REGIONAL PATTERNING IN THE PALEOINDIAN RECORD FROM KANSAS, OKLAHOMA, AND TEXAS

by

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ABSTRACT

After 70 years of research devoted to Paleoindian studies, several alternative models concerning Paleoindian economies, social organization, and mobility patterns have been developed. Answers to such questions remain elusive due in part to the emphasis on specific site studies. Regional studies provide information on prehistoric behavior and land use which complement site studies. This thesis provides a regional investigation of Clovis, Folsom, and Cody projectile point distributions in the area of Kansas, Oklahoma, and Texas in order to address Paleoindian land use. This region of North America covers a total of 1,067,067 km^2 and encompasses a diversity of physiographic zones from the High Plains to the Woodlands.

Marked climatic and ecological changes occurred during the Plains Paleoindian period (11,500 BP to 8,000 BP) that resulted in extinctions and the reorganization of flora and fauna by 10,000 BP. By altering subsistence strategies, technology, and mobility patterns, prehistoric people responded to these climatic and biotic changes. Kelly and Todd (1988) have argued that early Plains Paleoindians (Clovis and Folsom) were highly mobile and exhibited limited technological variability between environmental areas due to a species-specific rather than geographical-focused adaptation. Through time, Paleoindians may have become more regionally focused. Selected pressures including changing environment and population may have resulted in technological variation correlated regionally with environmental and economic patterns.

This study suggests significant variability existed among Clovis, Folsom, and Cody land use patterns. Each of these cultural complexes exhibit distinctive regional patterning which enables a reassessment of existing models. The revealed projectile point distributions supports the argument that Clovis adaptation may have been independent of geographical region; whereas Folsom was more regionally focused. The distinctive Cody distribution includes a strong link to the Woodland environment.

Kelly, R. and L. Todd
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CHAPTER ONE - OVERVIEW AND PROBLEM STATEMENT

The archaeological record of mobile peoples should be viewed not as a system of structured sites, but as a pattern of continuous artifact distribution and density... information on land use patterns may in some cases be better obtained through the study of non-discrete artifact distribution in specific zones than from orthodox site distributions.

Foley 1981a:163

The purpose of this thesis is to provide a regional investigation of Paleoindian land use in the area defined by the political boundaries of Kansas, Oklahoma, and Texas (Figure 1.1). This region of North America covers a total of 1,067,067 km^2 (411,995 mi^2) and encompasses a diversity of physiographic zones. In order to accurately reconstruct Paleoindian lifeways, regional studies are a necessary complement to individual site studies providing information on general land use (Amick 1994; Greiser 1985; Hofman 1991; L. Johnson 1989; Story 1990) resource use (Bamforth 1988; Beck and Jones 1997; Hofman 1992, 1995; Meltzer 1988), and site variability (Hester and Grady 1977; Judge 1973; Judge and Dawson 1972; Wendorf and Hester 1962).

Paleoindian projectile points represent diagnostic cultural markers (Hayden 1982; cf. Gamble 1982). They are the most recognizable trace of Paleoindian occupation and provide a key means by which to reconstruct prehistoric land use. In non-site regional studies projectile points are the primary source of diagnostic information relevant to land use studies. This study suggests that significant variability existed among Paleoindian land use determined by the analysis of the distribution of Clovis, Folsom, and Cody projectile points. Each of these cultural complexes exhibit distinctive regional patterning which enables a reassessment of existing models concerning Paleoindian economies (Kelly and Todd 1988; Meltzer 1988), social organization (Greiser 1985), and mobility patterns (Kelly and Todd 1988; Meltzer 1988; L. Johnson 1989).

Kelly and Todd (1988) have suggested that Early Plains Paleoindians (Clovis and Folsom) were highly mobile and exhibited limited technological variability between environmental areas due to a species-specific rather than geographically-focused adaptation. Given this model, were Clovis and Folsom large herbivore-focused specialists as evidenced by their land use patterns? It has been suggested (Thurmond 1990), that through time Paleoindian adaptation may have become more regionally focused. This raises the question of whether the later Cody complex projectile point distribution supports a regionally focused adaptation. Selected pressures including a changing environment and population may have resulted in technological variation correlated with specific environmental regions.

During the Plains Paleoindian period (11,500 BP -8,000 BP), marked climatic and ecological changes occurred with the amelioration of cold moist conditions due to a world-wide warming trend that began by 14,500 BP. With glacial retreats well underway, significant changes occurred in the plant and animal distributions. In general terms, due to increasing seasonal temperatures and decreasing effective moisture, parklands over much of Kansas, Oklahoma, and Texas gave way to deciduous forests in the east by 11,300 BP. Grasslands dominated the central and western regions transected by riparian vegetation. The reorganization of flora corresponded with extinction and extirpation of fauna by 10,000 BP. This process resulted in modern day vegetation by 8,000 BP. The transition from vegetation dominated by woodland to grassland is complicated and the processes involved are not fully understood. Environmental changes at the end of the Pleistocene may not have been contemporaneous, uniform, or sudden. As stated by Bryant and Shafer (1977:19), "The changes were demonstrably gradual, occurred over several thousand years and probably went completely unnoticed by successive generations of aborigines. These changes, however, were nonetheless manifested over time and eventually created concomitant changes in the human adaptive systems." However, recent evidence suggests that extinctions occurred more rapidly (Graham and Lundelius

1994; Mead and Meltzer 1989). Along with long-term changes were short term fluctuations that resulted in year to year differences in productivity. These fluctuations were not predictable and encouraged hunters and gatherers to implement diverse subsistence strategies (Binford 1980). Changes in prehistoric mobility patterns may have resulted.

The Paleoindian archaeological record is argued to represent highly mobile groups who utilized large territories (Bonnichsen *et al* 1987; Kelly and Todd 1988; West 1983). There appears, however, to have been a wide range of variation among Paleoindian complexes. Sites appear to reflect short term occupation and typically have low artifact density. These characteristics contribute to the low frequency of excavated Paleoindian sites in the study area. Compounding the ephemeral nature of Paleoindian sites, is the visibility of Late Pleistocene and Early Holocene land surfaces due to geomorphological factors such as deeply buried sites in many settings (Collins 1991; Ferring 1994; Holliday 1997; Leonhardy 1966; Mandel 1992). Given these considerations, the use of surface-derived information is of increased importance and becomes a necessary component to the analysis of Paleoindian land use (Beck and Jones 1997; Hofman 1991).

