Plains¹</td>
<td>125</td>
<td>26</td>
<td>20.8</td>
<td>168</td>
<td>36</td>
<td>21.3</td>
</tr>
<tr>
<td>Postcontact Coalescent Arikara² (39DW2)</td>
<td>52</td>
<td>6</td>
<td>11.5</td>
<td>261</td>
<td>26</td>
<td>10.0</td>
</tr>
<tr>
<td>Disorganized Coalescent Pawnee³ (multiple sites)</td>
<td>997</td>
<td>28</td>
<td>2.8</td>
<td>1385</td>
<td>29</td>
<td>2.1</td>
</tr>
<tr>
<td>Disorganized Coalescent Omaha (25DK2, 25DK10)248</td>
<td>1</td>
<td>0.4</td>
<td>181</td>
<td>23</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>Ponca (25KX1)116</td>
<td>116</td>
<td>2</td>
<td>1.7</td>
<td>172</td>
<td>5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Note: N = Number of permanent teeth; C = Number with caries; % = Percent carious.

In summary, previous studies and the data presented in these tables demonstrate:

- Variation in susceptibility to caries among the different types of teeth. The incisors exhibit the highest resistance to caries, followed in descending order by the canines, premolars, and molars.

- Variation in susceptibility to caries among different surfaces of the same tooth. Initially, most cavities involve either the occlusal or interproximal surfaces. The buccal surface is prone to caries when a buccal pit is present.

- Similar rates of dental caries in both sexes. Only the Omaha show a noticeable difference in incidence in relation to sex, with a higher frequency for females.

- Geographic and temporal differences among Plains populations. Some of the greatest variation occur within the horticultural groups, which indicates varying degrees of dependence on maize.

- Lower frequencies of dental caries among the Plains Village horticulturists than among the sedentary farmers in many other parts of the continent. (Populations with heavy emphasis on agriculture show frequencies of at least 10% or more for caries [Patterson 1984; Turner 1979].)

Although a few of these assessments are based on large samples, often sample sizes are quite small, and there are many gaps in the data base, with a number of cultural units not represented. Furthermore, some of the available data are of limited usefulness for comparative studies because they fail to provide precise information on the percentage of carious teeth. Additional samples, categorized by age when appropriate, and derived from systematic, controlled studies must be included to validate trends and comparisons among population samples representing different areas and eras.

The frequency of pathological conditions in deciduous dentition has not been systematically evaluated. In general, dental caries is rare among subadults in the Central and Northern Plains except during the late Historic period and among early Plains Village populations. In Owsey's experience, caries is rare in Woodland populations and in most Coalescent samples from Nebraska and South Dakota. For example, there are few cases of caries in deciduous teeth in a large sample of children from the Extended/Postcontact Coalescent Sully site (39SL4).

The Disorganized Coalescent Omaha in northeastern Nebraska are an exception, with carious lesions present in the teeth of several children. This anomalous condition may reflect a change in the diet (e.g., the introduction and consumption of sugar) as a result of trade with Euro-Americans, or heavier dependence on maize than was the case for the contemporary Arikara and Pawnee.

Late nineteenth populations experienced problems with deciduous dental caries that are linked to changes in dietary patterns, such as greater reliance on cariogenic foods, sometimes in combination with ontogenetic factors that disrupted dental development and resulted in defective (i.e., hypocalcified or hypoplastic) enamel. The deciduous lateral maxillary incisors of a Sioux child (39ST50), ca. 1880, show notches from circular caries (Wille and Swegle 1980). Dental development was disrupted prenatally when the affected portions of enamel were forming, and this disturbance predisposed the child to tooth decay. Late nineteenth century Crow and Blackfeet children from Montana show similar increases in the incidence of caries.

The data available for deciduous dentitions reinforce the evidence for higher frequencies of caries in the permanent teeth of Central Plains tradition populations (relative to later Coalescent tradition populations). Subadults from at least four Central Plains tradition sites (14SA1, 14WY, 25FT1, and 25HW3) show deciduous dental caries. Two of 75 (2.7%) deciduous teeth (lost postmortem and recovered while screening the dirt prior to closing and backfilling the site) from the Indian Burial Pit (14SA1) were affected by caries (Finnegan 1990). Based on descriptive information provided for the Calovich burials (14WY7) (frequency data are not provided), deciduous dental
caries was fairly common (Barnes 1977). Carious lesions affected both the deciduous teeth and the permanent molars during childhood.

To substantiate the suggested higher frequencies of caries in Central Plains tradition subadults, and also in more southern Plains populations, will require additional data. Deciduous caries is a particularly sensitive indicator of relative dependence on corn or other sources of carbohydrates and of sugar in the diet, as these teeth are present for only a limited number of years before exfoliation. Problems with tooth decay in children indicate a diet that is highly cariogenic. To date, however, the implications of deciduous caries have received little attention and investigation.

**Alveolar Abscessing and Antemortem Tooth Loss**

Many factors affect the interpretation of oral pathology profiles for various groups. Progressive dental caries and heavy attrition can result in abscessing and exfoliation of a tooth by exposing the pulp chamber to bacterial invasion. Periodontal disease, primarily due to the accumulation of plaque deposits, leads to inflammation and deterioration of the periodontium. This condition is indicated by gingival and alveolar bone resorption, which can result in tooth loss.

Observations of antemortem tooth loss and abscessing are commonly noted in bioarchaeological reports; however, in most cases the information is descriptive and rarely is it synthesized in a format that facilitates comparison. Thus, comparable data for rigorous statistical evaluation of the occurrence of alveolar abscessing and antemortem tooth loss are limited. To compare selected Central and Northern Plains samples, counts in situ for teeth with periapical or periodontal abscesses (i.e., abscessing at the time of death) were combined with the numbers of teeth lost antemortem. This composite statistic provides a measure of the "frequency of serious dental pathology" in a few studies (Phenice 1969:61).

Table 79 shows the frequencies of alveolar bone pathology in two Woodland samples and a Southern Plains Village sample. Data for the protohistoric Arikara and Pawnee and the historic Omaha, Pawnee, and Ponca appear in Tables 80 and 81. Molars were more often affected than the incisors and canines.

The Southern Plains Village sample and the Middle Woodland Sonota complex sample from South Dakota had the highest frequencies of alveolar bone disease. Both caries and attrition were the primary causal factors in the Southern Plains sample, but attrition was the main cause in the Sonota series, which is consistent with the many older adults in this sample (Phenice 1969). In Middle Woodland burials from the Taylor Mound (14PD2), Klepinger and Bass (1971:185) describe teeth worn to the gum line as "a striking feature of the dentition." A high incidence of periodontal disease and a low incidence of caries characterized this group. Only three, or possibly four, teeth were carious, yet nearly all dentitions showed alveolar resorption and tooth loss from abscesses caused by the extreme degree of wear. In contrast, other Woodland samples (e.g., 14PO14 (Cumming

### Table 79. Alveolar Bone Pathology in Woodland and Southern Plains Village Samples.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Woodland¹ Sonata Complex</th>
<th>Late Woodland² Schultz Focus</th>
<th>Southern Plains Village²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(39DW233, 39DW240, 39DW252)</td>
<td>(Multiple Sites)</td>
<td>(34GV2, 34WA5)</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>P</td>
<td>%</td>
</tr>
<tr>
<td><strong>Incisors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxillary</td>
<td>75</td>
<td>19</td>
<td>25.3</td>
</tr>
<tr>
<td>Canines</td>
<td>37</td>
<td>6</td>
<td>16.2</td>
</tr>
<tr>
<td>Premolars</td>
<td>74</td>
<td>11</td>
<td>14.8</td>
</tr>
<tr>
<td>Molars</td>
<td>98</td>
<td>40</td>
<td>41.7</td>
</tr>
<tr>
<td><strong>Mandibular</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>74</td>
<td>20</td>
<td>27.0</td>
</tr>
<tr>
<td>Canines</td>
<td>38</td>
<td>10</td>
<td>26.3</td>
</tr>
<tr>
<td>Premolars</td>
<td>74</td>
<td>18</td>
<td>24.3</td>
</tr>
<tr>
<td>Molars</td>
<td>112</td>
<td>54</td>
<td>48.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>580</td>
<td>178</td>
<td>30.7</td>
</tr>
</tbody>
</table>

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss%

¹ Phenice (1969:61)
² Osley and Jantz (1989:151)

### Table 80. Alveolar Bone Pathology in Plains Village Samples from Nebraska.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Protohistoric Pawnee¹</th>
<th>Historic Pawnee¹</th>
<th>Historic Omaha (25DK2, 25DK10)</th>
<th>Historic Ponca (25XX1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Multiple Sites)</td>
<td>(Multiple Sites)</td>
<td>(N</td>
<td>P</td>
</tr>
<tr>
<td><strong>Incisors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxillary</td>
<td>93</td>
<td>4</td>
<td>4.3</td>
<td>157</td>
</tr>
<tr>
<td>Canines</td>
<td>49</td>
<td>0</td>
<td>0.0</td>
<td>81</td>
</tr>
<tr>
<td>Premolars</td>
<td>100</td>
<td>9</td>
<td>9.0</td>
<td>165</td>
</tr>
<tr>
<td>Molars</td>
<td>144</td>
<td>15</td>
<td>10.4</td>
<td>243</td>
</tr>
<tr>
<td><strong>Mandibular</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incisors</td>
<td>188</td>
<td>9</td>
<td>4.8</td>
<td>155</td>
</tr>
<tr>
<td>Canines</td>
<td>92</td>
<td>4</td>
<td>4.3</td>
<td>78</td>
</tr>
<tr>
<td>Premolars</td>
<td>187</td>
<td>12</td>
<td>6.4</td>
<td>157</td>
</tr>
<tr>
<td>Molars</td>
<td>288</td>
<td>43</td>
<td>14.9</td>
<td>235</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1141</td>
<td>96</td>
<td>8.4</td>
<td>1271</td>
</tr>
</tbody>
</table>

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss%

¹ Zitt (1982:165)
Table 81. Alveolar Bone Pathology in Coalescent Tradition Samples from South Dakota.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>Postcontact Arkares(^1) [39D2W]</th>
<th>Extended/Postcontact Arkares(^2) [39SL4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar</td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>Incisors</td>
<td>60</td>
<td>6</td>
</tr>
<tr>
<td>Canines</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Premolars</td>
<td>51</td>
<td>3</td>
</tr>
<tr>
<td>Molars</td>
<td>33</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss; % = Percent pathological.

\(^1\) Owsley and Jantz (1989:151)

\(^2\) Phenicie (1989:61)

1958), 14MO314 (Bass and Head n.d.) showed no evidence of abscessing, with retention of teeth into late life in spite of excessive wear. The incomplete mandible of a young adult female from a Late Archaic site (5WL26055) in the Northeastern Colorado High Plains was edentulous (Wanner and Brunswig 1992).

In the Late Woodland Shults series from Kansas and the historic tribal groups from Nebraska, the incidence of alveolar pathology ranged between 4 to 10%. Consistent with the higher frequency of caries, infections and tooth loss were more common in the Arkares.

The age distribution of a study sample is a key factor in populations with significant rates of tooth wear, for when the diet is abrasive and mastication heavy, older individuals are more likely to suffer tooth loss resulting from pulp exposure. All individuals over 50 years of age from the Calovich Mound (14W77) show extreme attrition, abscesses, antemortem loss of several teeth, alveolar bone resorption, and hypercementosis (Barnes 1977). In the case of the Pawnee, the frequency of alveolar bone pathology was more than four times greater in adults who were more than 30 years old compared to those between the ages of 15 and 29 (Table 82; Zitt 1992). Because of the low frequency of caries in this population, this difference is mainly attributable to the cumulative effect of tooth wear. Abscesses and tooth loss were twice as common in males as females in this sample. Both sex and age differences are statistically significant.

As in the case of caries, Omaha burials from 25DK2 and 25DK10 differ in the frequency of alveolar bone pathology (Table 79), thus providing further evidence of dietary divergence in a single village. The sample from 25DK2 has virtually no pathology (0.9%), as compared to 13.1% of tooth sockets showing pathology in the 25DK10 sample, with all tooth types affected.

McWilliams (1965) compared alveolar abscessing and periodontal disease in young (20-35 years) and older (35-50 plus) males and females in a sample from Sully (39SL4). He found the incidence of alveolar pathology the same for males (16.6%) and females (16.7%). In both sexes, the maxillary sockets were more frequently affected that the mandibular. As might be expected, for both sexes, alveolar pathology was greater for those of advanced age for both sexes than for the younger adults. Of 747 sockets of young adult males, 48 (6.5%) were affected, compared to 151 (33.5%) of 450 sockets of older males. For females the data were as follows: 7 (1.2%) of 555 sockets of the younger group showed pathology, compared to 158 (37.6%) of 420 sockets of older females. In regard to individuals, 28.1% of the 32 younger males had alveolar bone pathology compared to 86.4% of the 22 older males. Similarly, 29.2% of the 24 younger females had such pathology compared to 60% of the 20 older ones. Thus, McWilliams' data are consistent with the data from other samples showing an increase of alveolar bone pathology with age; however, he found no difference in incidence of such pathology in relation to sex.

Available data are too limited to provide a more comprehensive statement about differences in temporal or regional patterns in alveolar bone pathology. More thorough documentation of the incidence and causes of such pathology is necessary, with base counts indicated for the number of healthy, abscessed, and resorbed dental sockets for each tooth type per individual, as well as comparisons between sexes and for different age categories.

Table 82. Alveolar Bone Pathology in the Protohistoric and Historic Pawnee by Age and Sex (Zitt 1992:98, 100).

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>15-29 Years N</th>
<th>15-29 Years P</th>
<th>30+ Years N</th>
<th>30+ Years P</th>
<th>Female N</th>
<th>Female P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td>N</td>
<td>P</td>
<td>%</td>
<td>N</td>
<td>P</td>
<td>%</td>
</tr>
<tr>
<td>Incisors</td>
<td>124</td>
<td>1</td>
<td>0.8</td>
<td>126</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Canines</td>
<td>65</td>
<td>0</td>
<td>0.0</td>
<td>69</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Premolars</td>
<td>132</td>
<td>1</td>
<td>0.8</td>
<td>133</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Molars</td>
<td>182</td>
<td>7</td>
<td>3.9</td>
<td>195</td>
<td>44</td>
<td>23.0</td>
</tr>
<tr>
<td>Mandibular</td>
<td>N</td>
<td>P</td>
<td>%</td>
<td>N</td>
<td>P</td>
<td>%</td>
</tr>
<tr>
<td>Incisors</td>
<td>198</td>
<td>2</td>
<td>1.0</td>
<td>145</td>
<td>12</td>
<td>8.3</td>
</tr>
<tr>
<td>Canines</td>
<td>90</td>
<td>1</td>
<td>1.1</td>
<td>74</td>
<td>8</td>
<td>10.8</td>
</tr>
<tr>
<td>Premolars</td>
<td>101</td>
<td>1</td>
<td>1.0</td>
<td>133</td>
<td>15</td>
<td>11.3</td>
</tr>
<tr>
<td>Molars</td>
<td>206</td>
<td>27</td>
<td>13.3</td>
<td>224</td>
<td>50</td>
<td>22.3</td>
</tr>
<tr>
<td>Total</td>
<td>1297</td>
<td>45</td>
<td>3.5</td>
<td>1115</td>
<td>181</td>
<td>16.2</td>
</tr>
</tbody>
</table>

Note: N = Number of tooth sockets; P = Number of teeth lost from antemortem abscessing plus the number with perimortem abscesses.

% = Percentage of sockets showing alveolar bone pathology.
Behaviorally and Culturally Induced Alterations in Dentition

Dental Attrition at the Macroscopic Level

Most bioarchaeological research that includes information on dentition mentions—sometimes only in passing—the level of dental attrition as an indicator of chronological age, or more often, of type of food processing, subsistence pattern, or dental pathology. Colorado Plains Woodland complex burials, for example, generally have a low incidence of caries but occasional abscesses caused by rapid and extremely heavy wear that results from the use of soft sandstone milling stones and a diet including a substantial amount of wild plants and seeds (Scott and Birkedal 1972). Clearly, temporal and regional differences in rate of tooth wear must be present; for example, limited food processing techniques in Archaic and Woodland populations resulted in fairly heavy attrition. However, the nature of such differences is as yet poorly documented and primarily impressionistic. Quantitative data with which to compare populations are generally lacking, and some of the data that do exist have not been published.

Dental wear is difficult to score and analyze. It varies, in part, in relation to the age of an individual, so age composition of a sample must be controlled when making comparisons, which is not easy. Age determinations of bioarchaeological samples can be influenced by observations of the level of tooth wear, resulting in circularity and bias in such research. One way to address this problem is to compare relative levels of occlusal surface wear between adjacent molars, which differ by an interval determined by the time of eruption. For example, the attrition gradient (i.e., differences between scores for the first, second, and third molars) for two individuals from Swan Creek (39WW7) indicated a rapid rate of tooth wear and an abrasive diet, even though the actual scores were not especially high (Rose, Marks, and Kay 1984).