The archaeological notion of "site" has resulted in the omission of elements comprising the archaeological record (Dunnell 1992; Dunnell and Dancy 1983; Foley 1981a, 1981b; Hofman 1991; and Thomas 1975). In fact, Dunnell (1992:36) writes, "the notion 'site' not only biases our understanding of the human past, but it is also rapidly leading to biased destruction of the record, forever impairing our understanding of the human past." Thus, "the archaeological record is most usefully conceived as a more or less continuous distribution of artifacts over the land surface with highly variable density characteristics" (Dunnell and Dancy 1983:272). This siteless or nonsite view is not a "different interpretation of the discipline's subject matter but a different view of what the subject matter is" (Dunnell 1992:34). For regional scale analyses, the documentation and recognition of the distribution of artifacts across the landscape is equally important and complementary to the number of sites (Foley 1981a, 1981b; Thomas 1975). Furthermore, "Many patterns of landscape and resource use will simply not be visible if we only study a selected handful of 'productive' sites" (Hofman 1996:77). This is especially true for the Plains Paleoindian period.

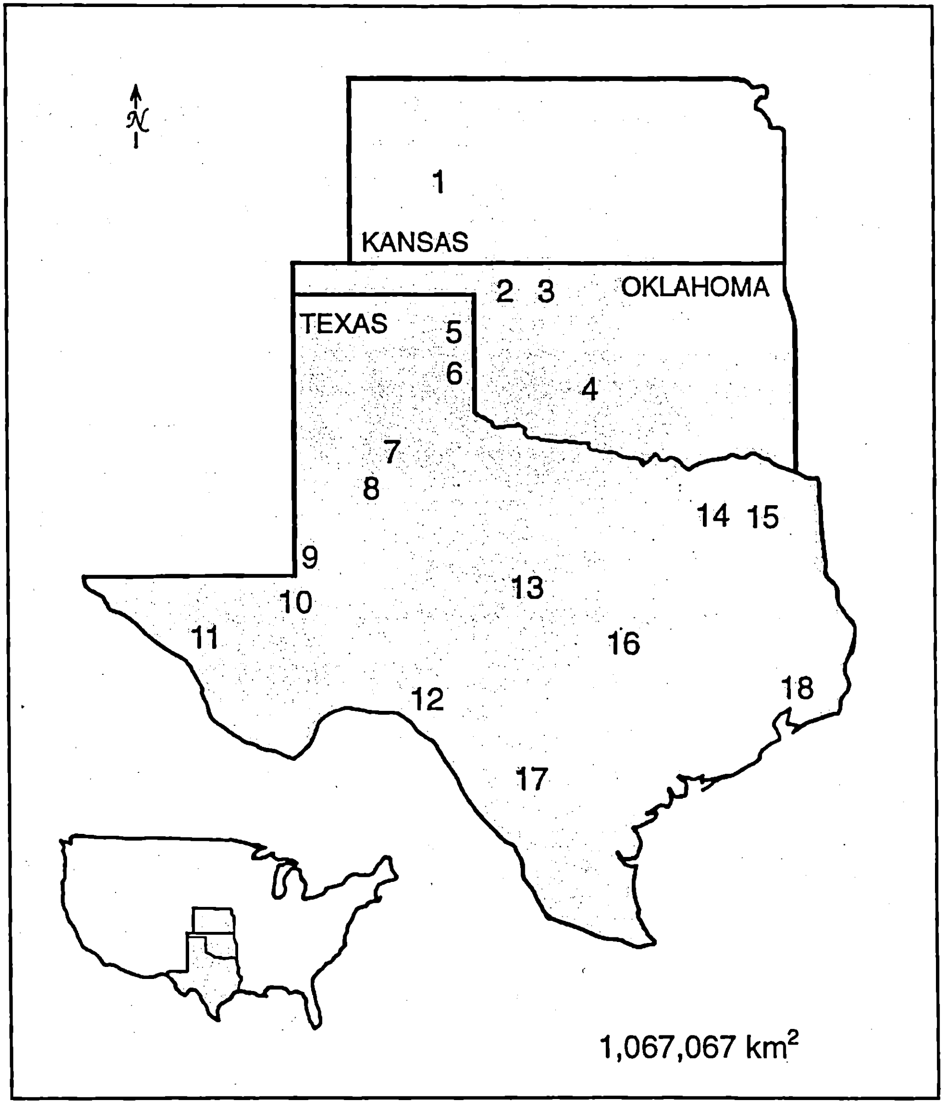


Figure 1.1. Location of Study Area and Selected Sites: (1) 12 Mile Creek (2) Waugh (3) Cooper (4) Domebo (5) Lipscomb (6) Miami (7) Lake Theo (8) Lubbock Lake (9) Seminole Rose (10) Shifting Sands (11) Chispa Creek (12) Bonfire Shelter (13) Adair Steadman (14) Lewisville (15) Aubrey (16) Horn Shelter (17) Kincaid Rockshelter (18) McFaddin Beach.

CHAPTER TWO - GREAT PLAINS PALEOINDIAN RESEARCH: THE CLOVIS, FOLSOM, AND CODY COMPLEXES

Clearly, a single life-way is represented, one homogenous in its big-game hunting orientation, although the particular species hunted changed in time and space...Everything points to a single culture type whose unity and cohesiveness through time can be documented by reference to artifact typology, subsistence basis, and shared traits. This continuum, tradition, culture stage, or culture type- however it may be viewed- is what American archaeologists usually call Paleoindians.

Mason 1962:229

Despite more than 70 years of research devoted to Paleoindian studies, there still remains much controversy surrounding Paleoindian lifeways. Although the term "Paleo-Indian" , coined by Roberts in 1940, was adopted by archaeologists the term remains elusive. It has been used to include all discoveries associated with now extinct Pleistocene mammals or alternatively, discoveries that include early lanceolate projectile points whether associated with Pleistocene mammal or not. Sellard's (1952) book was devoted to the Paleoindian period concentrating on the validity of evidence for association of artifacts with extinct fauna.

As reflected by Mason (1962), early students of Plains Paleoindian research regarded this "cultural stage" as a homogenous way of life characterized by mobile hunters and gatherers with an economic focus on large game (Jennings 1974; Mason 1962; Willey 1966; Willey and Phillips 1958). This perception is heavily biased largely due to the nature of Paleoindian sites which often represent kill and/or processing events. Well-known sites on the Great Plains were often discovered due to bones of large, now-extinct mammals eroding out of cutbanks or deflation events subsequently associated with artifacts. These artifacts commonly include projectile points. Many localities were discovered in such a manner, including Cooper (Bement 1997), Domebo (Leonhardy 1966), Lake Theo (Harrison and Smith 1975) Lipscomb (Schultz 1943); Lubbock Lake (Johnson and Holliday 1987); Miami (Sellards1938), Plainview (Sellard *et al* 1947); and 12 Mile Creek (Hill 1996). Many of these discoveries were made and then studied by geologists and vertebrate paleontologists

(Antevs 1955; Bryan 1937; Evans and Meade 1945; and Haynes 1964, 1969). Such interdisciplianary studies were an early component of Paleoindian research for the time of these early discoveries (e.g. Blackwater Draw (Howard 1935a,b), Lindenmeier (Wilmsen and Roberts 1978), and Domebo (Leonhardy 1966).

This notion of Paleoindian as primarily "big-game hunters" has been argued against by Meltzer (1988) and Kornfeld (1996). Concern that "Paleoindian" represents a loaded term, basically equivalent with a focus on large game, has led Beck and Jones (1997) to use the term "Paleoarchaic" rather than Paleoindian for the Great Basin cultural chronology. (For a discussion of problems with the Paleoindian concept see Simms 1988.) This notion of a homogenous lifeway is generally linked to the notion of specialization (Hofman and Todd 1995; Kelly and Todd 1988). Initial interest and questions pertaining to the antiquity of early humans in the New World changed to establishing chronology and subsistence/economic organization following the acceptance of the discoveries at Folsom, New Mexico (Figgins 1927; Meltzer 1983).

Paleoindian Typology

In the early 20th century the focus of Plains Paleoindian research fit with Willey and Sabloff's classificatory-historical scheme. Once it had been established that humans were in North America during the late Pleistocene based on site discoveries such as Dent, Blackwater Draw, and Folsom, and with additional sites it became apparent that multiple technologies and presumably human groups were present in Pleistocene North America. As a result, typology became a primary focus of Paleoindian studies. Most of these typologies were based on variability in projectile point form serving to subdivide the Paleoindian period (Irwin 1968; Irwin and Wormington 1970; Irwin-Williams *et al.* 1973; Jennings 1974; Krieger 1947, 1964; Renaud 1932; Sellards 1952; Wilmsen 1965; Wormington 1948, 1957). As shown on Table 2.1 numerous attempts were devoted to constructing organizational schemes based on projectile point and stratigraphic descriptions of early sites. Key typological issues included the definition of "Yuma" and fluted point types. The 1941 Santa Fe conference was crucial in resolving some of the Paleoindian point type complexity with the recognition of only three fluted point types: Clovis fluted, Folsom fluted, and Ohio fluted (Krieger 1947). Further clarification of Paleoindian projectile point typology resulted with the elimination of the term "Yuma" (Wormington 1957).

TABLE 2.1. Early History of Paleoindian Typology Schemata (1932-1965)

AUTHOR	YEAR	CLASSIFICATION SCEME/MAIN CONTRIBUTION
Renaud	1932	Fluted (Folsom) and Non-Fluted (Yuma) Typology
Roberts	1940	Description of Folsom and Yuma Points
Krieger	1947	Fluted and Yuma discussion; Clovis fluted distinct from Folsom fluted
Wormington	1948	Revision of Yuma Point Terminology
Sellards	1952	First to document sequence of Clovis (Llano) - Folsom- unfluted lanceolate; Portales Designation
Jennings	1954	Plano=late Paleoindian/unfluted
Suhm, Krieger, Jelks	1954	Paleo-America Stage for Paleoindian Period
Willey and Phillips	1955	2 Distinct Paleoindian technological traditions (Upper Lithic): 1) fluted 2) unfluted
Wormington	1957	Eliminaton of Yuma; definition of Cody
Irwin	1968	Itama Culure
Mason	1962	Plano=Paleoindian/ Homogenous lifeway
Krieger	1964	Paleoindian=fluted points; Protoarchaic= unfluted Llano= Clovis and Lindemeier= Folsom
Stephenson	1965	Llano, Lindenmeier, Plano

Cultural-historical patterns on the Plains during the Paleoindian period have largely been determined by studies of diagnostic projectile points and secondarily on economic evidence and primary prey species. Paleoindian points are readily recognizable and attributes of shape and technology are indicative of antiquity. Many Plains points are bifacially flaked and fluted lanceolates, and today assigned to the Clovis and Folsom complexes. In addition to fluted points, however, parallel flaked lanceolate points are also regarded as belonging to the Paleoindian period (Bryan 1965; Renaud 1932; Sellards 1952; Wormington 1957; Bryan 1965; Willey and Phillips 1958). Recent evidence from the Goshen complex indicates that unfluted points can be as old or older than fluted projectile points (Frison 1996). This latter evidence supports the notion that archaeological complexes should not be described merely on the basis of projectile point type, but an incorporation of subsistence strategy and lifeways.

Initial site studies revealed a diversity of fluted and parallel flaked points interpreted to represent historically related groups that developed in a sequential unilineal fashion. Projectile points continued to be the most important chronological indicators even after the advent and widespread use of radiocarbon dating, because many "Paleoindian sites commonly produce only small amounts of datable materials in contrast to sites of the later periods" (Frison 1993:7). However, the relationships and chronological significance of the established point types often are unclear. Even in stratified sites it is not necessarily safe to assume that the same stratigraphic order will occur elsewhere. If there were multiple contemporary technologies, we might expect that not all stratigraphic records will exhibit the same sequence.

Based on research at Hell Gap and elsewhere, Irwin and Wormington (1970: 24) wrote,

> One or more components make up a complex characterized by a single projectile point type. Both stratigraphy and radiocarbon dating demonstrate a succession of these types, in time, on the Plains; and while there is variation in the projectile points of a type, there is no overlap between the successive categories themselves.