Several coding systems (e.g., Murphy 1959; Scott 1979; Smith 1984) have been used to score dental attrition in individual Plains samples (cf., Masters 1987; Rose, Marks, and Kay 1984). The Scott (1979) system scores each quadrant of the occlusal surface of a molar according to the proportional area of enamel wear facets and the amount of remaining enamel when dentin is exposed. In the Murphy and Smith systems, the stage of dentin exposure is matched with standardized drawings arranged in ordinal scales. In addition, angles of occlusal wear and size of distal interproximal wear facets on first molars have been measured for a few groups (Masters 1984, 1987).

The severity of wear is determined by the vigor and amount of mastication required for food consumption, the presence of abrasive material, and individual variables such as oral pathology (e.g., abscesses and antemortem tooth loss) or malocclusion. With attrition, the occlusal surfaces of the posterior teeth can be worn flat or sloped (i.e., angled), with the mandibular and maxillary molars showing opposite wear planes. Patterns of oblique occlusal wear are common in Plains Village dentitions and are a progressive function of attrition, abrasion, and age. (Attrition refers to normal wear of the teeth from rubbing against each other; abrasion reflects the presence of grit in the diet.)

Age-related change in patterns of occlusal wear for the premolars and molars has been documented for Arikara dentitions from the Larson site (39WW2), a Postcontact Coalescent village. Up to about 18 years of age, the occlusal surfaces of the mandibular teeth and the maxillary premolars show lingual sloping and the maxillary molars show buccal sloping (Butler 1969, 1972). Attrition during the young adult years begins to reverse these wear planes in such a way that the maxillary first molars show increasing wear on the lingual halves of the crowns and the mandibular first molars show greater wear on the buccal cusps. These wear gradients gradually produce a lingual slope in the maxillary first molars and a buccal slope in the mandibular first molars. With increasing age, the mandibular premolars and second molars also develop buccal wear planes, and the maxillary premolars and molars show an increased lingual slope.

Plane angles of wear for Nebraska and South Dakota groups were compared in a test of Smith’s (1984) hypothesis that hunter-gatherers exhibit flatter wear and that an oblique angle is more characteristic of agriculturalists (Masters 1984, 1987). The rationale was as follows:

Hunter-gatherers eating tough fibrous food tend to use a vertical chopping type of mastication followed by a grinding and shearing across the teeth which requires more lateral movement of the jaw and a more robust crano-facial mastication morphology. Horticulturalists (sic), on the other hand, eating a more refined diet requiring less jaw movement, less robust mechanisms of mastication and smaller grinding tooth to tooth contacts develop a more buccally angled wear on the mandibular first molars and a lingually angled wear on the corresponding maxillary first molars. (Masters 1984: 27-28)

Seven groups were compared:

• A combined Archaic and Woodland sample (N = 21)
• A Central Plains tradition sample (N = 36)
• Extended (N = 24), Postcontact (N = 33), and Disorganized (N = 22) Coalescent Arikara samples
• A Coalescent tradition Pawnee sample (N = 32)
• A Coalescent tradition Omaha/Ponca sample (N = 11)

On a scale of 1-8, the Central Plains group had the least amount of wear (3.5) on first molars, and the Archaic/Woodland sample had the most (5.5). The Extended, Postcontact, and Disorganized Coalescent samples were similar, with the levels of wear ranging from 4.7 to 5.0. The Central Plains sample showed the least amount of slope on first molars, followed by the Archaic/Woodland sample. The Extended Coalescent and Disorganized Coalescent Arikara showed the highest plane angles of wear.

An index of the size of interproximal wear facets was developed. The smallest facet (0.16) size occurred in the Archaic/Woodland group; increases in size appeared in the Central Plains (0.22), Extended Coalescent (0.36), and Postcontact and Disorganized Coalescent Arikara and Omaha/Ponca (0.42-0.44) samples. This increase in the facet index was not anticipated,
being the “opposite of what would be expected for groups with increasing reliance on horticulture” (Masters 1987:115). (The expected pattern was a decrease in size of facets among horticulturists as a result of their softer diet. Yet, the Postcontact Coalescent sample had the highest rate of caries and the largest facet index.) As noted in the section on “Subsistence in the Central and Northern Plains,” the Plains Village horticulturists were unique in their ecological adaptation because of heavy dependence on bison hunting. Late Village populations varied in their emphasis on horticulture. Larger sample sizes, a refined temporal model, and alternative hypotheses will be necessary to achieve a better understanding of patterns of dental attrition over time. Cultural activities that required use of the teeth for specific processing tasks could be responsible in part for the increased interstitial wear found in groups representing later periods. Other limitations in the research design should also be considered. Separate Woodland and Archaic samples should be analyzed, as incipient horticulture among some Woodland groups suggests that the combined sample is not typical of hunter-gatherers. Further, possible variation in the demographic profiles of these samples should be controlled; for example, age differences in the composition of samples could affect values obtained for dental wear (cf. Butler 1972).

Nearly all of the available data concern the permanent teeth. However, deciduous teeth are also subject to wear. Finnegan’s (1990) field examination of burials from the Indian Burial Pit (14SA1) showed that 20.8% of the deciduous incisors, 38.5% of the canines, and 42.2% of the molars displayed attrition, evidence of considerable grit in the diet.

Central and Northern Plains Indian dentitions show grooves in the occlusal surfaces of the anterior teeth (e.g., tailor’s notch) (Symes, Case, and Thurston 1985), although examples are relatively infrequent and have not been systematically studied or reported. Most of these modifications can be attributed to the use of the teeth in specific task activities (e.g., working with fibers or sinew) that gradually abrade the dental enamel and underlying softer dentin of affected teeth.

More common, but also poorly documented, are noticeable differences that occur in some individuals in the levels of tooth wear between the anterior and posterior teeth. In these cases, the incisors and canines show more pronounced wear and occasionally also have rounded occlusal/facial surfaces. These features reflect use of the anterior teeth in tasks that accelerate the rate of wear above that which occurs in normal mastication. For example, both males and females from the Sargent site (25CU28), a Central Plains tradition ossuary, show a gradient of decreasing wear for the posterior teeth (O’Shea and Bridges 1989). Wear is moderate to heavy for the anterior teeth, becoming much lighter toward the back of the dental arcade. In the oldest individual, aged 40 to 50 years, the incisors are worn to the gum line.

Two historic tribal groups in the Central and Northwestern Plains that show noticeably heavy anterior tooth wear are the Omaha and the Crow. The dentition of females, in particular, tends to show this pattern, along with other features (e.g., pronounced development of the attachment sites of the muscles of mastication and a high frequency of temporomandibular pathology) that indicate heavy use of the anterior teeth for processing of materials. The level of anterior tooth wear in the historic Omaha (25DK2 and 25DK10), when compared to the Nebraska phase adults from 25DK9 and 25DK13, indicates a temporal difference; 58.8% of the Historic sample displayed extreme anterior wear in contrast to 34.2% of the prehistoric sample (Toth and Peterson 1992). Detailed documentation and scoring of observations are necessary in order to clarify individual and sex-related patterns resulting from specific activities and differences in these patterns among populations.

Molar Enamel Microwear

Microwear analysis of molar cusp surfaces with a scanning electron microscope (SEM) provides information about diet and food processing techniques (Blauuer and Rose 1982; Rose, Marks, and Kay 1984). Photographs at low (15-30X) and high (1500X) magnifications make possible both qualitative and quantitative analyses of striations, compression fractures, gouges, and polish in enamel. For example, high magnification micrographs and proportional estimates of the surface area covered by each type of feature on a standardized grid yield data on the average width of striations, fractures, and gouges. These data, in turn, provide information about the coarseness of foods and the relative amounts of grit, hard seed particles, and unprocessed vegetable fiber in the diet. Large striations (i.e., elongated grooves cut into the enamel surface) indicate coarsely prepared, abrasive foods, with large amounts of grit, generally resulting from use of a grinding stone. Compression fractures (i.e., roughly circular depressions) occur when chewing hard particles embedded in a relatively soft food matrix. Large, hard objects compressed between the teeth produce gouges. Polished enamel, that is, smooth enamel without visible striations at 1500X, suggests unprocessed vegetable fiber in the diet or, possibly, the chewing of dried meat.

Rose, Marks, and Kay (1984) conducted a pilot study in which they examined a small number of molars from remains recovered during salvage operations from 1979-1982 at Lakes Oahe, Francis Case, and Sharpe in South Dakota. The sample included single molars from Bergner (39BR36), Crow Creek (39BF11), DeGrey (39HU205), Stricker (39LM1), Donahue (39LM27), and Mobridge (39WW1) and two molars from different individuals from 39GR21 and Swan Creek (39WW7). Because of the small sample, the results, summarized in Table 83, are only preliminary. Samples from Medicine Crow, a possible Archaic burial, and 39GR21 (Woodland) display gouges, short striations produced when there is only a small amount of shear component during mastication. Specimens from Coalescent tradition sites lack polish and have numerous large striations and compression fractures. Only the tooth from Donahue shows extensive polishing. Comparison of the two specimens from Swan Creek with the one from Mobridge (matched as second mandibular molars of individuals of like age) demonstrated great similarity between the molar of Swan Creek Burial 3 and the Mobridge molar (Rose, Marks, and Kay 1984). The qualitative and quantitative differences between the two individuals from Swan
Table 83. Scanning Electron Microscopy of Molar Enamel Microwear (Rose, Marks, and Kay 1984)

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>Description</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaic?</td>
<td>39BF2</td>
<td>Numerous large, sharp-margined striations and gouges, a few compression fractures, no enamel polish.</td>
<td>Large striations indicate a coarsely prepared diet with considerable grit that required heavy mastication. No unprocessed fiber. The microwear pattern indicates a coarse, abrasive diet containing numerous grit particles and no vegetable fiber. The diet of Burial 5 included hard seeds.</td>
</tr>
<tr>
<td>Woodland?</td>
<td>39GR21</td>
<td>Burial 4: A rough enamel surface with numerous large, sharp striations and a few small compression fractures. Burial 5: Similar, but has more compression fractures and a small number of gouges.</td>
<td>Diet was coarse and gritty, prepared with stone utensils; contained hard seed particles, no unprocessed vegetable fibers. Grit in the diet indicates the use of grinding stones. Dental caries, a moderate rate of dental attrition, and the microwear pattern suggest a moderately refined diet high in carbohydrates from maize, and also the use of seeds.</td>
</tr>
<tr>
<td>Initial Middle Missouri</td>
<td>39BF11</td>
<td>Large sharp-margined striations, numerous compression fractures, no polishing.</td>
<td>Diet was coarse and included some non abrasive polishing material and a few hard seeds.</td>
</tr>
<tr>
<td>Extended Coalescent</td>
<td>39BR36</td>
<td>Numerous large striations and a few compression fractures. The margins of many striations are smooth.</td>
<td>Diet was coarse and prepared with stone utensils; also included fruits with hard seeds.</td>
</tr>
<tr>
<td>Postcontact Coalescent</td>
<td>39LM1</td>
<td>Moderate and large-sized striations with sharp to rounded margins and numerous compression fractures.</td>
<td>The pronounced differences between these patterns may indicate seasonal variation in diet.</td>
</tr>
<tr>
<td>Postcontact Coalescent</td>
<td>39WW7</td>
<td>A rough enamel surface with numerous compression fractures and striations at cusp margins. Large chatter marks from holding or crushing a large hard object.</td>
<td>Diet was coarse and included large numbers of seeds and, possibly, vegetable fiber.</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39LM28</td>
<td>Numerous large, sharp-margined striations and compression fractures, large chatter marks, extensive polish.</td>
<td></td>
</tr>
</tbody>
</table>

Creek indicated different diets, perhaps reflecting seasonal changes in food availability. Other conclusions based on these Coalescent tradition samples are the following:

- The villagers consumed a coarse diet, with the primary source of abrasive grit derived from the use of grinding stones.
- The high frequency of compression fractures indicates the presence of hard seeds and nuts in the diet, similar to chokecherries and hackberries.
- The diet included little vegetable fiber, and food processing techniques (e.g., grinding and extended boiling) reduced fiber content.
- Rates of dental attrition exceeded those of southeastern U.S. agriculturists and approximated those of Southeastern hunter-gatherers.

This pilot study shows the usefulness of SEM analysis of enamel microwear in reconstructing dietary patterns and food processing techniques among Plains populations. Controlled studies with adequate sample sizes would contribute substantially to the understanding of temporal and regional patterns of subsistence and the technologies of food preparation.

Interproximal Grooves

Several studies have reported on the occurrence of artificial interproximal grooves in Plains Indian dentitions. A tubular alteration was first observed in the right maxillary second and third molars of an adult male from the Leavenworth site (39CO9) in South Dakota (Ubekelker et al. 1969). To determine possible causation and the temporal and spatial distribution of this feature, archeological collections from five states were surveyed. The survey showed that the occurrence of interproximal grooves was geographically widespread and extended from the Archaic to the Historic period, a span of approximately 6,000 years. In North America, interproximal grooves have been reported in California (Schulz 1977), the Great Basin (Larsen 1985), the Southeast (Ubekelker et al. 1969), and especially in the Great Plains (Willey and Hofman 1994).

Table 84. Interproximal Grooves in Woodland and Coalescent Tradition Collections.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Site</th>
<th>N</th>
<th>E</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaic-Late</td>
<td>14GE8</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodland</td>
<td>14CY32</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Woodland</td>
<td>14GE3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14GE4</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14GE5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14GE6</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodland</td>
<td>39HT2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39HU203</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39LM256</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39RO102</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Late Woodland</td>
<td>39RO42</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coalescent</td>
<td>39CA4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended</td>
<td>39CA4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39CO32</td>
<td>2</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>39HU7</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Extended/Postcontact</td>
<td>39SL4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39WW1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39WW7</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postcontact</td>
<td>30CO34</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39DW2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39HU2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39ST1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Disorganized</td>
<td>39CO9</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39CO9</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>25CU201</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Note: N = Number of individuals with grooves; E = Number of examples; Average = Average Number per individual
1 Ubekelker, Phenece, and Bass (1989:148)
2 Willey and Hofman (1994:149)
3 Williams (1988:105)
4 Willey et al. (1987)
5 Berryman, Owsley, and Henderson (1979)

Table 84 summarizes the temporal and geographical distribution of interproximal grooves that have been reported in this region. The listing includes the number of individuals with grooves, the number of grooves observed in each sample,
and the average number of grooves per individual. Woodland sites from both Kansas and South Dakota and Coalescent tradition sites from South Dakota are included. There are almost no reports of this trait from Nebraska. Based on personal experience, grooves are relatively uncommon in the dentitions of individuals of the Central Plains tradition Ishkari phase, the Lower Loup phase, and the Historic Pawnee. Of 161 adults from Larson (39WW2), a Postcontact Coalescent tradition site in South Dakota, 49 (30.4%) showed one or more pronounced interproximal grooves (Berryman et al. 1979); 36 were male (73.5%) and 13 were female (26.5%). Three percent (N=106/3,479) of the teeth in the Larson sample showed grooves. The frequencies of occurrence in three South Dakota samples representing multiple archeological components appear in Table 85.

These anomalies are found in the interproximal surfaces at the cementoenamel junction. When the grooves are viewed from the buccal aspect, they appear tubular-shaped, with the axis directed distolingually. Grooves on the distal surfaces of teeth tend to be more pronounced in the distobuccal area and less so in the distolingual area, whereas grooves in the mesial interproximal surfaces are more pronounced on the lingual aspect. Under magnification, they frequently exhibit polish and parallel striations or scratches in the dentin.

Increasingly detailed studies have demonstrated that:
- Grooves are relatively common in some groups.
- Multiple grooves often occur within a dentition.
- The maxillary teeth are more frequently affected than the mandibular.
- Hard-to-reach posterior teeth are more often affected than anterior ones.
- The frequency is much higher in males than in females.
- Grooves are more common in older than younger adults.
- Most of the grooves are associated with diseased teeth and alveoli (Ubelaker et al. 1969; Berryman et al. 1979; and Willey and Hofman 1994).

There has been considerable debate about the cause of such interproximal grooves. In the case of Plains Indians, the primary explanation is that they result from the use of therapeutic or palliative dental probes for cleansing or soothing diseased or inflamed dental tissues. Certain plants with mild anesthetic qualities, such as black samson (Ribinacea augusrtifolia), were used to relieve pain caused by dental problems, and thus have been implicated as a likely source material for dental probes (Willey and Hofman 1994). In rarer cases where there is no evidence of dental disease, compulsive or habitual behavior may explain the occurrence of grooves. The use of probes seems to have been more predominantly a male activity.

In conclusion, the location, orientation, morphology, and association with diseased dental and periodontal tissues indicate that most grooves were produced by the repeated insertion of toothpick-like probes in a palliative or therapeutic attempt to alleviate dental distress. Additional data reporting the frequency of this trait in various population samples are needed to determine geographical and temporal patterning. Available data are insufficient to demonstrate whether there are differences that relate to subsistence strategy (i.e., hunting and gathering versus horticulture) or cultural tradition.

Cranial Deformation

Artificially deformed crania are rare in the Central and Northern Plains. Table 86 shows the sites that have produced examples and their archeological context. This compilation is based on published and unpublished reports and on data on Plains Indian cranial measurements collected by the University of Tennessee. The craniometric data include any evidence of deformation and a brief description. Using the data forms, the number of deformed and undeformed crania present is tabulated for each site. (It should be noted that counts derived from this data base are biased as they pertain only to measured crania.)

Most examples involve flattening of the occipital and the posterior parietals. Only three examples of occipital deformation with lambdoidal flattening were reported. The deformation is sometimes asymmetrical, with the effect more pronounced on one side than the other. Both Woodland and Plains Village sites are represented, though deformation in both periods appears to have been infrequent and sporadic. Only two Middle Woodland period skulls show evidence of artificial occipital deformation, one from the Taylor Mound (14DP3) and one from Arbor Hill (39UN1) (Klepinger and Bass 1971; S. Osley, personal communication 1994). A majority of the crania recovered from two Late Woodland Schultz focus mounds in North Central Kansas show artificial occipital deformation (Phenice 1969). Related samples from the Lower Republican Valley do not show such deformations.

Examples reported from Iskari (25HW2), Nebraska (25DO4, 22S5Y1, 25SY67), and Upper Republican (25FT13) phase sites suggest that cranial deformation may have been slightly more common and geographically widespread during the Central Plains tradition and may also have been more common in the east near the Missouri River. Most of the skulls from the Wallace Mound (25SY67) in east-central Nebraska exhibit slight occipital flattening, which often was more pronounced on the right side (Poynter 1915). Recovered from the Calovich Mound (14W7), a Steed-Risker complex site in eastern Kansas (Barnes 1977), were seven crania with asymmetrical occipital deformation and
seven with symmetrical vertical flattening. Steed-Kisker and Nebraska phase sites on the opposite side of the Missouri River in Platte County, Missouri, show a similar pattern of symmetrical and asymmetrical deformation.

Deformed crania are infrequent in Coalescent and Middle Missouri tradition sites, and when present cannot be used as an indicator of cultural affiliation (e.g., Williams 1993:29,32). Deformation is not associated with the following Historic era tribes: Arikara, Arapaho, Blackfeet, Cheyenne, Crow, Hidatsa, Mandan, Pawnee, Ponca, Omaha, and Sioux. However, one skull with pronounced occipital flattening has been reported for a Historic Ponca site (25XX207), and the craniometric data base includes an Osage skull with slight occipital deformation from Fort Osage, Kansas. Skulls from the Doniphan site (14DP2), a historic Kansa village, show symmetrical and asymmetrical occipital deformation (Bass and Nelson 1968; Stewart 1959; Willey and Bass 1969). Any examples as yet unreported should be documented using the coding system adopted by the Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

Some of the examples in Table 86 have been attributed to unintentional deformation resulting from the use of a hard-backed cradle board. However, symmetrical vertical flattening at the Calovich Mound probably resulted from intentional cultural practices involving restraints that prevented an infant from turning the head while attached to a cradle board (Barnes 1977). Schultz focus crania with occipital flattening show increased vault heights without widening or bulging at the sides, postcoronal constrictions, narrower frontal breadths, and, occasionally, lateral frontal depressions. The frontal depressions might represent areas where pads were placed against the sides of the head to apply pressure to the frontal, the sides of the parietals, and the occipital (Phenice 1969). This type of intentional deformation during the Late Woodland period might reflect a Southeastern cultural influence (Phenice 1969).
10 Prehistoric Adaptation Types and Research Problems, by Jack L. Hofman, Brad Logan, and Mary Adair

Cultural and historical definition and integration of prehistoric societies based on the archeological record has consumed a substantial component of archeological effort (e.g., Willey and Phillips 1958; Lehmer 1971). The need for unit concepts for discussion and comparison of archeological assemblages and for the organization of material remains into logical analytical units which enable and reflect approaches to archeological study is widely evident in archeological literature. Decades of research in the Great Plains region and elsewhere have resulted in at least two significant problems in the use and development of archeological unit concepts.

One problem is the attribution or assignment of specific collections or assemblages to archeological taxa as a means of, or in lieu of, explanation. It is perhaps too easy to succumb to the tactic of considering the assignment of a component or assemblage to a specific archeological phase as a normative explanation of that portion of the archeological record. Unit concepts should be used as organizational tools, not as explanatory ones (Binford 1968; Clarke 1968; Flannery 1968; Struver 1968; Watson et al. 1971).

Secondly, the history and politics of archeological research has been such that state boundaries or river basins, and historical flurries of geographically localized archeological effort have tended to result in the narrow definition of complexes. The focus of most archeological unit definitions has been normative, to encompass the "typical" common or standard elements of phases and other taxa, and less concern has been given to demonstrating and studying the variation within such taxa. For example, archeological complexes within the Plains Village tradition have often been viewed or defined as occurring within major river valleys, without consideration or incorporation of affiliated satellite sites such as seasonal hunting camps, quarries, or kill-butcherly sites. It is commonly assumed that these other components of a prehistoric culture's archeological record will be self evident, obvious, or of secondary importance.

Archeological taxa which initially appear distinctive and temporally or geographically discrete become less so as more is learned about additional assemblages or adjacent periods and places. The end result is that archeological unit concepts tend to progress through awkward and often erratic periods of growth and development as the archeological record becomes better documented and more completely represented. This growth has a different cadence for each region and time period. Likewise the tempo and scales of cultural change varied dramatically throughout the prehistory and history of human occupation of the Plains, and an archeological phase from 9,000 years ago may have a very different temporal and geographical scale and composition than one based on evidence from 300 years ago.

It is not unusual for locally defined complexes to "complicate" the archeological literature with a "plague of phases" (cf. L. Johnson 1987) which can do as much to hinder as to help in developing an understanding of cultural processes, variability, relationships, and comparisons through archeology. One of the efforts to overcome the specifics of locally defined unit concepts in a broad comparative framework is Fitzhugh's concept of adaptation types.

The concept of adaptation types as developed and used by Fitzhugh (1975) is a framework which integrates information about environment and technology in categorizing or summarizing lifeways of human groups at a level which is intermediate between the more general and encompassing stage and the smaller more particularistic phase (Willey and Phillips 1958). Adaptation types are in part comparable to the concept of pattern in the McKern system. According to McKern (1939); "The traits used as determinants for the pattern will be such as deal with the cultural reflection of the primary adjustments of peoples to environment, as modified by tradition. For example, the Mississippi Pattern, as compared with the Woodland Pattern." The notion of adaptation types as used by Fitzhugh, ultimately has its roots in cultural ecology, the culture core concept, and the environment-technology interface (Steward 1954, 1978).

The importance of comparative studies in archeology, studies which involve larger than traditional units of archeological analysis, is undeniable. And, as noted by McKern (1939), "archeological classification necessarily must be based upon criteria available to the archeologist." The broadened perspective which results from comparative studies should in and of itself provide the incentive for such pursuits. When addressing questions which reach beyond the culture history of a specific region, expanded comparative analysis is necessary. In turn, such broadened perspective will potentially enhance recognition of distinctive and significant aspects of local archeological remains or the definition of previously unrecognized patterns at a variety of scales. With the potential of archeology to contribute to anthropological comparative studies in mind, Fitzhugh (1975:341-342) provides these remarks concerning the purpose for the concept of adaptation type.

To compare culture units and traditions from different historical and geographic areas, a new concept which links environmental potential and technological capabilities is required. Adaptation type performs this function suitably since it describes a nonspecific cultural or chronological unit which may be archeological or ethnographic, and its particular usage may depend on the definition ascribed to it in the context of the discussion. As such its use is similar to that of the term "complex" in archeological systematics. Further, an adaptation type may include a series of subtype variants which...
may be defined to correspond with demographic and economic realities.

The term complex is used in a variety of contexts in this volume and it is used in a very flexible manner. Complex is not used by Fitzhugh or us as congruent with or equivalent to adaptation type.

The limitations of using the adaptation types framework should also be mentioned. The use of adaptation types to overcome some of the historical factors and problems of scale which occur when making comparisons among archeological assemblages from different states or regions is an important goal. The concept of adaptation as generally used in anthropology and archeology since the 1960s and 1970s has been taken to form a purposefully constructed humanly directed articulation between cultural and natural systems. Adaptations are historically seen as the directional or goal-oriented actions of people or groups to conform to or expand into a specific environment with a particular technological system.

The adaptive systems are generally discussed in normative terms as being in stable or dynamic equilibrium with the nature of systems operation being of much greater concern than system change. This adaptive-functional perspective has tended to emphasize the normative operation of cultural systems rather than variability. This has historically resulted in the definition of discrete prehistoric cultural complexes which are stacked and fitted together like bricks in a chronological and spatial wall (Clark 1968:246, Figure 53). During the process of definition of normatively formulated cultural units, variability at all levels (stylistic, functional, local, regional) tends to be neglected in the course of designating the primary or distinguishing cultural elements for each archeological "culture." Variability is generally considered as unimportant, uninteresting, and inessential noise.

An alternative approach which is increasingly evident in archeological literature is to consider change and variability more directly through a selectionist (Darwinian) evolutionary perspective (Dunnell 1980, 1982, 1988, 1992a; Leonard and Jones 1987; O'Brien and Holland 1990, 1992; Telleser 1995). From this perspective an adaptation is seen as the result of selective forces acting on behavioral variation in a human system. The variation and selection generally occurs at the individual level, with the cumulative effect reflected in the archeological record as changes in patterning. Only through a deliberate focus on variability (at multiple scales) as an important topic of analysis will it be possible to understand the processes of change, and the full operation of cultural systems. As opposed to the brick wall model of archeological complexes, the cultural brick theory (Clarke 1968), we must concern ourselves with the boundaries of the units and the mortar which holds them together. The details provided in the preceding cultural history chapters is intended to provide an awareness of the variability not just between but within the cultural complexes which have been defined for the Central Plains region.

The adaptation types and subtypes outlined in this section generally follow the concept as defined by Fitzhugh and as applied by Sabo and others (1982). For each adaptation type recognized in the Central Great Plains region, a series of information categories will be addressed. These include the date range, environmental context, cultural context, technology and subsistence activities, settlement and site distribution, and trade and exchange, areas with high probability of site occurrence, and finally data gaps and critical research questions. In many cases the critical research questions involve or indicate the significance of the intermediate areas and time periods as the key to understanding the development, change, and even the operation of cultural complexes and adaptation types.

Fitzhugh (1975) based his definitions of General Northern Maritime and Riverine adaptation types on the economy and "core" technological and integrative elements of several hunter-gatherer groups in the Arctic region. In this study, the large encompassing category of hunter-gatherers is subdivided into five primary adaptation types based on known or inferred information pertaining to economy, population, environmental conditions, and cultural situations. These five adaptation types are First Arrivals, Early Specialized Hunters, Broad Spectrum Foragers, Incipient Horticulturists, and Late Aboriginal Hunter-Gatherer-Traders. The Village Horticulturist adaptation type is the final adaptation type recognized for the aboriginal prehistoric and protohistoric groups. Historic period adaptation types include Indigenous Native Americans, Resettled Native Americans, Transportation, Military, Rural Settlement, Urban Settlement, and Industrial categories, which were discussed in Chapter 8.

First Arrivals Adaptation type

Date Range.

The date range for this adaptation type is that portion of the Pleistocene before 12,000 B.P. when early hunters occupied the New World. Prior to 12,000 years ago, evidence for human occupation of the Central Great Plains, and for North America, is equivocal. No available evidence remains entirely unquestioned and completely accepted by the archeological community as a whole (e.g., Stanford 1982; Waters 1985). Two facts are generally accepted: sometime before 12,000 years ago there were no humans present in the New World, and by soon after 12,000 R.C.Y.B.P. there is widespread and well-accepted evidence of human activity in both North and South America (Bryan 1986; Bonnichsen and Steele 1994; Bonnichsen and Turmire 1991; Soffer and Praslov 1993; Meltzer 1993). First arrivals were those peoples who are assumed by many researchers to have inhabited the New World before the time of the well-known Clovis or Llano cultural complex. The time frame for this archeologically poorly known interval extends from 11,500 years ago to some undetermined earlier time which marked the first entry of human groups into the New World. The presence of human settlement in southern Chile and other
parts of South America by about 12,500 or 13,000 B.P. (Dillehay 1989; Bryan 1986) leaves open the questions of when and how the Central Plains region was first occupied.

Environmental Context.

The Pleistocene period was substantially cooler and wetter than the present environment in the Plains region (Jacobson et al. 1987; Porter 1983; 1988; Wendland 1978; Wright 1991; Kutzbach and Webb 1991). The chronology of climatic fluctuations has been fairly well established for the late Pleistocene (Martin and Klein 1984), and it is known to have been a period of dynamic fluctuations in climate, vegetation, and animal populations. The environments of many localities were apparently distinct from those presently known, and the changes were not simply a matter of north-south changes in biotic districts, but include numerous occurrences which are considered dissonant when compared to modern biotic associations (Graham 1990; Graham and Lundelius 1984; Graham and Mead 1987; Graham and Grimm 1990; Lundelius 1988). For the vast majority of species composing the Rancholabrean fauna, including mammoth, mastodons, horse, camel, dire wolf, and ground sloth, there is no unequivocal evidence of human involvement. Several sites in the Central Great Plains have been dated to the period between 12,000 and 20,000 B.P., which have been suggested by some researchers to represent early human activity (Anderson 1975; Stanford 1979; Holen 1994). Evidence from these sites is generally in the form of patterned modification or "high-impact" breakage of bones from extinct species, especially mammoth. The general lack of chipped stone tools in association with these bone assemblages is seen as problematic among some researchers.

Cultural Context.

Information pertaining to social organization, mobility, and demography is lacking for the pre-Clovis period. There is general agreement that population density was very low during this period and that any groups present would have been mobile hunter-gatherers. Assuming their derivation from Eurasia via Beringia, we may expect technological organization similar to that expressed at Paleolithic sites such as described by Soffer (1985). Soffer has argued for two primary periods of relatively intense occupation of the Ukraine, one between 24,000 and 30,000 RCYBP and the second between 12,000 and 18,000 RCYBP. However, there is evidence for much earlier occupations in Siberia, which predate the radiocarbon time scale (more than 50,000 B.P.), and which may indicate that, during relatively warm periods of the Pleistocene, technologically simple human groups utilized northern Asia and Siberia.

Technology and Subsistence.

It is likely that the first arrivals in North America would have possessed a technology generally comparable to that of the Russian Upper Paleolithic (Soffer 1985). Controlled use of fire and manufacture of bone and stone artifacts, clothing, and shelter is assumed (Jelinek 1992). These people would have had access to a variety of Pleistocene fauna which would probably have provided the primary economic focus. Furthermore, these animal populations would have had little or no previous interaction with human predators and may have been particularly susceptible to hunting. A variety of studies including research in optimal foraging theory indicate that large mammals generally provide a first line resource and that smaller animals, invertebrates, and plant resources become increasingly important as economic pressures or population increase and territory sizes decrease (Winterhalder and Smith 1981; Pianka 1983). Plant foods were probably not as economically important as in many ethnographically recorded hunter-gatherer groups because of the abundance of animal foods. Also, detailed knowledge of a variety of new plant species would have required a longer term familiarity with local areas and some degree of "settling in." This would not be conducive to a highly mobile hunting economy. In colonizing a new region we can expect an economic focus on already familiar animal species rather than the less secure information on new plants in an unfamiliar terrain.

Settlement Pattern.

Information pertaining to site distributions is not available for specific areas. Few sites potentially attributable to this time period are known, and most of these are widely dispersed. Study of this period will require detailed study and definition of land surfaces of the appropriate age. Terraces and lake margin deposits are perhaps those most likely to hold well-preserved remains from this period. These locations may not be representative of the overall settlement, but may reflect in large part the historical events relating to land surface modifications and preservation (Johnson and Logan 1990).

Trade and Exchange.

No information is available concerning interactions among groups of this time period. We assume that such supposedly small, mobile groups would have required interaction with other such groups in order to be viable. Exchange of information pertaining to specific resources and locations would have been of considerable benefit. Exchange of marriage partners was probably essential to long-term group fitness and maintenance of intergroup contacts and alliances (e.g., Gamble 1982).

Ideology.

Specific information pertaining to religious activities and ceremonies is not available.

Bioarcheology.

No human remains attributable to this period and adaptation type have been documented in the Central Great Plains region.
Areas of High Site Probability.