The significance of the investigations at Hell Gap was the initial establishment of Paleoindian cultural chronology with Clovis preceding Folsom, followed by Midland, Agate Basin, Hell Gap, Alberta, Cody, Frederick, and Lusk (Irwin and Wormington 1970). As stated by Frison (1993:14), "The analysis at [Hell Gap] left the impression that all Paleoindian cultural complexes on the Plains were limited to a given time slot and that each developed out the one immediately preceding it." Reinvestigations at Hell Gap have called into question the initial findings (Sellet and Frison 1994).

Apparently, different Paleoindian cultural complexes were coeval displaying considerable chronological overlap between them (Eighmy and Labelle 1996; Pearson and Blackmar 1997; Stanford 1998; Thurman 1990). Even with the emergence of radiocarbon dating, projectile points remained the most important chronological indicators. The Paleoindian complexes are defined primarily on the basis of distinctive projectile point styles and their associated technology (Bradley 1991).

Clovis Complex

The oldest clearly defined North American culture is the Clovis complex named from the type site on Blackwater Draw near Clovis, New Mexico. Other sites in the study area are represented by kill sites near springs, playas, or ponded sediments such as Lubbock Lake, Domebo, Kincaid Rockshelter, Miami, Lewisville, and Aubrey (Figure 1.1). Radiocarbon dates place the Clovis culture between 11,500 to 10,900 yr BP (Haynes 1992, 1993) (Table 2.2).

Fluted projectile points that are basally thinned by the removal of channel flakes are hallmarks of the complex (Figure 3.1). Lithic tool kit also included bifaces, blades, scrapers, gravers, burins. Bone and ivory tools are also documented (Haynes 1987; Saunders *et al* 1991; and Stanford 1991). Caches of Clovis artifacts include the Simon site in Idaho (Woods and Titmus 1985), Anzick site in Montana (Lahren and Bonnichsen 1974), Ritchie Roberts in Washington (Frison 1991; Gramly 1993), and

TABLE 2.2. Selected Radiocarbon Dates for the Clovis, Folsom, and Cody Complexes.

SITE/LOCATION	**MATERIAL**	**14^{C} DATE**	**LAB NUMBER**	**REFERENCE**
CLOVIS				
Domebo, OK	wood	11,045±647	SM-695	Stafford et al 1990
Domebo, OK	wood	11,490±450	AA-823	Haynes 1992
Domebo, OK	bone	11,220±500	SI-172	Haynes 1992
Lubbock Lake, TX	clam	12,150±90	Smu-295	Holliday *et al* 1983
Lubbock Lake, TX	wood	11,100±100	SMU-548	Holliday *et al* 1983
Lubbock Lake, TX	wood	11,100±80	SMU-263	Holliday *et al* 1983
Aubrey, TX	clam	11,590±90	AA-5274	Humphrey and Ferring 1984
Blackwater Draw,NM		11,170±110	A-481	Hay *et al* 1984
FOLSOM				
Bonfire Shelter, TX	charcoal	10,230±160	TX-150	Dibble and Lorrain 1968
Folsom, NM	charcoal	10,890±150	AA-1710	Haynes 1993
Kincaid Roskshelter, TX	charcoal	10,065±185	TX19	Haynes 1967
Lake Theo, TX	bone	9,360±170	TX-2879	Harrison and Killen 1978
Lubbock Lake, TX	humates	10,015±75	SI-3203	Haas *et al* 1986
Lipscomb, TX	charcoal	10,820±150	NZA-1092	Hofman 1996
12 Mile Creek, KS	apatite	10,435±200	GX-5812-A	Rodgers and Martin 1984
Waugh, OK	charcoal	10,379±85	NZA-3602	Hofman 1996
CODY				
Lubbock Lake, TX	humates	9,550±100	SMU-118	Haas et al 1986
Lubbock Lake, TX	humates	8,585±145	SI-5499	Haas et al 1986
Wilson-Leonard,TX	charcoal	8,820±120	TX-4784A	Johnson 1989
Wilson-Leonard,TX	humic	8,860±150	TX-4784C	Johnson 1989
Blackwater Draw, TX	humates	9,890±100	AA-1366	Haynes 1995
Blackwater Draw, TX	humates	8,630±310	A-4700	Haynes 1995
Blackwater Draw, TX	organic	8,230±100	AA-1365	Haynes 1995

Drake in Colorado (Stanford and Jodry 1990). High quality exotic lithic material was utilized in the manufacture of projectile points. Material included Knife River flint, Flattop chalcedony, Alibates agatized dolomite, Tecovas jasper and quartzite, Dakota quartzite, and Edwards chert. This implies that Clovis peoples were highly mobile exploiting large territories or possibly trade networks were established (Hayden 1982; Irwin 1971; Meltzer 1988; Tankersley 1991).

Unlike Folsom, that was largely confined to the Great Plains, Clovis represented a widespread culture extending from western North America to the Eastern Woodlands. Clovis localities are largely represented by surface finds and the occurrence of sites *in situ* with stratigraphic context are rare (Haynes 1991). During Clovis times, a variety of now-extinct Pleistocene mammals inhabited the Great Plains. Although once viewed as big game hunters subsisting primarily on mammoths, bison, and to a lesser degree on camel, horse, sloth, and antelope, it is recognized that much variability existed in Clovis subsistence patterns. It appears that Clovis peoples have a broad-based economy reflecting the availability of diverse resources. Evidence of small mammals, reptiles, and amphibians comprise the Texas faunal assemblage at Lewisville (Stanford 1983), Aubrey (Ferring 1994), Lubbock (E. Johnson *et al* 1987) and Kincaid Rockshelter (Collins 1990). Meltzer (1993:306) writes:

> The essential question is whether megafauna hunting was a critical part of their diet, or even a common part of their diet, or if an individual killed a mammoth and then spent the rest of his or her life talking about it. I suspect that more effort was expended in talking about these animals than actually killing them. As to whether hunting as a specialized activity dominated the diet, I suspect that these groups were more generalized and used a wide range of hunted and gathered resources. Such would seem to have been the evolutionarily stable strategy on the Late Pleistocene landscape.

By the end of the Clovis occupation, paleoenvironmental data suggest a relativley moist and favorable environment. Thus water filled basins on the southern plains and associated grasslands dominated the vegetation. These criteria provided the ideal habitat for herbivorous grazers such as the bison.

Folsom Complex

The Folsom peoples are generally regarded as seasonal big game hunting specialists focusing on an extinct form of bison (*Bison bison antiquus*, or *Bison bison occidentalis*). Noted by Sellards (1952:49), "the range of abundance of Folsom points probably coincides essentially with the range of an abundance of bison at that time". A diversity of hunting strategies were employed from ambush kills around lake settings, such as Lubbock Lake, to cliff jumps at Bonfire Shelter. Also, contrary to Clovis times where seldom more than one large mammal was taken at a time (but see Saunders 1977, 1980), multiple animals were killed at many Folsom sites (Bonnichsen *et al* 1987). For example, ten animals were killed at 12 Mile Creek (Rogers and Martin 1984) and 56 bison were recovered at Lipscomb (Hofman and Todd 1995). At the Cooper site located in Oklahoma, Bement (1997) has revealed evidence for multiple kills representing at least three kill events. During Folsom times animals were hunted throughout the year and kill episodes were not confined to a particular season. It is very likely that Folsom peoples exploited additional resources. In fact, site excavations have provided evidence for usage of non-bison species including antelope, deer, wolf, fox, and rabbits. Fluted points also characterize the Folsom complex although they are smaller, thinner, and usually have a longer flute than the preceding Clovis culture (Figure 2.2).

The Folsom culture had a more restricted geographical distribution confined largely to the High Plains. Representative sites and localities from the study area include: Lipscomb, Lake Theo, Lubbock, Adair Steadman, Horn Shelter, Kincaid Rockshelter, Shifting Sands, Bonfire shelter, Chispa Creek, in Texas; Waugh and Cooper in Oklahoma; and 12 Mile Creek in Kansas (Figure 1.1). Dates obtained from these sites and others indicate a span of nearly 700 years from 10,900 BP to 10,200 BP (Haynes 1992,1993)(Table 2.2).

Cody Complex

The Cody complex is one of several late Paleoindian complexes recognized in the Great Plains dating between 9,700 - 8,000 BP (Table 2.2). With other Paleoindian complexes such as Agate Basin, Hell-Gap, Plainview, and Milnesand, Cody shares the general projectile point form known as Plano or unfluted lanceolate. The Cody complex is widely distributed throughout the Plains with several sites representative of bison kills. Sites in Texas include Lubbock Lake, Horn Shelter, McFaddin Beach, Seminole Rose, and Lake Theo (Figure 1.1). Numerous isolated points assigned to the Cody complex are documented from eastern Texas in the pine woods physiographic region and extending 320 km into Arkansas and Louisiana (L. Johnson 1989). Currently, no Cody site has been excavated in Oklahoma or Kansas although isolated and surface collected projectile points have been reported.

The Cody complex was originally defined by Jepson (1953) at the Horner site near Cody, Wyoming. As the type site for the Cody complex, the Horner site revealed the contemporeneity of Eden and Scottsbluff points occurring in association with Cody Knives which combined have traditionally been the defining characteristics of the complex (Frison and Todd 1987; Wormington 1957) (Figure 2.3). However, a lack of agreement concerning the typology of these points exists due to the considerable range of variation and distribution. Consequently, subdivisions have been proposed within the Cody complex (Knudson 1983; Wheat 1972). It has been suggested that the earliest manifestation of the Cody complex is represented by Alberta followed by a transitional stage regarded as Alberta/Cody (Agenbroad 1978; Bradley and Frison 1987). In addition to Scottsbluff and Eden point types, San Jon, Firstview, and Kersey Points have been considered part of the complex. Bonnichsen and Keyser (1982:138) write, "At the present, there is no consensus as to which projectile points compose the Cody complex, and the relationships between the component types are not well defined." A central problem that comes out of this is whether or not the Cody complex represents a cultural continuum or "micro-traditions" (Bonnichsen and Keyser 1982). Greiser (1985:70) concludes that Scottsbluff, Eden, Firstview, and Kersey may "represent various bands within the same cultural complex."

Bison was undoubtedly a critical resource during Cody times as reflected by the large number of bison bone beds. However, like in Folsom times, a diversity of fauna and flora resources were exploited.

Regional Studies

Traditionally, research in Paleo-Indian materials has been concentrated on the nature of individual sites, with special emphasis on detailed analysis of artifact types. This orientation has inhibited large scale settlement pattern studies.

J.J.Hester 1975:247

Some 30 years of research emphasizing the regional perspective is now reflected for the Paleoindian period on the Plains (Table 2.3). An important contribution to early settlement patterns was the recognition of variability during Paleoindian times. As stated by Judge (1973:336), "Variations in Paleoindian settlement technology do exist, both at the subcultural and intercultural levels. A considerable amount of change through time was demonstrated in the general settlement patterns."

Regional studies have focused on the documentation of site types (Irwin-Williams and Haynes 1970; Judge 1973; Judge and Dawson 1972), site distribution (Hester 1975), pattern of resource utilization (Amick 1994; Hofman 1992, 1995; Johnson and Holliday 1995), and territory size (Hester and Grady 1977). Using nearest neighbor analysis and Theisen polygons, Hester and Grady (1977) concluded the territory size for Paleoindinan groups on the Llano Estacado was estimated at a radius of 90-120 miles. Settlement studies conducted in the Central Rio Grande Valley (Judge 1973; Judge and Dawson 1977), the Llano Estacado (Bamforth 1988; Johnson and Holliday 1995) and the Southwest (Irwin-Williams 1968; Irwin-Williams and Haynes 1970) concluded that the distribution and availability of water were the primary factors conditioning the location of sites. Irwin-Williams and Haynes (1970) observed Late Paleoindian distribution in the southwest corresponded to effective moisture. They state (1970:64), "the most direct mechanism through which climatic change could have affected human demography at this period was distribution of water sources and large maximal herds of bison...which played a basic role in the structuring of the subsistence system". Combined, these studies revealed that as desiccation progressed, large grazing mammals became less reliant on playas as a source of water

TABLE 2.3 Prior Settlement Studies in the Plains and Adjacent Areas

AUTHOR	YEAR	REGION INVESTIGATED
Wendorf and Hester	1962	Llano Estacado, western Texas and eastern New Mexico
Irwin-Williams and Haynes	1970	Southwestern North America (New Mexico, Arizona, Utah, Nevada, S. California, N. Mexico)
Judge and Dawson	1972	Central Rio Grande Valley,New Mexico
Judge	1973	Central Rio Grande Valley,New Mexico
Hester	1975	Southern Texas
Hester and Grady	1977	Analysis of Wendorf and Hester's (1962) and Judge's (1973) data
Greiser	1985	Texas
Bamforth	1985	Llano Estacado
Kelly and Todd	1988	North America
Meltzer	1988	eastern North America
Johnson	1989	eastern Texas, Oklahoma, and western Louisiana
Story	1990	Gulf Coastal Plain
Hofman	1991,1995	Southern Plains
Amick	1994, 1996	New Mexico
Johnson and Holliday	1995	Southern High Plains (Llano Estacado)
Holliday	1997	Southern High Plains
Beck and Jones	1997	Great Basin

and more reliant on streams, rivers and springs. This pattern is manifested culturally by Folsom sites located near playas and Cody sites located near streams and springs.