Only landscapes of pre-Holocene age will have the potential to contain intact sites of this adaptation type. In alluvial bottomlands, Pleistocene-age deposits tend to be deeply buried, but these situations have the potential to contain relatively well-preserved land surfaces and so archaeological sites of pre-11,500 B.P. age. Upland areas, terraces, and terrace slopes of late Pleistocene age provide the best opportunity to encounter archeological remains from the First Arrivals, however, the problems of component mixing and dating make adequate evaluation of such sites less feasible. The best chances of finding unequivocal evidence of the earliest occupants of the Plains and Rocky Mountain regions is probably in cave deposits, stratified alluvium, loess, or stratified ponded sediments (Drew 1979; May and Holen 1993; Holliday 1982; Johnson and Logan 1990).

Data Gaps and Critical Research Questions.

Because so little is known about this period, any site bearing evidence of human activity prior to 12,000 years ago is of considerable significance. Site locations are not predictable at present except that late Pleistocene land forms are typically deeply buried in alluvial valleys, contained within deep loess deposits, buried beneath Holocene dune fields, or exposed in prominent terrace faces or upland ridges. As dating of these sites will be a critical consideration, those with primary research potential will occur in buried situations (below dunes or in Pleistocene dunes, in loess, in playa deposits, in buried terrace deposits) where there is the potential for faunal and floral remains. Upland sites which are deflated or heavily weathered are unlikely to produce materials which would allow verification for the age of artifacts which might be recovered from the surface or upper portion of Pleistocene-age deposits. The target of research should include systematic investigation and sampling of late Pleistocene deposits which are known to date between 25,000 and 12,000 years ago.

Early Specialized Hunters Adaptation Type

Date Range

An increasing number of radiocarbon dates pertaining to Paleoinian kill and habitation sites are available which document the activities of mammoth and bison hunting groups in the Plains region to the period between 12,000 to 8,000 RCYBP (Cassells 1983; Frison 1991a; Haynes 1992, 1993; Wedel 1986). Examples of defined cultural complexes which are included in this adaptation type are Clovis, Folsom, Plainview, Cody, and Allen/Frederick.

Environmental Context.

An increasing amount of paleoenvironmental information pertaining to this period in the study area has been developed through studies in Colorado, Kansas, and Nebraska in recent years (Dort and Jones 1970; Holliday 1986, 1988; Johnson 1987; Johnson and Logan 1990; Johnson and Park in this volume; Lundelius et al. 1983; Mandel 1995). This period encompasses the Pleistocene-Holocene transition and is a dynamic one in terms of climatic changes and biotic communities. By soon after 11,000 years ago the Rancholabrean fauna became extinct (Grayson 1951; Kuret and Anderson 1980; Mead and Melzer 1984). Climatic and ecological reconstructions vary between investigators and depending on the study location and the type of ecological data used, but the overall pattern of change is generally agreed upon. For the Central Great Plains, the period before 12,000 years ago was cooler, more moist, and more equitable with less extreme temperature fluctuations between winter and summer than during the Holocene.

Lower summer maximums and less severe winter temperatures (with an absence or rarity of extended hard freezes), in conjunction with greater effective moisture, resulted in a rich and diverse fauna and flora probably not directly comparable to any that exist at present. Perhaps the primary distinction between the late Pleistocene and Holocene climates is the increased seasonality during the Holocene which acted to restrict the ranges of many species that are (were) sensitive to extremes of temperature and moisture. Animal taxa which survived this transition are generally those which were able to accommodate the competitive and climatic stresses. Often this was accomplished in part by reduction in body size (e.g., bison, beaver) and changes in social behavior (e.g., larger herd size for bison). Continental glaciers were retreating rapidly by 12,000 years ago but still covered a significant proportion of North America. By 6,000 years ago the ice was restricted to northern Canada (Wendland 1978), and by 4000 B.P. the glacial ice had reached its approximate modern position. There was not a simple norward and elevation movement of biotic provinces following the glaciers, but a complex reorganization of ecological communities (Lundelius et al. 1983; Graham and Lundelius 1984; Graham 1979, 1985; Guthrie 1984, 1990).

The Central Great Plains region was not glaciated, but the area was dramatically impacted by the climatic, geomorphic, and biological changes associated with the close of the Wisconsin glaciation. Co-occurrences of species in faunas from the Pleistocene/Holocene transition which today are nonsympathetic (disharmonious) has led to the discussion of biotic provinces which are distinct from those presently known (Holman 1976; Graham 1979; Guthrie 1984; Martin, Rogers, and Neuner 1985) and which include species now restricted to boreal or tropical climates. As stated by Graham and Lundelius (1984:224), “the degree of diversity of late Pleistocene disharmonious biotas suggests that they existed during times when the climate was equable and seasonal extremes in temperature and effective moisture were reduced.”

Also, “many late Pleistocene communities had higher species densities than their modern counterparts” (Graham 1985:139) which is related in part to the fact that “there is a positive correlation between increased species diversity and decreased climatic variability as measured by winter-summer differences in mean temperature” (Graham and Lundelius 1984:224). Specific animal taxa of particular significance include mammoth, horse, camel, giant armadillo, giant tortoise, short-faced bear and a variety of others which become extinct by
11,000 years ago or soon thereafter (Graham 1987; Martin, this volume). Palynological information for the Pleistocene/Holocene transition in the Central Plains area is most widely known from study of ponded sediments (Baker and Wain 1985; Barnosky et al. 1987; Gruger 1973; Johnson and Park, this volume; Wright 1970, 1989). The Younger Dryas interval between 11,000 and 10,000 B.P., representing the last important and distinct cold event during the Pleistocene to Holocene transition (Wright 1989), has been the focus of paleoecological research on a global scale, and correlates roughly with the Folsom period on the Great Plains. The early period of formation of the Brady paleosol in the Nebraska and Kansas region correlates with the Younger Dryas cold interval (Johnson and Park, this volume).

There is general agreement that despite fluctuations the close of the Pleistocene was generally cooler and wetter (less severe summers and more effective moisture) than at present, and there was a general warming and drying trend during the early Holocene.

Cultural Context.

The terminal Pleistocene is the first period during which there is evidence of a substantial human population in the Central Plains and Rocky Mountain region. With due consideration to the fact that “absence of evidence is not evidence of absence” (Thomas 1978), prehistoric people during this period did not inhabit permanent occupation sites, but were apparently mobile hunter-gatherers whose economy focused to varying extents on large herbivores. The social groups were probably small bands, but the structure and organizational variation of these is not known (Kelly and Todd 1988; Bamforth 1988). Flexibility in group composition can be expected, but group sizes and dynamics of group aggregation and dispersal are not known (Holman 1994). If the basic premise is correct that these early hunters were highly mobile and not keyed into specific locations but rather to specific resources such as large herbivores (Kelly and Todd 1988), then it is unlikely that cyclical or seasonally regular aggregations would occur at the same location for more than a few consecutive years. Intergroup relationships would have been maintained or established in order to provide marriage partners and to enhance information “networks” pertaining to resource locations and conditions. These networks may have been very extensive and of the anucleate nature discussed by Yellen (1977). The Lindenmeier site in north-central Colorado has been suggested by some researchers to represent the location of Folsom period aggregations (Wilmsen 1974; Wilmsen and Roberts 1978; Price and Feinman 1993). This is an important possibility which deserves further evaluation. Also, large bison kills of Paleoindian age have often been argued to represent the efforts of communally organized hunting events (e.g., Bamforth 1988).

Technology and Subsistence.

A highly developed stone and bone technology is documented for the Paleoindian groups in the Plains region. Direct information pertaining to the perishable technology is essentially lacking. Possible structural remains of Paleoindian age attributable to the Early Specialized Hunter adaptation type are documented at the Hell Gap site in Wyoming (Irwin 1968, 1971; Irwin-Williams et al. 1973), and consist of relatively small roughly circular patterns of shallow postmolds in the Agate Basin and Midland components. A possible stone circle of Frederick age is also present at the site. Possible evidence of temporary structures is also reported from the Folsom components at the Agate Basin (Prison and Stanford 1982) and Hanson sites (Prison and Bradley 1980) in Wyoming. All evidence suggests that whatever structures were used were of a light frame and temporary nature. Another form of structure documented at the Colby mammoth site in Wyoming (Prison and Todd 1986) is interpreted to have been a security cache where meat was stored under a pile of mammoth bones (probably combined with snow or ice) in order to protect it from scavenging carnivores. The stone technology was highly versatile and consisted of bifacial blanks or preforms which could serve as tools, sources for large flakes for various scrapers and knives, and as preforms for production of projectile points (Bradley 1991, 1993; Ingbir 1992; Kelly 1988, Stanford and Day 1992). Distinctive tool forms for the adaptation type include delicate gravers, spurred endscrapers, composite scraping-graving-cutting tools, and a variety of nonstylized tools made from large thin flakes of bifacial reduction. Bone technology included projectile points, at least during Clovis and Folsom times, and the use of eyed needles. The latter were apparently an important component in the manufacture of tailored clothing which would have been integral to adaptation in many areas during the late Pleistocene.

Settlement Pattern

Variability in the “settlement” or land use patterns of Early Specialized Hunters has been documented primarily through the study of lithic raw material utilization and source area studies. There are strong differences in the lithic material frequencies of Folsom and Clovis points from Kansas for example. Such differences may reflect changes in directions or patterns of group movement. As noted above, the occupation sites exhibit only minimal evidence for the presence of habitation structures. Mobility of groups was apparently extensive, but the specific nature of movements is not well documented (Kelly and Todd 1988; Wheat 1971). Evidence from kill-butchery sites indicates that the processing and consumption of large animal such as bison by Paleoindian groups was distinctly different than during the Late Prehistoric Period. Todd (1983, 1987, 1991) has referred to one common pattern as a gourmet butchering strategy in which only selected portions of the animals were utilized. Factors such as small groups size and high mobility would have influenced decisions pertaining to butchering and intensity of resource use. High mobility may have been a factor providing increased security for early hunters (Wilmsen 1973; Kelly and Todd 1988).

Because of mobility and related factors, patterning of Early Specialized Hunter sites is probably biased and is certainly poorly understood. Animal kill sites where faunal remains have
been preserved have an increased likelihood of being observed and reported, whereas many camp and bivouac sites would have been temporary in nature and located in settings which preserve minimal archeological evidence (Hofman and Ingbar 1988; Naze 1986). Dawson and Judge (1969; Judge 1973), and Hester and Grady (1977) have provided useful discussions of site variability and occurrences which hold considerable promise for developing refined models of land-use patterning by Early Specialized Hunters. In the High Plains region, the occurrence of sites on stable dunes located on the leeward side of playa lake beds has been noted repeatedly. Often, however, these sites contain materials from later components. The occurrence of kill sites in sand dunes or dissected and eroded areas of small tributary valleys is also a recurrent pattern. The presence of kills in situations which apparently lacked distinctive topographic features is also documented (Stanford 1978, 1979; Frison and Todd 1987) and suggests that the use of deep snow or constructed “corrals” may have been important options in procurement of large animals during this period. Recognized site types for this adaptation type include animal kill-processing sites, caches, campsites, hunting overlooks, lithic workshops, and possible burials. No rock art sites of this age are yet documented in the region.

Trade and Exchange.

Determining the nature and importance of trade and exchange in the Early Specialized Hunter adaptation type is a problem which has received varied attention. Opinions differ as to the extensiveness and importance of trade, with some researchers (Hayden 1982) suggesting that the common occurrence of “exotic” raw materials is a result primarily of trading between groups of Paleoindians. Others believe that this extensive pattern of raw material use resulted from mobility of the early hunting groups (Goodyear 1989; Wheat 1971; Irving 1971; Kelly and Todd 1988; Meltzer 1989). Exchanges between hunting bands can be expected to have occurred, based on what is known of the operation of modern mobile hunter gatherers (Weissner 1982, 1983). Such exchanges of materials and ideas probably went hand-in-hand with intermarriage between bands and served to provide extended networks of information and economic support.

Ideology.

A recurrent theme at several sites of the Early Specialized Hunter adaptation type is the presence of intensive use of red ochre (Roper 1991; Stafford 1990; Frison 1991; Bement 1994a). A variety of uses are indicated for this material including painting of artifacts, covering burials (Anzick site in Montana), use or intentional deposition in occupation areas (Frison and Stanford 1982; Frison and Bradley 1980). A variety of artifacts have been recovered for the processing of red ochre into powder (Willmsen and Roberts 1978). On the Central Plains, Bement (1993, 1994) reports the occurrence of a bison skull painted with red ochre in the lowest level of the Cooper bison kill site of Folsom age.

Ritual activities have been interpreted for Jones-Miller site in eastern Colorado where there is evidence of ceremonial activities associated with a Hell Gap bison kill which show close similarities to the pre-kill ceremonies of the Cree Indians (Stanford 1978, 1979). A post hole near the center of the bonebed may represent a shaman’s pole, near which were found a miniature Hell Gap point, a bird bone whistle, and remains of a dog.

Bioarcheology.

Minimal human remains have been recovered and reported which pertain to the Early Specialized Hunters adaptation type. The Gordon Creek burial, dated to about 9,600 years ago (Breternitz et al. 1971) was a flexed female associated with a few artifacts and red ochre. Potentially early human remains from the lower Kansas River basin have been radiocarbon dated and are apparently of Holocene age (L. D. Martin, personal communication; Steele et al. 1991).

Areas of High Site Probability.

Archeological sites representing the Early Specialized Hunters adaptation type are documented in a variety of open settings as well as cave sites. These sites will occur on land surfaces which are of late Pleistocene and early Holocene age, but will be buried, if preserved, in stream bottoms containing middle and late Holocene sediments or contained in thick loess deposits in upland, slope, or valley settings. Prominent terrace scarps, buttes, and other elevated settings will potentially provide evidence of short-term camps or hunting overlooks, but often lack good preservation or stratified archeological deposits unless they are contained in loess or dunes. Campsites and kill-butchery sites or often exposed in sand dune regions which were usually near ponds or lakes in the past, but which may lack nearby water sources at present. Key sites of the Early Specialized Hunters are definitely not limited to present-day water courses or stream valleys. Distinctive ponded or lake sediments of late Pleistocene and early Holocene age occur in many localities in the Central Great Plains and Rocky Mountain regions (Stanford 1979; Holliday et al. 1994; Johnson and Park, this volume). These deposits have good potential for preservation of faunal and floral remains and represent potential situations for the occurrence of Paleoindian activity. Often the paleoecological information which can be gained from such sites is of considerable importance whether or not archeological materials are found (e.g., Wyckoff and Carter 1994). The occurrence of occupation sites of Early Specialized Hunter buried in alluvial situations has been widely documented (Davis 1962; Ferring 1994; Holliday 1986; Howard 1935; Johnson 1987; Johnson and Logan 1990; Mandel 1995; Schmids 1980; Wyckoff 1964).

Data Gaps and Critical Research Questions.

The number of early sites that have provided quality information pertaining to the Early Specialized Hunters for the period between 12,000 and 8,000 years ago is few and the
locations are scattered. There remain many gaps in the basic information for the various archaeological complexes recognized which represent this adaptation type. Finding sites of this age is hampered not only by the age of the deposits, but also by the relatively limited human population of the time. Therefore, any site of this age is potentially highly significant, even if perishable materials are not preserved.

Detailed studies of intrasite structure are needed, regional studies of site distributions have met with limited success due to the small data base, and documentation of assemblage variability and site functional differences have only been addressed at a cursory level (Hofman 1994b). Research at the Lindenmeier site provides an exceptional example of the scale of excavation which may be needed to sample Paleoindian campsites (Wilmsen and Roberts 1978). The problem of scale and the spatial extent of sites has become increasingly evident at other excavations as well including Cattle Guard (Jodry 1992; Jodry and Stanford 1992), Murray Springs (Haynes 1982), Aubrey (Ferring 1994), and Hanson (Frisone and Bradley 1980). The scale of excavations has generally been inadequate in part due to low artifact density at some sites (e.g., Sellards 1952:151-152), and to the limited concern for spatial and organizational studies rather than primarily cultural historical and temporal concerns. O'Connell (1987; O'Connell et al. 1992) has shown that most open air hunter-gatherer sites, especially those that involve butchery of large animals, are very extensive and that most archeological investigations have probably been severely inadequate to gain information about site structure and activity organization.

A key problem, certainly not limited to the sites of this adaptation type, is the ability of archeologists to distinguish between repeated use of site areas and long-term habitation (Schiffer 1987; Hofman and Enloe 1992). Archeological research focused on distinguishing the nature of occupations, whether repeated short-term camps or long-term habitation, must go hand in hand with investigation of site formation processes. The problems of studying group organization and mobility patterns through the archeological record are just beginning to be developed.

The Paleoindian or Early Specialized Hunters adaptation type is represented by groups of hunter-gatherers who possessed a highly developed technology, comparable to the later Upper Paleolithic of the Old World, and who lived in productive environments where they were essentially unfettered in their movements. This provides an important scenario for the study of hunter-gatherers in general terms and with regard to the impacts of population growth, environmental change, subsistence change, and the eventual adoption of more intensive subsistence systems. Because of the extreme importance of these sites for addressing a variety of anthropological, environmental, technological, and historical questions, and due to their relatively rare occurrence, all site of the Early Specialized Hunters deserve careful consideration and evaluation of their research potential. Much of the available information pertaining to this adaptation type, with regard to occurrence, density, and nature of artifacts and sites, is in the hands and minds of nonprofessional archeologists and interested laypersons.

Recognition of many early sites will only be possible through cooperative work between field archeologists and interested local persons. Recent work involving surveys of Paleoindian projectile points (Meltzer 1987; Hofman 1987, 1993, 1994; Hofman and Wyckoff 1991; Weatherill 1995; Banks et al. 1994; Wyckoff and Bartlett 1995) has provided encouraging results for the use of information which can be gained only through cooperation between archeologists and interested laymen. Figure 62 provides an example of a form through which this is being used to record artifacts in private collections. Several hundred of these have been completed, many by interested individuals with brief training. It is increasingly evident that short-term visits and studies (from a few hours to a few months) of an area provide a limited view not only of regional archeology, but also of the potential of specific sites. Reliance upon avocational input can provide a substantial increase of information potential for CRM and other projects.

The transitional period between the Early Specialized Hunters and Broad-Spectrum Hunter-Gatherer adaptation types represents a significant interval of significant ecological, technological, and perhaps social changes which is poorly documented or understood. Many projectile point types occur which may pertain to this period, but most have received minimal study. The assemblages associated with these potentially early point types are not well documented and the regional/temporal variation in these materials is essentially unknown. Focused research is needed on the earliest Holocene period in order to better define the climate and technologies of this dynamic period. Documenting the changes which lead to what we recognize as the Broad-Spectrum adaptation type is an important regional research theme. The distinctiveness of late Pleistocene versus early Holocene hunter-gatherer groups in the Plains region has been to an extent assumed rather than demonstrated, and this is especially true concerning the supposed distinctiveness of middle Holocene (8,000 to 4,000 B.P.) archeological record as compared to the early Holocene record. Simms (1989) and others have suggested that if we document the variability within Paleoindian and Archaic assemblages and other evidence, that there are potentially many lines of continuity rather than an abrupt and dramatic change. We must address the Paleoindian to Archaic transition and the variation within Holocene hunter-gatherers as important research questions, not simply assume them to be dramatic or rapid cultural changes or events.

**Broad-Spectrum Hunter-Gatherer-Forager Adaptation Type**

**Date Range.**

This adaptation type is considered to date primarily between 8,000 and 2,000 B.P. with this adaptation type possibly lasting until the historic period in some of the High Plains and Mountain portions of the region. The variety of Archaic
complexes defined in Kansas, Nebraska, and Colorado are subsumed within this adaptation type.

Environmental Context.

Several lines of evidence indicate that the mid-Holocene period from about 8,000 until almost 4,000 years ago was the hottest and most dry since the Pleistocene. The Alithermal climatic period was first recognized by Antevs (1955) based on stratigraphic evidence primarily in the Southwest, and subsequently referred to as the Hypsithermal in the midcontinent region (Deevey and Flint 1957). On the eastern prairie and deciduous forest border, several palynological and paleoclimatic studies have documented the occurrence of a mid-Holocene dry and warm period (Benedict 1979; Brakenridge 1980, 1981; Holliday 1989; Hunt 1966; Johnson 1987; King 1981; Reeves 1973; Wendland 1978; Wright 1970).

This period is variously referred to as the Hypsithermal or Atlantic episode and may not have been a single event with progressively drier and warmer climate. Evidence from Colorado suggests that the Hypsithermal was a relatively dynamic period with at least two intensive dry periods (Benedict 1979). Evidence from several sites strongly suggests that there was a dramatic lowering of the water table during the mid-Holocene and that utilization of the High Plains or more arid portions of the Plains was significantly impacted. Similar evidence for middle Holocene drought is found at sites on the southern High Plains (Evans 1951; Green 1962; Meltzer 1989). Several lines of evidence indicate that seasonal variability was more extreme and species diversity was significantly less than during the late Pleistocene (Dort and Jones 1970; Graham 1987; Johnson 1987; Semken 1983).
Cultural Context.

There is a substantial increase in the number of reported Archaic archeological sites for the middle and late Holocene period, but whether this evidence resulted from population increase, a different pattern of land use and occupation types, increased proportion of exposed sites, the ability of archeologists to recognize the sites, or some combination of these factors is not well established. On a continental scale there is general agreement that Native American populations increased in North America. This was not, however, a steady increase in all areas of the Plains throughout the period. Localized foraging territories seem to have been the pattern with a relatively limited amount of long-distance trade or mobility, if the pattern of lithic raw material usage is a reliable indication.

Hunter-gatherer groups are thought to have operated as foragers (following Binford's 1980 terminology) during much of the year, maintaining a high degree of group flexibility which would enable effective use of various resource patches on a seasonal basis. Group size may have varied from occasional or regularly patterned aggregations of multiple family groups to dispersed small groups of foragers operating within a familiar area. Aggregation sites may appear in the archeological record as "base camps" if they were repeatedly utilized, even though they may have been occupied only briefly. Collecting, processing, and short-term camp sites— including lithic workshops—are the most common expressions of Holocene Broad Spectrum foragers in the Central Plains. Regional population density probably varied depending upon productivity and reliability of key resources such as bison, deer, turkey, fish, grass, fruits, and nuts. Artifacts indicative of long-distance trade and interaction are relatively rare in these assemblages, at least until late in time. No reliable information is currently available pertaining to group size from a site or regional perspective.

Technology and Subsistence.

The technological repertoire included atlatls, which were probably made in a variety of types based on finds in adjacent areas to the east and west (Harrington 1971; Baker and Kidd 1957). Other tools include a variety of hafted knives and scraper forms including Munkers Creek gouges, ground stone tools and a wide range of stemmed projectile points which probably also served commonly as cutting tools. Some specialized cutting tools, such as the Munkers Creek Knife which was apparently used for cutting grasses, also reflect some technological changes during the Holocene. Features include common hearths and roasting pits containing fire-cracked rock and sometimes extensive burned rock middens. This constellation of features probably reflects the intensive processing of tenacious plant foods including grasses, yucca, mesquite, and perhaps acorns which required parching and/or leaching. Bison appear to have been limited in occurrence, distribution, and availability on the Plains during the middle Holocene. They were apparently not abundant in the region until after 4,000 B.P. Smaller animal resources figured prominently in the subsistence of the Broad Spectrum Forager's adaptation, but relatively few sites have been studied which exhibit good faunal preservation (Graham 1987).

The technology is thought to have had a substantial component of expeditiously used tools, but with a variety of curated tool forms including the atlatl and component parts, hafted knives, gouges, axes, grinding stones (perhaps caches at locations of redundant usage), and probably basketry. Although clay containers were apparently unknown until the late Archaic period where they are minimally represented in the Nebo Hill complex, use of fired clay or ceramic objects in other functions occurs much earlier (Witty 1982). A predominance of unpatterned core-flake assemblages may characterized some of the Broad-Spectrum hunter-gatherers. The importance of planning depth and seasonal storage probably varied by region and year, but the pit house dwelling hunter-gatherers probably had a substantial component of collectorlike behavior during the winter.

For some areas and during some periods, the importance of plants such as yucca in production of sandals, baskets, matting, garments, twine, and so forth was extremely important. The versatile and widely useful bison and deer products were not always accessible or bountiful. A significant portion of these technological systems was focused on processing of vegetal materials for purposes other than food. The perishable technology was substantial, if our clues from dry cave deposits in the Ozarks and Rocky Mountains is any indication.

Settlement Pattern.

Evidence of structural remains is extremely limited for the Broad Spectrum foragers, although many researchers believe such evidence will be forthcoming. Late Archaic structural evidence from the McEntree Ranch site in Colorado (Cassells 1983) is extremely important but only briefly reported. Semisubterranean structures are now known to occur on the western Plains and Rocky Mountains (Larson and Francis 1996; Metcalf and Black 1991). Utilization of rockshelter sites becomes extremely important during the middle and late Holocene with evidence of occupation in most areas which have shelters or caves in the vicinity of water and other resources. It is likely that seasonal aggregations occurred and these may be reflected at sites such as burned rock middens or locations of high bison density during the fall of the year. To date there has been little effort directed toward documenting the occurrence or timing of aggregate activities by Holocene foraging groups.

Trade and Exchange.

Few artifacts recovered from sites of the Broad Spectrum Forager adaptation type provide evidence of long-distance or intercultural trading. Relatively few occurrences of bannerstones, gorgets, pipes, axes or other such curated objects made from "exotic" materials are known in the Plains region, and the context of most such finds is poorly understood. It is
probable that trade was conducted between groups in a variety of perishable and durable commodities and that the need for intergroup contact and interaction was important for long-term group viability. Marriage partners would usually have been sought outside the immediate extended family. Trade and marriage relationships between groups, perhaps being focused during specific seasons, would have been extremely important to these groups but the details of these relationships have not been studied effectively through the archeological record.

Ideology

It is during the middle and late Holocene when cemeteries first appear in the archeological record of the Plains, but whether this reflects an increased concern for the deceased or simply a decreased mobility pattern with redundant use of burial sites is not known. Burials are most often flexed interments which possess utilitarian offerings, shell pieces, or most commonly, no preserved offerings at all. There does not seem to be a consistent use of red ochre, burial orientation, or other such pattern, but the number of burials for this adaptation type for specific areas is very low (Owsey and Sandness, this volume), especially when we consider the long time span this adaptation type represents in the region.

Bioarcheology.

The vast majority of burials attributable to this adaptation type come from sites where only one or two burials are documented (Owsey and Sandness, this volume), and little patterning is evident. Archaic cemeteries are not known until very late Archaic or Woodland times. Intermets are generally flexed and occasionally have associations.

Areas of High Site Probability.

Deeply buried land surfaces in alluvial settings provide one of the prime areas for occurrence of Broad Spectrum Hunter-Gatherer sites. However, the majority of reported sites attributed to the Archaic or Broad Spectrum adaptation type are located in eroded or otherwise exposed upland settings. Sites of primary importance for providing information on subsistence, site structure, and relatively unmixed assemblages, however, are usually those found in alluvial settings. Even though our best information may be derived from stratified burried sites, these are extremely difficult to locate and expensive to study. Depth of burial of old land surfaces, often demarked by buried A horizon paleosols, depends upon local geomorphic history and stream characteristics. Any interest in study of middle Holocene or early late Holocene archeological sites in stream valley settings must necessarily consider the potential and importance of buried sites. Effective location, evaluation, and study of stream valley sites requires cooperative integration of archeological, geomorphological, and soils studies. Rockshelter sites appear to have been intensively utilized by the Broad Spectrum Foragers, but these sites tend to have higher visibility and are more readily recognized than those in deep alluvial settings.

Data Gaps and Critical Research Questions.

One of the prominent gaps in our information pertaining to the Broad Spectrum Foragers pertains to the dearth of information on physical anthropology, mortuary practices, and the relationship of these data to the organization and structure of the forager societies. Many of the archeological sites recorded for the region reflect the activities, primarily or in part, of Broad Spectrum Foragers. The number of available detailed studies, reliably dated components, economic subsistence studies, settlement and land use studies, and technological analyses does not reflect the richness of the archeological record or the potential it holds for interpretations which reach beyond cultural historical concerns. On a regional scale, so little is known about the Broad Spectrum Forager adaptation type that any site which has good integrity and potential for functional, economic, technological, or bioarcheological study should receive special consideration. Dramatic changes apparently occurred in the region's climate and natural resource productivity. Changes in economy throughout the region and during the long time span of the Archaic have been hinted at in numerous studies, but the details of these changes and the seasonal or yearly variation in behaviors of groups have not been investigated. Recent discoveries and documentation of substantial architectural remains, primarily pithouses, for this adaptation type open exciting new possibilities for research concerning sedentism, storage, and technological organization (e.g., Metcalf and Black 1991; Osborn 1993). More extensive site studies and detailed recovery of botanical and faunal remains for ecological and subsistence information should be forthcoming which will complement the lithic and faunal information which is currently available. The variability of hunter-gatherer adaptations included within the Broad Spectrum Forager adaptation type is tremendous. It should not be assumed that all these groups were similar or that they all engaged in truly broad-spectrum economies. Some groups, especially in some seasons or years, may have been economic specialists, but with a wide repertoire of economic and technological options at their disposal. Documenting the variability in Holocene hunter-gatherer adaptations in the Plains and Mountains, and developing an understanding of the interface between plains, foothills, and mountain adaptations will remain key issues for years to come.

Late Aboriginal Hunter-Gatherer-Traders

Date Range

Only one currently recognized culture complex of the Central Plains, the Dismal River phase, is assignable to this adaptation type. Dendrochronology and Southwestern pottery in Dismal River assemblages date the complex to ca. A.D. 1675-1725, though Gunnerson (1987) suggests on the basis of historic records that this adaptation was in place by 1640.

Environmental Context

Dismal River sites have been recorded from the Black Hills of South Dakota to throughout the western half of Nebraska
and Kansas, eastern Colorado and the Oklahoma Panhandle. Though most of this region is High Plains, the most extensive sites are in the eastern, mixed-grass Prairie-Plains of the range where rainfall conditions permitted more sedentism and the practice of maize-based horticulture (Gunnerson 1960, 1968, 1987). Wedel (1986:135-136) has pointed out that the appearance of this and other late ceramic cultures correlated with the Neo-Boreal climatic episode, though the affects of this cool period on Central Plains cultures may have differed in various regions. It may have accounted for the increased size of bison herds on the High Plains that were the staple of Dismal River subsistence (Gunnerson 1972).

Cultural Context

The Dismal River people were active participants in a trade network that linked the Central and Southern Plains with Puebloan cultures of the Southwest. The coincidence of this complex with the arrival of the Spanish in the Southwest, Southern and Central Plains also affected its development. The relationship between Dismal River and Puebloans is particularly evident at the site of “El Curatelejo,” the Kansas Pueblo in Scott County, Kansas, which is believed to have been occupied by refugees from Taos or Picuris. Dismal River hunter-gatherer-traders have been convincingly identified as ancestral Apacheans who later merged with Jicarilla and Lipan Apache (D. Gunnerson 1974).

Technology and Subsistence

While maize agriculture was a part of the economic adaptation of the Dismal River culture, it was only in the eastern part of its geographic range that successful farming based on rainfall could have been practiced (Wedel 1986). Irrigation ditches at the Scott County pueblo (14SC1) indicate that gardening was not entirely forsaken in the western range. Hunting, particularly of bison, and gathering of wild foods continued to be integral to the subsistence of this High Plains adaptation. Technologically, Dismal River shares a variety of characteristics with its contemporaries in the Central Plains. Among these are unnotched arrow points, ubiquitous endscrapers and side scrapers, shaft adadors, splinter bone awls, serrated bison metapodial fleischers, and bison scapula hooves (Gunnerson 1987).

Settlement Pattern

Sites vary in size but include, particularly in the eastern part of the range, villages as extensive as 185 ha. They are found in a variety of topographic locations, including streamside terraces, in lacustrine settings of the Nebraska Sand Hills, in blowouts, on buttes, and in rock shelters (Wedel 1986:140). Houses, supported by a unique five post pattern, occur at random in clusters and show no sign of the need for defense. Sites lack thick middens or other signs of dense population. Storage pits are lacking as well, which suggests a more nomadic lifestyle than their Great Bend and Lower Loup contemporaries. Bell-shaped roasting pits are a distinctive feature of the Dismal River expression of this adaptation type.

Trade and Exchange

As this adaptation type implies, trade was central to the economy of the Dismal River culture. Archeological evidence of contact and exchange with groups of the Southwest includes Puebloan potsherds of a type called Ocate Micaceous or painted types such as Tewa Red-on-Buff; obsidian and turquoise from New Mexico, Olivella shell beads and a few Pueblo style shaft straighteners. The exchange system with between the Plains and Rio Grande Pueblo groups has been argued to have been an integral component of the social and economic systems of both groups (Baugh 1982, 1994; Spielmann 1983, 1986, 1991). Contact with Euro-Americans is limited and suggests trade with them was limited or indirect. The strongest indication of a relationship with Puebloan groups is at the Scott County site, where all evidence but dry-laid masonry structure, irrigation ditches, and a minority of the ceramic assemblage is attributable to the Dismal River culture. The pueblo itself and irrigation are sufficient evidence of a close relationship between these cultures.

Ideology

Given the generally supported view that the Dismal River culture is ancestral Plains Apache, we might expect that the ideology of this manifestation was comparable to the historic groups with which they have been linked. Gunnerson (1987:104) has described the Dismal River house as a “Navajo forked-stick hogan with the five religiously prescribed posts set vertically and use like the center posts of a plains earth lodge.” The inclusion of ceramic pipes comparable to the “cloud blowers” of the Southwest in Dismal River assemblages may also have ideological implications. However, the fact is that Dismal River artifact assemblages and settlement/house do not yet provide insight to this aspect of their culture.