Sites functioned during the Paleoindian period as camps, kills, quarries, and lookouts. Their position on the landscape, however, changed through time. For example, Judge and Dawson (1972:1214) report, "a general progression from the Folsom emphasis on proximity to a major hunting area with very specific locational relationship to it, to the Eden pattern of increasing distance from the hunting area with much less concern for specific directional relationships." In addition to regional analyses conducted on the southern Plains and the Southwest, the Rocky Mountain area including Wyoming and Colorado has also been heavily investigated. There has been little attempt at incorporating regional analyses in these areas with the Central Plains.

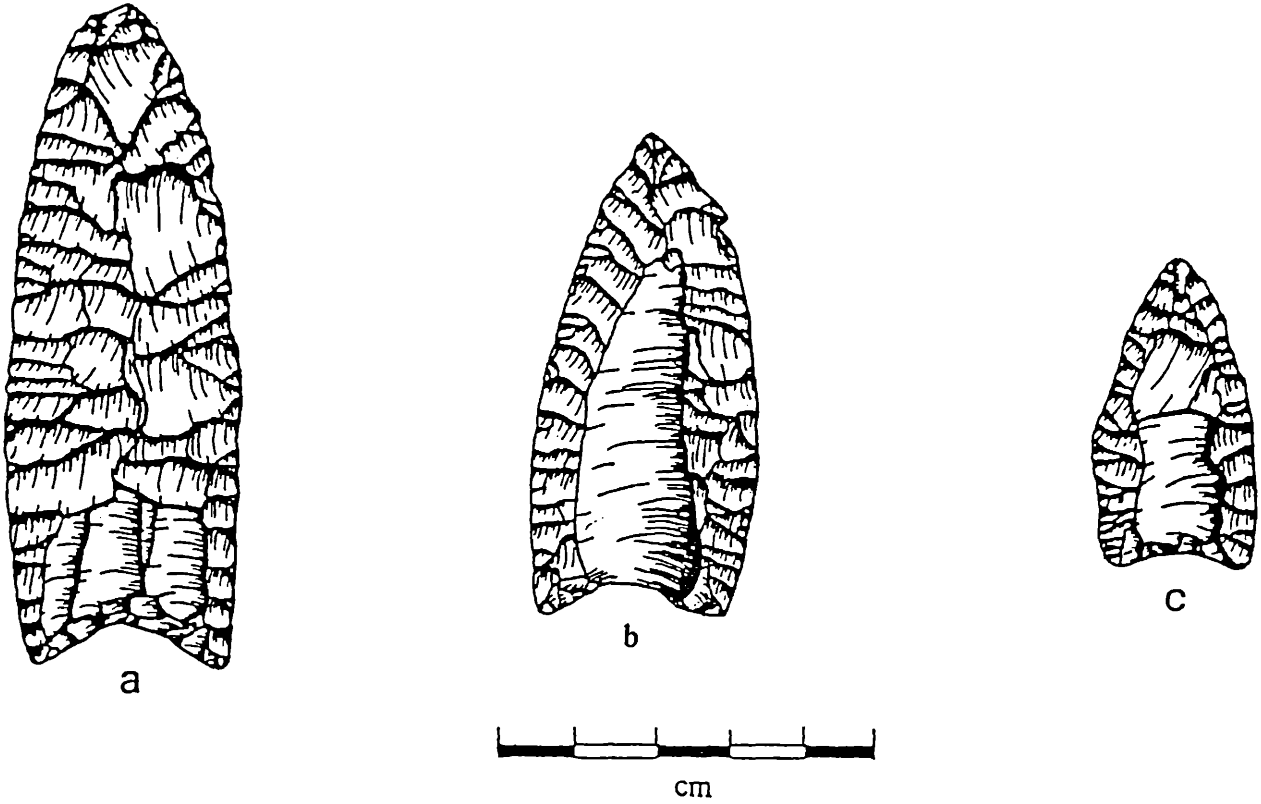


Figure 2.1. Clovis Projectile Points: a. Republic county, KS; b. Sherman county, KS; c. Cheyenne county, KS. (all from Hofman 1996.)

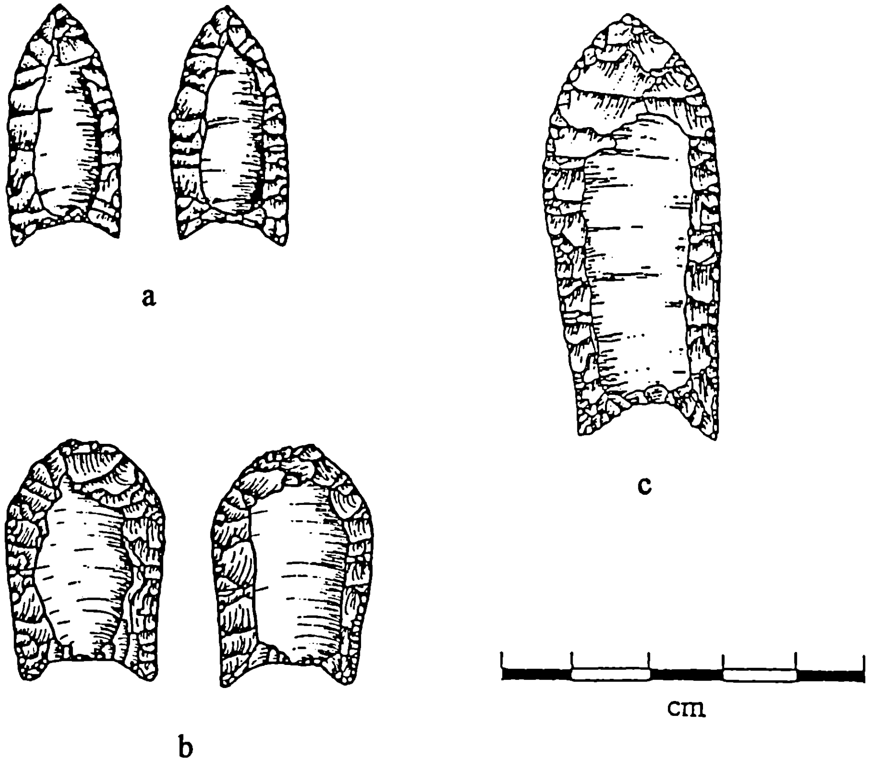


Figure 2.2 Folsom Projectile Points: a. Doniphan County, KS (Hofman and Blackmar 1998); b. Cedar Creek, OK(Hofman and Wyckoff 1987); c. Texas (Hofman 1996)