Bioarcheology

Only three interments, all in roasting pits, have been recorded. These were found at sites in South Dakota, New Mexico (described as a Navajo site; Carlson 1965; Gunnerson 1987:104) and the Scott County pueblo in Kansas. Gunnerson (1987) suggests these may not have been remains of Dismal River people, who may have shared with their historic Apache relatives a general fear of the dead and disposed of their remains at locations distant from their settlements. Consequently, direct biological analyses of the Dismal River people have not been possible.

Areas of High Site Probability

The wide variation in site locales and their distribution across the gradient of rainfall-dependant maize horticulture preclude identification, with any specificity, of the areas of greatest site probability. Given the nomadic lifestyle of the Dismal River people, their settlements and campsites can be sought, perhaps with greater probability of success, in both stream valleys and distant upland settings.
Data Gaps and Critical Research Areas

Wedel (1986:150) has pointed out that, despite the variety of information available about Dismal River, only three major sites—Scott County Pueblo, Lovitt, and White Cat Village—have contributed most of what we now know about it. Given the wide dispersion and great number of sites of this complex, this is a truly dismal sample of the potential data available. The chronological placement of the complex appears to be firmly fixed, as does its geographic range. Less well known are the nature of smaller campsites scattered throughout the High Plains and how these relate to the larger settlements. Trade with Southwest Pueblos has been demonstrated but the significance of this aspect of Dismal River economy in their overall cultural system has not been evaluated. Neither do we understand the relations between this hunter-gatherer-trader culture with its Central and Southern Plains neighbors, Lower Loup and Great Bend. If the basis of exchange was bison products for maize, what prevented or discouraged trade for the latter commodity with these eastern corn-growing peoples?

Incipient Horticulturists Adaptation Type

Date Range

The time frame for this adaptation type is roughly the first millennium following Christ, 2000 to 1000 B.P. (A.D. 1 to 1000). Examples of defined archeological complexes which are included in this adaptation type are the Kansas City Hopewell, Valley, Cuesta, Keith, Grasshopper Falls, and South Platte phases.

Environmental Context

Available evidence suggests that the first millennium A.D. was more moist with generally more mesic conditions than immediately preceding or following the period (Ferring 1982; Hall 1982). Bison were apparently less common in the prairie-plains region during this period and there was apparently an expansion of forest and tall grass prairie at the expense of short grass plains. Deer are common are known in the archeological deposits of this time, as noted from both the Middle and Late Woodland faunal assemblages. Although bison are represented in the archeological record, deer and antelope predominate at sites located in both the eastern prairies and the western plains. Evidence from geomorphology, land snails, vertebrate fauna and pollen all suggest that this period was substantially cooler and wetter or had less severe summers than previously (Hall 1982; Graham 1987).

Cultural Context

The Woodland or Incipient Horticulturist adaptation type was relatively short-lived by comparison to the preceding Archaic tradition. Population size has not been studied in a systematic manner, although several researchers believe that population increased significantly during the Woodland period (Wedel 1959, 1961). Sites attributed to the Woodland period tend to be more numerous, especially in the eastern portion of the study area, than earlier period occupations. Given the potential for buried Archaic components, however, this observation may not be an adequate measure of population size. Other researchers note the complexity and quality of artifacts and the structural debris at Woodland period sites as indirect evidence of increased population size. With increased sedentism, and a concomitant focus on more locally available food resources, population is likely to rise (Binford and Chasko 1976; Cohen 1977; Lee 1972; Hassan 1977). It is further argued within this context, that population growth can stimulate subsistence change (Boserup 1965; Cohen 1977; Styles 1981).

Within the Central Plains, subsistence change during the Woodland period is marked by the introduction and increased use of cultigens, although the importance for this change remains an open question. It is quite likely that native groups had reached a point where continued expansion using traditional hunter-gatherer tactics was becoming less feasible. Settlements appear to have become highly localized with an increasing importance of plant foods and smaller game animals. Technological advances such as the widespread acceptance of ceramics and the bow and arrow were, however, almost certainly factors in this scenario.

Technology and Subsistence System

The key technological developments distinguishing this adaptation type are earthenware ceramic vessels and the bow and arrow. Use of atlatls continued and is evidenced by fairly common finds of "boarstones" and other forms of atlatl weights. The ceramic technology varies considerably from east to west across the region. On the eastern prairie border, ceramics of the Early and Middle Woodland periods reflect contact or influence from temporally equivalent groups in the Eastern Woodlands. Thick, stone-tempered ceramics with cordmarked exteriors occasionally overlain in the rim area with geometric designs have been compared to the Liverpool type and appear in limited contexts before the time of Christ. Hopewellian ceramics, distinctive with incised cross-hatched lines and punctate designs on vessel rims, are more widespread during the first five millennia after Christ. Between 1500 and 1100 B.P. (A.D. 500-800), there was a widespread occurrence of cordmarked vessels, both conical and globular in shape, across much of the Central Plains. Temper inclusions consist of bone, stone, or clay. Use of these vessels was apparently as much for storage as for cooking, as evidenced by numerous examples of mending holes, baked-on food residue in the vessel interiors, and the large conical shape.

The bow and arrow was in use in the region, based primarily on a relatively dramatic decrease in the size of some projectile points, at the beginning of the Christian Era and soon thereafter. Replacement of dart points with arrowpoints may have occurred sooner or more rapidly in the Plains and Prairie areas than in the Woodlands (Vehik 1984). The earliest arrowpoints are typically elongated with corner notches, but there are a number of intermediate sized projectile points which were possibly versatile in use and appear intermediate in form between some late Archaic dart points and typical corner-notched arrowpoints.
Subsistence for the Incipient Horticulturists was focused to a variable but increasing degree on plant foods, with the introduction or adoption of native and tropical cultigens occurring during this period. The extent to which domesticates were known to the earlier Archaic populations in the Central Plains remains unknown, despite the recovery of several species of domesticates in adjacent areas (Asch 1994; King 1985, Kay 1983). The identification of domesticated marshelder seeds in Early Woodland contexts on the eastern border of the study area suggests that some level of cultivation was in place before the beginning of the Woodland period. However, significant involvement in the propagation of domesticates with a corresponding reliance on crops for food items did not occur until the latter part of the Woodland period. The mechanisms by which native groups altered their subsistence from the traditional hunter-gatherer-forager tactics to ones of cultivation and harvesting are fairly difficult to elucidate due to significant gaps in the archeobotanical record. It appears, however, that the use of garden plots varied throughout the region, a situation perhaps due to a combination of less than ideal climate and availability of environmentally tolerant plant species. Many indigenous wild plants were also utilized by Woodland groups, with nuts being more common from sites in the eastern part of the study area.

A variety of nonplant foods were used with continuing emphasis upon small animals such as turtles, turkeys, migratory birds, freshwater mussels, and small mammals. Deer and antelope were apparently a staple supply of protein, with bison being represented in fewer numbers (smaller MN) at many sites. The overall economic focus was decidedly riverine in nature, with sites located on terraces of both major waterways and secondary tributaries. Seasonal occupation and regional occupation patterns have been suggested for peoples in both the eastern and western areas of the Central Plains (Reynolds 1979; Grange 1980).

Settlement Pattern

Settlement patterns for the entire Woodland period vary considerably between the Middle Woodland Hopewell complex and the later Plains Woodland complexes. The Middle Woodland has been identified by the presence of both large villages with extensive features and middens and smaller sites indicative of shorter periods of occupation and perhaps more restricted activities. It is difficult to determine, however, if the large village sites were occupied on a permanent basis since no house patterns have been identified. The extensive midden accumulations and numerous features may be more a product of a larger number of people during repeated shorter occupations.

An appropriate description of the settlement pattern for the latter part of the Incipient Horticulturist period in the Central Plains may be "entrenched mobility," a term also applied to the Southern Plains Woodland period. This term implies that groups were not completely sedentary, but moved periodically (perhaps seasonally) as the need arose. Several types of sites are known, including isolated houses, small hamlets, and rockshelters. No true villages are recognized. The known site types imply that people were organized around family or related small groups and that the decision making for the group was conducted on a more egalitarian basis than later village groups. Small hamlets or middens located along stream valleys are more frequent in the eastern half of the study area, with rockshelters and sparse midden deposits more typical of the western High Plains. In both areas, seasonal or limited occupation of the sites has been suggested (Butler 1988; Reynolds 1979; Grange 1980). House patterns, while unknown for most of the Woodland complexes, are identified by postmold stains, daub scatters, and interior hearths and other features. A wattle and daub construction is therefore assumed to have been the common mode of construction while post stains outline structures of variable size. For the Grasshopper Falls phase in northeastern Kansas, one or two oval patterns of postmolds associated with daub scatters are typical. Burial patterns for the late Plains Woodland vary from single interments in prepared graves, cremations, ossuaries, multiple individuals placed together in a prepared grave, and isolated remains within habitation features (Thies 1990). The number and uniqueness of grave goods also varies considerably. Utilitarian goods, including ceramics and lithic tools, are perhaps more commonly found in graves of the late Woodland period, whereas more exotic or specially prepared funerary items have been recovered from the Middle Woodland burials.

Trade and Exchange

While ceramic decorative styles in the Early and Middle Woodland periods are indicative of contact or influence from the Eastern Woodlands, research on the vessel paste suggests that the ceramics were manufactured locally. Reid (1983) has also demonstrated that some of the lithic raw material was traded into the Middle Woodland region from central Missouri. Other items of trade documented from Middle Woodland period sites include shells from the Gulf Coast, obsidian from the Yellowstone area, and copper from the Great Lakes region. The actual number of items made of these exotic materials is very limited, suggesting that the Middle Woodland people were not engaged in an extensive trade network or any reciprocity agreements. The extent to which Hopewell materials, especially ceramics, were traded west into the Plains to non-Hopewell groups is unknown. Evidence for trade associated with the Late Woodland complexes is even more limited. A few artifacts manufactured from Gulf Coast shell have been recovered from Keith complex sites.

Ideology

Elaborate burial mounds are attributed to the Middle Woodland Kansas City Hopewell, Schultz, and Valley complexes and have a limited distribution within the study area. Within the rest of the Central Plains, however, elaborate burial rituals are suggested by the size of the burial sites and modifications of the deceased. Examples such as the extensive use of shell beads on select individuals assigned to the Keith and Ash Hollow complexes attest to the time allocated for the preparation of
the body, while the cremation identified for the Deer Creek phase documents the variable practices of interment during the Plains Woodland period.

Ceremonial sites or burial mounds only occur in the northeastern portion of the study region, but relatively elaborate mortuary rituals are suggested by the diverse and intensive modifications of the deceased (including defleshing and cremation). Some of this variability may, however, relate to mobility and group aggregation patterns as much as to specific burial ideology (Hofman 1986). Ritual activities associated with burial may have been elaborate for some of these groups or in specific instances, but the highly imaginative reconstructions sometimes offered (e.g., O’Brien 1971) are not compelled by the evidence and are unrealistic. It is probable that repeated use of burial sites intensified during this period, and it is during this adaptation type that sites used specifically for repeated burial are first well documented. These factors reflect changing settlement and land use patterns which go in hand with changing ideology and ritual practices. The changes in ideology which occurred during this adaptation type represent an important research topic, but one which will require substantially more information for most of the recognized complexes.

Bioarcheology

The number of reported burials for the Incipient Horticulturist adaptation type is limited, and well-documented cases within the study area are extremely rare (Phencice 1969; Button and Agogino 1987). Burials are most commonly flexed single interments, but multiple burials and cremations are documented.

Data Gaps and Critical Research Areas

Significant research areas which should be addressed for the Central Plains Woodland period include an elucidation of factors and influences surrounding the beginning of the period; a comprehension of the social, political, and economic dynamics involved in the relationships between Middle Woodland Hopewellian groups and surrounding Plains Woodlands populations; a documentation of cultural changes involved in the shift from forager to farmer; a more complete appreciation of the importance of domesticated crops in an area considered by many to be marginal for horticultural pursuits; and a comprehension of the spatial and temporal parameters of the various Woodland complexes. These and other problems will require substantially refined data retrieval mechanisms and corresponding persistence in analyses.

There are many Woodland assemblages curated without having originally received adequate description, let alone formal analysis. In addition, many new Woodland sites are excavated without well-defined descriptions of how the settlement-subistence pattern will be reconstructed, how the lithic and ceramic technologies will be defined and compared, and how intersite variability will be addressed. The Woodland period offers researchers an opportunity to study significant anthropological issues such as the adoption of new technologies, changing settlement patterns, changing resource use, and the sociopolitical foundations which were surely altered as well. By comparison, the Woodland period was a relatively short-lived time in the cultural sequence of the Central Plains, but an extremely dynamic and important one from the perspective of cultural, economic, and technological developments in the region.

The adoption of domesticated plants and the increasing dependence on cultigens was a central focus in the chapter on the Woodland period. It is very clear, however, that the archeobotanical data needed to critically address the nature and status of Central Plains Woodland horticultural activities are insufficiently represented in the assemblages. More importantly, however, these data need to be identified and evaluated for their economic importance within their surrounding cultural setting. The possibility of profitable western dry farming (with the use of highly drought resistant maize varieties), the dietary percentage of plants vs. animals in association with group size and mobility, and the potential for trade as a means of acquiring the necessary crop commodities are research areas which transcend the recovery and identification of plant remains, but which can only be accomplished with the recovery and identification of plant remains as the first step.

Several distinctive ceramic traditions occur in the Central Great Plains region during the Incipient Horticulturists adaptation including materials comparable to Kansas City Hopewell, Plains Woodland, and Mogollon. The users of these diverse ceramics apparently shared a variety of social and economic similarities including relatively large regional population, decreasing territory sizes, emphasis upon plant foods and nonherd animals, use of domesticated plants, and repeated burial in selected or preferred locations. This adaptation type represents a relatively short-lived period in the prehistory of the Central Plains, but an extremely dynamic and important one from the historical perspective of cultural and technological developments in the region. The correlation of temporary camps, shelter sites, and burials with semipermanent habitation sites presents a significant problem to be confronted. This and other problems of intersite comparisons will require substantially refined information on the ages of and variability within assemblages. There are many components and collections presently assigned to the “Woodland” period simply because they do not fit within the defined or recognizable Archaic or Late Prehistoric complexes.

The development of the Incipient Horticulturist technologically and economically in a region which is largely marginal for horticultural pursuits provides an important setting for the study of important anthropological issues such as the interface between hunter-gatherers and food producers. Also important is the documentation of cultural changes necessary to cope with environmental, population, and economic change. The adoption of new technologies (ceramics and the bow and arrow), changing settlement, and changing resource use are probably all factors that relate to solving general problems which were facing the peoples of this region. The possibility of population movements into the Plains area during the.
Woodland period deserves consideration and might be monitored through detailed study of skeletal samples.

Also, the changes in diet and nutrition that occur with the Incipient Horticulturist adaptation may be reflected in bone chemistry. If intensification of horticultural activities reflects increased pressure from population increase, decreased size of hunting or resource use territories, and/or environmental changes, then these pressures may also be reflected through evidence of increased competition or even conflict between groups.

Developed Village Horticulturists Adaptation Type

Date Range

The temporal range of the Developed Village Horticulturists adaptation type in the Central Plains is from about the tenth to the eighteenth century A.D. As in the case of any given cultural adaptation type, its beginning and end are not yet fully known, the former more so than the latter. Historical records indicate the abortive Spanish entrada of the sixteenth century and the continued presence and trade of the Spanish in the Southwest had considerably less affect on the continuity of the Plains Villagers of the Central Plains than those of the French traders of the succeeding centuries. Severe acculturative pressures on indigenous peoples of the region were increased considerably by American settlement in the nineteenth century. With respect to the first appearance of this adaptation type in the Central Plains, archeologists face two problems, one physical and the other theoretical. The former, enhancement and refinement of radiocarbon control, requires only the acquisition of more dates from more sites and improvements in radiocarbon laboratory techniques or calibration. Theoretically, we have yet to define that threshold that separates Incipient Horticulturists from other cultures who relied on cultigens sufficiently for us to recognize them archeologically as farmers. At the present time, radiocarbon dates and taxonomic recognition of Central Plains tradition complexes as representative of Village Horticulturists suggests this threshold had been crossed by A.D. 900.

Environmental Context

Village Horticultural groups of the Central Plains adapted to a variety of environments dominated by grasslands that graded eastward from the shortgrass communities of the High Plains through mixed shortgrass and tallgrass prairies to ecotones of tallgrass prairies and oak-hickory woodlands along the Missouri River trench. These vegetational communities and their associated faunas had been established in the region since the Altithermal climatic episode of the mid-Holocene.

The most dramatic change of the late Holocene that some (e.g., Baeris and Bryson 1965, 1966, 1967, Bryson et al. 1970, Lehmer 1970) have suggested was a significant factor in the readaptation of Plains Villagers was the Pacific climatic episode that prevailed from ca. A.D. 1200 to 1550. The prevalence of strong westerly air flow across the Great Plains resulted in an increase in the frequency of summer droughts. There is no consensus about how or whether this episode, recognized in correlated pollen and radiocarbon analyses (Bryson 1974; Bryson and Wendland 1967; Wendland 1978; Bryson and Padoch 1980) and supported by some faunal studies (e.g., Semken 1983; Hall 1982), caused or influenced the movement or readaptation of horticultural groups in the Great Plains. That interpretation has its proponents and detractors (e.g., Ludwickson 1978; Dallman 1983; Lintz 1986; Wedel 1986) and the disagreement suggests the contribution of the physical environment to adaptations of Central Plains horticulturists still promises to be the subject of future research.

Cultural Context

Cultures recognized as significantly more dependant on horticulture in the Great Plains are generally referred to as Plains Villagers. All share the adaptive economic strategy of producing a large part of their food as compared to the supplementary or redundancy strategy characteristic of Incipient Horticulturists. In the Central Plains this adaptation led to a more sedentary lifestyle than their Plains Woodland predecessors, though different cultures of the region practiced sedentism to varying degrees (Wood 1969). Indeed, the variety of hunting-gathering-gardening cultures that are here assigned to the Village Horticulturist adaptation type are not adequately described by the term Plains Villagers since not all occupied settlements of sufficient size to warrant use of the term "village."

Those archeological cultures of the region that can be described as Village Horticulturists include the Pomona variant, Steed-Kisker phase, three phases of the Central Plains tradition—Nebraska, Upper Republican and Smoky Hill, and the Itskari (Loup River), St. Helena, Oneota (Orr, Correctionville/Blue Earth, and White Rock), Lower Loup, and Redbird phases.

Technology and Subsistence

The subsistence economy combined hunting and gathering of wild resources with cultivation of domestic plants, including maize, beans, squash, sunflowers, and marshelder (Adair 1988). The extent to which Plains Villagers were reliant on horticulture is reflected in their technology in the form of gardening tools such as the scapula hoe and "squash knife." Bones of bison (in the west) and deer (in the east) were modified into a variety of tools such as flakers, awls, needles, beamers, "corn shells," etc. Lithic tools related to hunting that are diagnostic of the adaptation type in the Central Plains include notched (side or side-and-basal) and unnotched, triangular arrow points. Beveled knives make their first appearance in the region with this adaptation type.

The impact of maize-based agriculture on Central Plains Villagers in a semiarid environment has been explored in several articles by Wedel (1941, 1953, 1961, 1979a, 1983b, 1986:114-129). The most recent of these treatments explores the range of factors that influenced this aspect of Upper Republican economy, including dependency on rainfall, length of frost-free seasons, food preparation and storage capabilities.
Archeological inference of the practice of long-distance bison hunting expeditions by Village Horticulturists of the western portion of the region has both its advocates (e.g., Wood 1969, 1990) and critics (Wedel 1986:123-126). The impact of change from a broad-based hunting-gathering-gardening economy by the Upper Republican culture to greater reliance on seasonally determined hunting forays by Iskari and Lower Loup populations has been explored by Roper (1989). The diverse yet bison-poor faunal assemblage from the Hulme site, an Upper Republican settlement on the divide between the Platte and Loup rivers, indicates readjustment of hunting practices to the increased aridity of the Pacific climatic episode (Bozell 1991).

Settlement Pattern

Settlements characterized as isolated farmsteads and hamlets or villages are located primarily in tributary drainages of major streams, including the Smoky Hill, Republican, Kansas, Platte and Missouri rivers. Lowland sites are more typical, as would be expected of farmers of alluvial soils. However, upland habitation sites of both the Pomoa variant and the Central Plains tradition are not at all unusual. It has been suggested that sites in these differing topographic contexts reflect seasonal variation in settlement patterns (Brown 1984).

There are proponents to both sides of the issue of whether the varying sizes of some settlements of this adaptation type, specifically the Nebraska phase, should be considered villages or accumulations of noncontemporaneous lodges in one area over a period of time. Gradwohl (1969) supports the nucleated village concept and Blakeslee and Caldwell (1979; Blakeslee 1990) support the latter interpretation. With respect to the issue as it applies to the Smoky Hill phase, the Minneapolis site in Ottawa County, Kansas has been described as a village (Wedel 1934). The cluster of lodge depressions in the vicinity of the Whiteford cemetery in Saline County and those strung along Wildcat Creek in the Manhattan, Kansas area (an arbitrary portion of which is called the Griffling site; Wedel 1959) could be interpreted in either fashion. Lacking such demarcations as fortifications or other discrete boundaries, archeologists cannot yet clearly infer whether these lodge accumulations represent contemporary occupations. Wedel (1986:100-106) interprets Upper Republican settlements as small villages or hamlets based on “loose aggregations of dwellings” which are located on valley terraces, sloping hillsides and bluff tops.

Social Organization

Inferring social organization, beyond recognizing general population size and the maximum number of occupants that a lodge might have accommodated (e.g., Wedel 1961.95, 1979b; Blakeslee 1989), has been one of the more controversial and frustrating problems of Central Plains archeology. One of the most criticized attempts to infer marital residence patterns from archeological data is that of Deetz (1965), who recognized matrilocality among the protohistoric Pawnee and Arikara in the high level of attribute association in ceramics. A more speculative interpretation of Central Plains Villager social organization was offered by Wood (1969:106-107), who suggested the dispersed hamlets of these cultures were linked through “matrilocal, matrilocus composed of extended, polygynous (sororal) families.” This hypothesis has also had its detractors (Wedel 1970, 1986:128).

Trade and Exchange

The existence of a single trade network that linked both nomadic and sedentary groups of the Great Plains and Prairie Peninsula during the late prehistoric and historic periods has been postulated by Blakeslee (1975; 1981a). Exchange was conducted during informal visits between or among groups, among informal visiting parties, and at intergroup trade fairs. The culmenent ceremony is suggested as one possible mechanism that solidified trade or warfare alliances formed during such exchanges among these groups, such as those of the Nebraska phase (Blakeslee 1981b). It has been argued, however, that the vastness of the Great Plains and its ecological and cultural diversity may have mitigated against the establishment or maintenance of any such trade network (Wedel 1986:129).

Trade between Upper Republican groups and cultures of the Eastern Woodlands is inferred from the presence of artifacts of such nonlocal materials as Gulf Coast conch shells, freshwater snail shells of the Ohio and Wabash rivers, marine olivellae and marginella from the Southeast coast at Upper Republican sites (Strong 1935; Neuman 1965; Wedel 1986:111).

The increasing importance of trade, direct or indirect, with groups of the Southwest is examined by Loosle (1992) in his analysis of Great Bend aspect data. The extent to which this protohistoric culture of the Southern Plains-Central Plains border involved the Developed Horticulturists of the latter region has yet to be determined.

Ideology

Ideological aspects of Central Plains horticulturists, as indeed of most prehistoric cultures, are most difficult to discern. Nonetheless, some archeologists have dared to interpret the superstructural realm of the cultures that are here our concern.

The presence of Mississippian and Caddoan traits or artifacts in assemblages from sites of the Steed-Kisker, Nebraska, Upper Republican and Smoky Hill cultures raises the possibility that the trade relationship between the latter and cultures of the Eastern Woodlands was subsumed within a broader ideological framework. O’Brien (1981:103; 1984) has suggested that the incised designs of Steed-Kisker pottery, including “weeping eyes, nested arches, crosses and the sunburst motif” are evidence of a connection with the Southern Ceremonial complex. McNerney (1987) has suggested that the effigy complex and some exotic ceramic vessel forms of the Nebraska phase points to the northward diffusion of the Spiro-Southeastern Ceremonial complex from the Caddoan area. The association of a single sherd of Crockett Curvilinear Incised ware and four well-made “ceremonial” bifaces with the burials at the Whiteford cemetery, in Saline County, Kansas, has been professed as tantalizing testimony of a comparable link between the Smoky Hill phase and the Caddoan area (Wedel 1959:519-
northwestern Missouri, include Amazonia Mound in Andrew County, Cloverdale ossuary in Buchanan County, and Sugar Creek ossuary in Platte County (Peagins 1988). Biological analysis of the Sugar Creek site has been completed by Nickels (1971). Strong (1935:172-175) describes what he suggests was a channel house at the Saunders site, where charred human bones were found scattered throughout the floor fill with other animal remains, ceramic, and lithic refuse.

Nebraska phase human remains have been used in comparison to those from St. Helena and Upper Republican sites to determine biological relationships between these cultures and also to infer continuity from earlier Woodland through Central Plains tradition and later historic (e.g., Arikara) populations (Jantz et al. 1978). Multivariate analyses of cranio metric data from protohistoric and historic Caddoan and Siouan populations with St. Helena human remains have further demonstrated that the latter were related to the Arikara (Jantz et al. 1981).

Smoky Hill burials are known from the Whiteford cemetery, where remains of more than 140 individuals were excavated in the early twentieth century by an amateur archaeologist, left in situ and sheltered by a frame structure (Wedel 1959:512-523). Long on display for tourists, this site was filled in and capped with a concrete slab following its purchase by the state in 1950. A team of researchers, including a physical anthropologist, completed data gathering at the site between January and March of that year. Except for a detailed analysis of four "ceremonial" bifaces from the cemetery (Reynolds 1990), no results of analyses have been published at this time. Phenice (1969) describes the physical attributes of human remains in the Schultz Collection at the University of Kansas Museum of Anthropology. While most of these are Plains Woodland individuals, at least one interment (from the Ditmar site in Clay County, Kansas) is now believed to be attributable to the Central Plains tradition (Smoky Hill phase). Others of that affiliation in the collection may have been intrusive burials in Woodland mounds (Ritterbush and Logan 1991). A critical review of the data from mortuary sites excavated by Schultz and described by Eyma (1956) and Phenice (1969) to determine, as far as the records permit, the cultural affiliation of the human remains.

Upper Republican burials, including ossuaries and individual interments, have been described from both Kansas and Nebraska (Strong 1935:103-114; Wedel 1959:560). One of the ossuaries examined by Strong is Graham Ossuary, located in the Harlan County Lake area, south-central Nebraska. Recent National Register evaluation of the site, extensively excavated by Strong in 1930, demonstrated that it still not only retains undisturbed deposits but that the variety of skeletal remains can provide significant information about Upper Republican lifeways. For example, the sample of individuals recovered during the 1985 test excavations point to a high mortality rate for infants (Adair et al. 1987:78-89).

Lower Loup mortuary practices may have been like those of the descendant historic Pawnee, who practiced flexed inhumation in tumuli, generally on overlooks and their villages (Wedel 1938:91-94). Human remains (cranialia) from two
Lower Loup sites were used by Ubelaker and Jantz (1979) to
examine biological relationships among Plains Caddoan groups.

Oneota burials are better documented in the Iowa portion
of the Central Plains where they occur as inhumations in
individuals graves in a cemetery area near villages (M. Wedel
1959; Harvey 1979). The Leary site in Richardson County,
Nebraska yielded 15 burials during the 1935 excavations (Hill
and Wedel 1937). Remains of three individuals were excavated
from one of several mounds at the site during salvage operations
in 1960. Bass (1961) presents a brief report with little physical
data beyond the elements represented, sex and age of these
discoveries.

Human remains from sites of the Redbird culture are
limited. Wood (1965:116) briefly describes the physical
attributes of two primary, extended burials and an isolated skull
from two sites of this protohistoric complex.

No bioarcheological information is available for the White
Rock culture.

Areas of High Site Probability

Past research has focused, for reasons of financial support
and site visibility, on sites in lowland settings. Early
archeologists such as A.T. Hill and W. Duncan Strong in
Nebraska focused on visible sites in stream valleys where lodge
depressions or plow-disturbed habitations were easily
discerned. Though Hill and others investigated sites
throughout the Central Plains (particularly in Nebraska), the
post-World War II era of cultural resource management has been
focused on the numerous federal reservoirs throughout the
region. A consequence of the research of our predecessors is
that what remains largely unexplored are areas beyond these
reservoirs. Some of these intervening areas have seen
archaeological work connected with highway, Soil Conservation
Service, oil and water line surveys, and the field training projects
of universities, state historical and avocational societies.
However, the scope of these projects has rarely been as broad
as those undertaken in stream reaches affected by federal
reservoirs. Thus, areas that we know from the reservoir studies
have high site probability, such as lowland terraces in tributary
valleys, have yet to be explored.

Recent geoarchaeological investigations in the Central Plains
have also pointed out the potential of various landforms for
containing sites in buried alluvial contexts heretofore largely
unexplored (Johnson and Logan 1990; Mandel 1987; May 1986).
While we have frequently acknowledged the affect of alluvial
burial on early and mid-Holocene sites, we generally assume
ceramic-age sites lie just below or at the surface. In some
drainages this may not be the case. For example, recent
reinvestment of the Mugler site, a Smoky Hill habitation in the
Republican River valley, Clay County, Kansas indicates some
lowland settings experienced substantial alluviation that
effectively buried evidence of occupation to depths of 70-100
cm (Ritterbush and Logan 1992). Such areas of site potential
have not yet been adequately investigated.

Data Gaps and Critical Research Questions

The Central Plains has long been one of the most
archaeologically well-documented regions of the Great Plains,
particularly with regard to the ceramic periods, but many
problem domains have yet to be thoroughly researched.
Though the basic culture historical outline of the region's
horticulturist/hunter-gatherers has been in place since the
1960s, refinements of it are still required. Indeed, recent
research has indicated the basic culture-chronological scheme
is flawed in some respects. An ecologically based cultural
sequence for the Central Plains tradition in the Glen Elder
locality (now Waconda Reservoir), Mitchell County, Kansas by
Krause (1970) was critically evaluated by Lippincott (1978a;
the sequences of Krause and Lippincott, particularly with regard
to the radiocarbon dates on which both were based, and
seriously undermined the validity of either scheme.

The recognition of three geographically and ceramically
distinct cultures of the Central Plains tradition (Strong 1935;
Wedel 1959) that has been the standard for so long is weakened
when sites generally referred to as "hybrids" are considered
(e.g., Strong 1935:181-182, 287 Hill and Cooper 1936:246-248;
Hill and Wedel 1936:3, 34, 34, 69; ). Ceramic assemblages from
these sites display greater variability than the "pure" or
homogeneous assemblages from core area occupations. These
sites hold more promise for answering questions about the
relations, or indeed, the reality of the Nebraska, Smoky Hill
and Upper Republican archeological cultures. Recent
examination and analysis of ceramic assemblages from Smoky
Hill sites in the lower Republican River basin has revealed what
may actually be an east-west (or upstream-downstream)
gradient in the pottery types that are one of the linchpins of
these cultures (Hedden 1992).

The relation of archeological cultures that may have
reflected distinct, contemporary populations (i.e., Steed-Kisker
and Pomona) has yet to be clarified (Logan 1988). The origin
and fate of all of the prehistoric Plains Villagers is still a subject
of dispute (e.g., Steinacher et al. 1991). Recent radiocarbon
dating of the White Rock aspect has indicated this culture, once
thought protohistoric, must now be assigned, at least in part,
to the Plains Village period. This requires a reassessment of
the influence of western Oneota cultures on Central Plains
tradition developments (Logan 1993, 1994).

The spatial and temporal nature of the Nebraska phase is
still the subject of reanalysis (Billeck 1993; cf. Anderson 1961;
Brown 1967; Krause 1969; Zimmerman 1977b; Hotopp 1978a;
1978b; Blakeslee and Caldwell 1979). St. Helena has only
recently seen the acquisition and analysis of new data, from a
single excavated lodge, after a hiatus of 50 years and this, of
course, has raised a variety of still new research problems
(Blakeslee 1988).

More extensive geoarchaeological studies are needed in
valley settings in order to gauge the geographic extent and
nature of buried Central Plains tradition sites. The early
recognition of Upper Republican sites buried below sterile silt
deposits and the climatic implications of that process are among
the more renowned accomplishments of regional archeology
(Strong 1935; Wedel 1941; Kivett 1948). However, whether the
process of burial was due to conditions of increased aridity or
precipitation in different parts of the region are opposing
interpretations yet to be substantiated. This is but one example
of the variety of culture ecological problems that can still be
addressed and which will require an interdisciplinary approach.
Appendix: Paleobiogeography of Post-Sangamonian Vertebrates in the Central Plains, by Larry D. Martin

The late Pleistocene is commonly regarded as the Sangamonian and Wisconsinan, although the Late Illinoian may be included. It corresponds roughly to the Rancholabrean Land Mammal age. There are probably no credible human associations in the Central Great Plains that are as old as Sangamonian and practically no sediments that can be clearly assigned to that age. The earliest widespread assemblage of Wisconsinan vertebrates is associated with the Gilman Canyon Formation. Feng, Johnson and Lu (1993) give a range of ages from 35,000-20,000 B.P. for the Gilman Canyon Formation, representing a late interstadial (Farmdalian) in the Wisconsinan sequence. It varies in thickness, and seems to be a mixture of eolian deposition and soil forming processes. During times of local surface stability it was extensively burrowed by rodents and especially by the fossil ground Squirrel Spermophilus kimballiensis Kent. Several local faunas from southwestern Kansas are time equivalents of Gilman Canyon deposition. The best known is the Jones Local Fauna that has recently been restudied by Davis (1975, 1987). Because Gilman Canyon Formation sites represent buried surfaces with reasonable preservation of bones and charcoal; are usually deeply buried and have good stratigraphic control, they should be searched by archaeologists for human evidence.