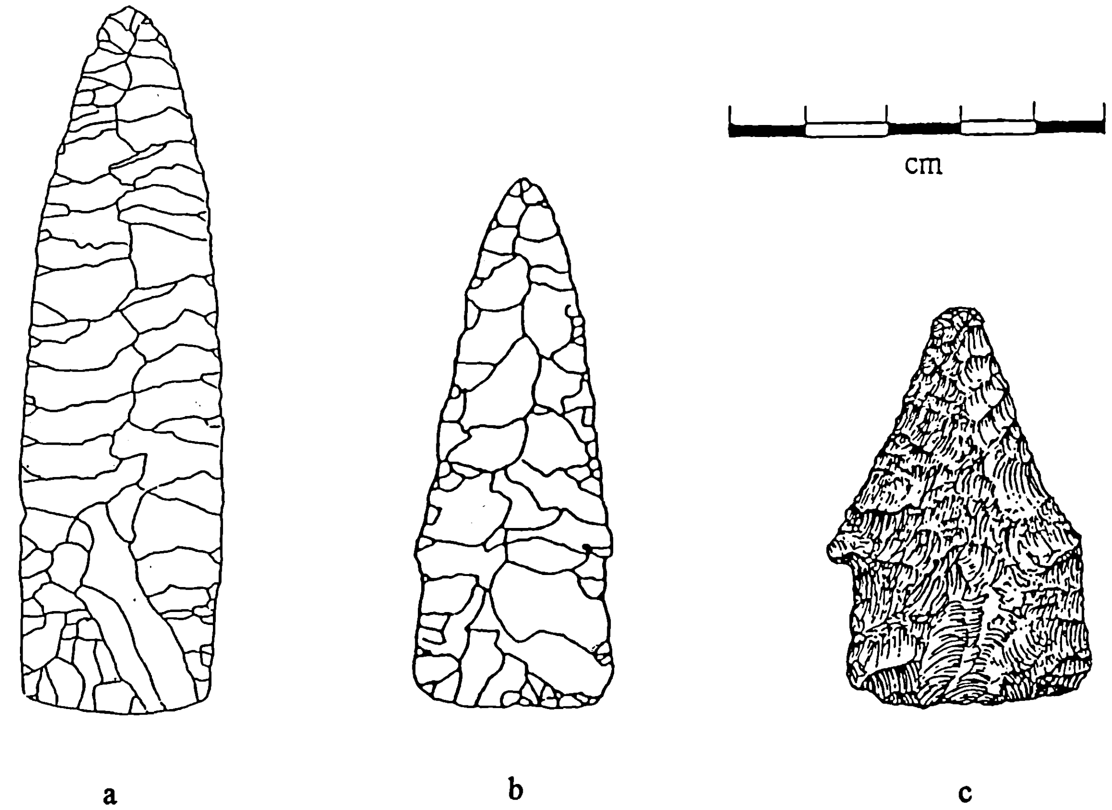


Figure 2.3 Cody Projectile Points: a. Seminole Rose, TX (Collins *et al.* 1997); b. Tulsa County, OK (Wyckoff 1992); c. Cody Knife from site 34MI136, Oklahoma (L. Johnson 1987).

CHAPTER THREE- REGIONAL SETTING: THE MODERN ENVIRONMENT AND PALEOENVIRONMENT

It is no exaggeration to say that the basis of sophisticated Paleoindian studies is a thorough knowledge of the paleoenvironmental conditions which affected these early populations.

T. Hester 1977:170

Modern Environment

Kansas, Oklahoma, and Texas encompass portions of the Central and Southern Plains (Figure 1.1). The region, characterized by semiarid to subhumid continental climates, is dominated by extensive prairies on a landscape with relatively low relief. Modern dynamic weather patterns are produced by three major upper air systems; the Cordilleran air mass, the arctic air mass, and the tropical maritime air mass. Regional distinctiveness is largely a result of differences in precipitation which with relative humidity increase from west to east. Rainfall is not evenly distributed throughout the study area and varies year to year. The Southern Plains is in the rainshadow of the Rocky Mountains and receives little moisture from the west. These factors result in a decrease in length of the growing season from south to north and from east to west with increasing elevation. A summary of selected weather information in the study area is shown in Table 3.1.

In the state of Kansas, elevation gradually changes from 244-305 meters above sea level (masl) in the east, to 458 masl in central Kansas, and 1,068 masl at the Colorado border. The major river drainages are divided between the Missouri and the Arkansas with the northern half of the state draining into the Missouri and the southern into the Arkansas River. The Smokey Hill, Republican, and Blue Rivers flow through the northern counties until they converge in the Kansas. The southeast section is drained by the Verdigris, Neosho, and the Marais de Cygnes. There are few natural lakes although natural springs sustain the flow of many of the streams. Springs

TABLE 3.1. Selected Climatological Data for Cities Located in KS, OK, and TX.