The Wisconsinan full glacial sequence is encompassed by the deposition of the Peoria Loess Formation ranging from 20,000-15, 000 B.P. The Peoria Loess is a massive sequence of windblown dust reflecting locally severe aridity and cold temperatures. Local concentrations of snails and plant macrofossils document scattered stands of trees (Wells and Stewart 1987a, 1987b), but pollen sites from the same areas lack evidence for extensive forests. The best interpretation is a conifer parkland in the uplands while the floodplains may have been forested with spruce permitting the westward extension of Bootherium, Cervulcus and Mammut.

Holen’s description of the La Sena site (Holen 1994) suggests a real possibility of human activity in Nebraska and Kansas during the full glacial. If people were living in the region, it seems unlikely that any elephant carcass would go unscavenged and a systematic examination of loess sites with large mammal remains would be a good way of investigating the possibility of a human presence.

The interval from 15,000 to 10,000 B.P. covers the transition from the end of the Pleistocene to the inception of the Holocene. The entire interval is encompassed by solid evidence of human occupation in South America (Rogers et al. 1992) and the latter part by the well-known Clovis, Folsom, and Plano cultures. This was a time of environmental change with the break up of the Wisconsinan forests and parklands and the establishment of modern prairies and deciduous forest along with modern vertebrate and invertebrate biogeographic distributions. Extirpation of both large and small mammals occurred throughout the region (Martin et al. 1983). Most of the small mammals found refuge at higher elevations or latitudes, but the large mammals with their more defined breeding patterns and large home ranges proved less able to adjust and many became extinct.

The critical period of extinction is now closely confined between 12,000 and 10,000 B.P. Bison are rare as fossils up to about 11,000 B.P. after which they become abundant and are often found as mass death assemblages associated with evidence of human hunting. This is especially evident during the interval from 10,000 B.P. to 5,000 B.P. It may be that as the competitive pressure from other grazers diminished, bison became more abundant and the total biomass of large game animals was not reduced much by the decrease in large mammal diversity. Certainly hunters would have had little choice but to rely on bison after 10,000 B.P. There is some evidence that arid conditions were widespread in the Early Holocene (Alithermal?) and prairie conditions may have spread eastward carrying the bison herds with them. The Early Holocene record of bison near Bonner Springs, Douglas County, Kansas seems more extensive than the Late Holocene record (Rogers and Martin 1983), and may suggest a movement of the prairie-deciduous forest ecotone to the east.

Very few Early Archaic living floors have been excavated in Kansas and Nebraska. It is clear that this will bias our record against small mammals and other aspects of collecting and gathering as opposed to big game hunting. The development of agriculture must have reduced dependency on large game and made such hunting a more seasonal activity. Certainly, the younger sites show a dominance of deer and a greater variety of small prey.

The geographical distributions of Late Pleistocene-Holocene organisms has only recently been appreciated. The first comprehensive efforts to map Pleistocene mammal distributions against vegetational distributions were those of Martin and Neuner (1978) who proposed a system of Pleistocene faunal provinces (Martin et al. 1985). Martin and Hoffman (1987) later suggested that those faunal provinces were the Pleistocene equivalents of modern biomes. Holocene distributions have been less extensively studied but good distributional data for Nebraska and Kansas have been recently published (David 1987; Semken and Falk 1987). The following maps, lists of sites, and lists of species rely on their efforts as well as other published reports. Only sites that can be reliably dated through absolute dates or stratigraphy are included although some latitude has been allowed for interesting sites that have dating information, but probably not for the whole assemblage. The intervals chosen are intended to group sites that may share a similar climatic history.
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<th>Scientific and Common Names of Mammals</th>
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<td>Insectivora</td>
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| Carnivora                                |
| *Zapus hispidus*                        | meadow jumping mouse |
| *Zapus princeps*                        | western jumping mouse |
| *Erethizon dorsatum*                    | porcupine |
| *Edentata*                              | Harlan’s ground sloth |
| *Glossophaga barlanti*                  | ground sloth |
| *Megalonyx*                             | coyote |
| *Canis latrans*                         | gray wolf |
| *Canis lupus*                           | domestic dog |
| *Canis familiaris*                      | dire wolf |
| *Vulpes vulpes*                         | red fox |
| *Vulpes velox*                          | swift fox |
| *Urocyon cinereoargenteus*              | gray fox |
| *Ursus americanus*                      | black bear |
| *Arctodus simus*                        | giant short-faced bear |
| *Procyon lotor*                         | raccoon |
| *Lupus americana*                       | marten |
| *Lupus nigripes*                        | noble marten |
| *Mustela erminea*                       | ermine |
| *Mustela frenata*                       | long-tailed weasel |
| *Mustela nigriceps*                     | black-footed ferret |
| *Mustela eisen*                         | mink |
| *Gulo gulo*                             | wolverine |
| *Taxidea taxus*                         | badger |
| *Mephitis mephitis*                     | striped skunk |
| *Lutra canadensis*                      | river otter |
| *Lutra canadensis*                      | mountain lion |
| *Puma concolor*                         | bobcat |
| *Puma concolor*                         | American lion |
| *Proboscidea*                           | American mastodon |
| *Manisus americanus*                    | Columbian mammoth |
| *Manisus colombi*                       | flat-headed peccary |
| *Artiodactyla*                          | long-nosed peccary |
| *Platygonus compressus*                 | elk |
| *Mylolophus nasutus*                    | white-tailed deer |
| *Cervus elaphus*                        | stagmoose |
| *Capreolus virginianus*                 | caribou |
| *Cervus canadensis*                     | pronghorn |
| *Rangifer tarandus*                     | bison |
| *Antilocapra americanas*                | barren ground muskox |
| *Bison bison*                           | woodland muskox |
| *Ovis canadensis*                       | bighorn sheep |
| *Camelus*                               | American camel |
| *Camelus bactrianus*                    | macrocephala large-headed llama |
| *Equus sp.*                             | horse |
| *Equus noradrensi*                      | Nhibara horse |
| *Tapirus terrestris*                    | extinct tapir |
Sites 35,000 to 20,000 yr B.P.

1. Twelve miles SE of Maxwell, Lincoln Co., NE, "Cieillus Zone" (Schultz 1934)
2. Ten miles SW of Maxwell, Lincoln Co., NE, "Cieillus Zone" (Schultz 1934)
3. Three miles south of Bignell, Lincoln Co., NE, "Cieillus Zone" (Schultz 1934)
4. Two miles south of Bignell, Lincoln Co., NE, "Cieillus Zone" (Schultz 1934)
5. Sixteen miles south of Bignell, Lincoln Co., NE, "Cieillus Zone" (Schultz 1934)
6. Dales Farm, Dawson Co., NE, "Cieillus Zone" (Neuner 1975; Goodwin 1990)

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7. Eastis, Frontier Co., NE, "Cieillus Zone" (Neuner 1975)
8. UNSM Coll. Loc. Hn 101, Harlan Co., NE, "Cieillus Zone" (Neuner 1975)
9. Gilman Canyon, Box Elder Canyon, and Cottonwood Canyon, Lincoln Co., NE (Neuner 1975)
11. Liechfield Local Fauna, Sherman Co., NE This was reported by Voorhis and Corrner (1985) and includes Phocaenaena and Glossochirontis. The only dates associated with it are Holocene and must certainly be in error. Based on its faunal composition it could be an equivalent of the Gilman Canyon fauna. It is one of the most diverse late Pleistocene faunas and would be very important if it could be securely dated. Rogers and Martin (1965) reported a small number of pollen grains from the Liechfield site most of which were from grass. As some of the fauna requires forest cover, he suggested a pine parkland.
12. Jones Local Fauna, Meade Co., KS. Discovered by Claude Hibbard (1970), this is a southwestern Kansas equivalent of the Gilman Canyon Fauna and has been dated at 26,700±1,500 YBP and 29,000±1,300 YBP (Davis 1987). The fauna includes Sorex cf. arcticus and probably Microtus montanus (Davis 1987) so that it has a more boreal aspect than the modern fauna. Large mammals include mammoth, pecary, bison, camel and horse. No human association is known.
13. Devils Gap, Dawson Co., NE. The type locality of Bison antiquus barbouri; Schultz and Frankforter (1946), 2.4 miles west of Gothenburg.
Sites 20,000 to 15,000 yr B.P.

1. La Seda Local Fauna, Frontier Co., NE, Pecoria Loess, dated at about 18,000 YBP.
2. Wolkach Local Fauna, Greeley Co., NE, laze of the Pecoria Loess (Schultz, et al. 1994)
3. Franklin Co., NE, peccary mass death, Pecoria Loess (Schultz 1934)
4. Smith Falls Local Fauna (Virchies and Corner 1985). A series of eleven separate sites on the highest terrace of the Niobrara River: Cherry, Brown, and Keya Paha Counties, NE. These faunas may not be strictly contemporaneous and the presence of the collared lemming, *Dicrostonyx*, makes it the most boreal NE fauna with tundra during at least part of the time.

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6. Harlan Co., Reservoir (North Side), Harlan Co., NE. This is a number of occurrences either in situ in Pecoria Loess or apparently just eroded out of it (Burres 1992).
7. Duck Creek Local Fauna, Ellis Co., KS. The Duck Creek Local Fauna was considered "Illinoian" in age (Zakrzewski and Maxfield 1971; Kolb et al. 1975; McMullen 1975 1978, Holman 1984) until Stewart (1987) provided a full glacial date of 17,000±350 YBP. The presence of *Clethrionomys* and *Mictomys* demonstrates its boreal nature.
8. Coon Creek Local Fauna, Graham Co., KS. The Coon Creek Local Fauna was discovered by J. D. Stewart, who described it as a thin veneer of late Pleistocene deposits lying on top of Flocene sediments. The fauna (Wells and Stewart 1987) included a boreal assemblage similar to that from the Trapshooting Local fauna including *Pelecyops inornatus* and a few macrofossils of *Picea flexilis* (limber pine). A full glacial radiocarbon date of 17,930±550 B.C. was obtained from this site.
9. Trapshooting Local Fauna. This site was discovered by J. D. Stewart, who was also responsible for its excavation and used it as the subject of an M.S. thesis (Stewart 1978). Most of the fauna was recovered from a large crotatena within loess considered to be Pecorian. This relationship suggests an age somewhat in the range of deposition for the Pecoria Loess or from 20,000 to 14,000 B.P. Fragments of baby bones indicate that the crotatena is a fossil fox den, and as such the site is an unlikely one for human associations. The presence of such boreal animals as *Pelecyops inornatus* indicate a glacial influence.
11. Wichita Sandpit, Sedgwick Co., KS. Bear balls from this site dated at 19,490±200/210 YBP (Fredlund and Jaumann 1987). This probably dates the oldest level at this site (Rogers and Martin 1985).
Sites, 15,000 to 10,000 yr B.P.

1. Selby-Dutton Sites, Yuma Co., CO. Dated at 13,600±485 on bone collagen (Stanford and Graham 1985). This site is supposed to be stratigraphically in the Peoria Loess although the date is a little young for that stratigraphic position. Human activity has been postulated for this site.


3. Twelve Mile Creek Site, Wallace Co., KS. Bison kill dated at 10,455±262 and 10,245±355 (Rogers and Martin 1984).

4. Adjacent terrace deposits to the Twelve Mile Creek Site (Hay 1926).


6. North Cove Local Fauna, Harlan Co., NE. The North Cove site was discovered by J. D. Stewart, who later joined W. Johnson in directing excavations at this site. It contains both abundant floral and faunal remains, making it the most important late Pleistocene site in the Central Plains. Two lithic flakes were recovered in association with bone remains, including: Phenacomys, Microtus xanthognathus, Clethrionomys, and Mioclemys. The spruce forest character of this association is confirmed by the presence of Picea glauca in adjacent strata (Stewart 1989). The human origin of the flakes has been questioned, but the presence of small concentrations of burned bones and charcoal coupled with the flakes should maintain a cautious interest in the possibility of an archaeological component. Among the burned remains are portions of bison (Stewart 1989). The proposed cultural remains are from a Woodfordian horizon that produced radiocarbon dates ranging from 12,750±100 to 11,015±115 B.C. Radiometric dates from the fossiliferous sequence range from 14,700±100 to 21,500±185 B.C. Prootic and horse, and camel remains occur in similar sediments near the site but do not appear in the published lists from the excavations. Similar Pleistocene remains and sediments occur as isolated occurrences on the north side of Harlan Co. Reservoir and there is potential for additional discoveries. The most interesting aspect of this assemblage is the undoubted local occurrence of spruce forest accompanied by a typical forest assemblage. Its existence in the middle of the plains may not require an extension of the Pleistocene forests of Iowa to south-central NE, but it does incorporate a conifer forest along the ancient drainages.

7. Classen Local Fauna, Meade Co., KS. The Classen Local Fauna produced a date of 16,100±250 B.P. (Stewart 1987).

8. Robert Local Fauna, Meade, Co., KS. This local fauna has a date of 11,100±390 B.P. (Schulte 1967). It still contains extralocal animals of boreal aspect, including: Sorae palustris, Thomomys talpoides, and Spermophilus kalmia (Stewart 1984). The locality was discovered by J. D. Stewart. It produced bones of Lepus americanus (Snowshoe hare) and snakes (Stewart 1984). A date on spruce charcoal places it near the end of the full-glacial 14,450±400 B.C. There is no archaeological association.


10. Koeba-Schneider Mammoth Site, Greeley Co., KS. Alluvial fill dated on bone at 11,050±190 B.P.

11. Crappie Hole Site, Keith Co., NE. The age on this site (Voelhies and Corner 1984) is uncertain and may be older than 15,000 B.P.

12. Wolverine Slide Site, Knox Co., NE. This locality is very similar to the Crappie Hole Site (Corner and Voelhies 1987) and is also of uncertain age.

13. Loweull Reservoir Hemianc dicha Site, Jewell Co., KS (Logan, Martin, and Neas 1991) from deposits dated at 13,410±330 B.P.

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**Cassetts**

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<td>Pantuera ax in</td>
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1. Logan Creek, Burt Co., NE. This is a complex of cultural zones dating from 8125±250 to 6633±300 (Kien 1962; Snyder and Rozell 1983).
2. Hudson-Meng Site, Sioux Co., NE. This is an Early Archaic Bison kill dated at 9820±160 and 8990±190 (Ageeboad 1978).
3. Scottsbluff Bison Quarry, Scottsbluff Co., NE. The type site for Scottsbluff points (Barbour and Schulz 1931).
4. Clay Ranch Site, Garden Co., NE. Mass kill of Bison cf. occidentalis should date around 8,000 YBP based on associated Frederick points (Myers et al. 1981).

5. Milburn Bison Quarry, Custer Co., NE. This is a peat deposit where bison bogged down around 8,000 YBP. Some artifacts were recovered from the peat (Hillerd 1970).
7. Preserve Bison Quarry, Hall Co., NE. A bison kill site with the original Preserve points (Barbour and Schulz 1936).
8. Lime Creek, Red Smoke, and Allen Sites. A series of deeply buried Terrace deposits containing occupational floors, the oldest dating at 9524±65 YBP (Schulz, Luteninghofer, and Frankforter 1951).
9. Suter Site, Jackson Co., KS. This site produced a small number of bison bones and dates of 7970±245 and 7685±245 YBP (Katz 1971:1972).
11. Coffey Site, Pottawatomie Co., KS. This site ranges in age from 5850±135 to 4860±95 (Schmitz 1978).
12. Kansas River Sandbars at Bonner Springs, Douglas Co., KS. This material is not in situ but radiocarbon dates, Early Archaic artifacts and the evolutionary state of many of the bison specimens demonstrate an Early Holocene component.
13. Sturgeon Site, Labette Co., KS. Early Archaic site dating around 7,000 YBP.

2. Gray-Wolf Site, Colfax Co., NE. Protohistoric (Bozell et al. 1982).


4. Schmidt Site, Howard Co., NE. Late Prehistoric (Moore 1982; Satterius-Fox 1982).

5. Bill Fackler Site, Sherman Co., NE. Late Prehistoric (Bozell and Rogers 1985; McKenney and Holen 1985).


8. Medicine Creek Terraces, Frontier Co., NE. Late Prehistoric (Mick 1983).


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