Location	Yrs.[1]	Elevation (m)	Growing Length[2] (days)	Annual Precip. (cm)	January Temp. (c)	July Temp. (c)	Annual Temp. (c)
KANSAS:							
Topeka	30	267	200	83.2	1	27.2	13.4
Wichita	30	403	210	76.8	0	27	14
Goodland	30	1112	157	45.4	3.5	24.4	10
OKLAHOMA:							
Oklahoma City	30	392	223	78.2	2.8	28	15.7
Elk City	25	594	208	57.9	3.3	27.7	15.7
TEXAS:							
Amarillo	10	335	191	50	2.6	27	14.8
El Paso	15	1195	243	19.7	6.2	28	17.5
Fort Worth	10	164	240	78.3	7.6	30	19
Houston	10	15	295	114.9	12	29	20.8

1- number of years with recorded information; 2- length of growing season
Sources: Curry 1974; Orton 1974; Robb 1974

are especially important at the escarpment marking the eastern margin of the High Plains. In Oklahoma, the Cimarron and Canadian River systems drain most of northern and western Oklahoma emptying into the Arkansas which drains eastern Oklahoma. South of the Ouachita and Arbuckle mountains, short streams run into the Red River, which delineates the Oklahoma-Texas border. The Washita is the principal tributary of the Red draining southwestern Oklahoma. Major streams in Texas include the Red, Peace, Brazos, Colorado, and the Pecos River systems with a general drainage pattern toward the southeast. In addition to rivers and streams, small deflation basins and playas dot the Southern Plains.

Since climatic and geological variables such as rainfall, humidity, and topography, are extremely diverse, many distinct physiographic regions are recognized within each of the states (Table 3.2), attesting to a diversity of environments and biotic communities. For this study, four broad physiographic regions are recognized based on elevation, topography, vegetation, and peleoecological evidence: the High Plains, the Prairie Plains, the Savannah, and the Woodlands (Figure 3.1). Due to the scale of

TABLE 3.2. Recognized Physiographic Regions for Kansas, Oklahoma, and Texas as Used in This Study.

HIGH PLAINS	**PRAIRIE PLAINS**	**SAVANNAH**	**WOODLANDS**
KANSAS			
High Plains	Smoky Hills	Osage Cuestas	Cherokee Lowlands
	Red Hills	Chatauqua Hills	Ozark Plateau
	Wellington- McPherson		
	Flint Hills		
	Arkansas R. Lowlands*		
	Glaciated Region*		
OKLAHOMA			
High Plains	Gypsum Hills	Arbuckle Mountains	Ozark Plateau
	Wichita Mountains	Sandstone Hills	Oachita Mountains
	Red Bed Plains	Prairie Plains	
		Red River Plains*	
TEXAS			
High Plains	Lower Plains	Post-oak Belt	Pine Wood Region
	Mountain and Basin	South Texas Plain	
	Blackland Prairie	Cross Timbers	
	Grand Prairie	Llano Basin	
	Gulf Coast Plain	Edwards Plateau	

*majority of the region is in this physiographic area

this study, the numerous microenvironments are not differentiated within each of these regions. In order to illustrate the diversity of flora and fauna, Tables 3.3-3.4 display selected biota in the western and eastern portions of the study area.

The western most portion of the study area is the flat short grass High Plains. This is the driest and highest portion of the region with warm summers and cold winters due to increasing elevation and the rain shadow of the Rocky Mountains. Bounded on the west by the Pecos Valley which forms a 150-240 m escarpment, is the Llano Estacado in western Texas that refers to the High Plains. Vegetation includes short and midgrasses dominated by buffalo grass (*Buckloe datyloides*), needle grass (*Stipa* spp.), and gramma grasses (*Bouteloua gracilis, Bouteloua hirsuta*) with sagebrush and yucca present on valley slopes. Sand-sage plant communities are found

TABLE 3.3. Selected Flora in the High Plains and Woodlands

COMMON NAME	SCIENTIFIC NAME	1	2	COMMON NAME	SCIENTIFIC NAME	1	2
TREES				poke	*Phytolacca americana*		X
cottonwood	*Populus deltoides*	X		mormon tea	*Ephedra antisiphilitica*	X	
willow	*Salix nigra*	X		lambsquarter	*Chenopodium album*		X
shinnery oak	*Quercus harvrdi*	X		smartweed	*Brassica arvensis*		X
blackjack oak	*Quercus marylandica*		X	grapes	*Vitus spp.*		X
post oak	*Quercus stellata*		X	rush	*Scirpus americanus*		X
sand plum	*Prunus angustifolia*		X	saltbrush	*Atriplex canescens*	X	
sumac	*Rhus spp.*		X	horsetail	*Conyza canadensis*		X
salt cedar	*Tamaix aphylla*	X		forestiera	*Forestiera sp.*		X
pinyon pine	*Punus edulis*	X		cockle burr	*Xanthium Strumarium*		X
hackberry	*Celtis reticulata*		X	**GRASSES**			
elm	*Ulmus americana*		X	little bluestem	*Antropogon scoparius*	X	X
dogwood	*Cornus sp.*		X	big bluestem	*Andropogon gerardi*	X	
persimmon	*Diospyros verginiana*		X	buffalo grass	*Buckloe datyloides*	X	
FOORBS AND WOODY PLANTS				side oats grama	*Bouteloua curtipendula*		X
sage	*Artemisia fillifolia*	X		blue grama	*Bouteloua gracilis*	X	
soapweed	*Yucca glauca*	X		hairy grama	*Bouteloua hirsuta*	X	
prickley pear	*Opuntia spp.*	X		threeawn	*Aristida spp.*	X	
purple cone flower	*Echinacea angustifolia*	X		wheatgrass	*Agropyron smithii*		X
prarie potato	*Psoralea esculenta*	X		sandbur	*Cenchrus pauciflorus*		X
sunflower	*Helianthus sp.*	X		swithgrass	*Panicum vergatum*		X
gourd	*Curcurbita foetidissima*		X	windmillgrass	*Chloris vericillata*		X
marshelder	*Iva spp.*		X	needle grass	*Stipa spp.*	X	

Areas of Primary Occurrence
[1]High Plains [2]Woodlands

TABLE 3.4. Selected Mammals in the High Plains and Woodland Physiographic Regions.

COMMON NAME	SCIENTIFIC NAME	1	2
bison	*Bison bison*	X	
antelope	*Antilocapra americana*	X	
white-tailed deer	*Odocoilues virginianus*		X
mule deer	*Odocoileus hemionus*	X	
elk	*Cervus elaphus*	X	
black bear	*Ursus americanus*		X
mountain lion	*Felis concolor*		X
coyote	*Canis latrans*	X	
gray fox	*Urocyon cinereoargenteus*		X
swift fox	*Vulpes velox*	X	
jack rabbit	*Lepus californicus*	X	
cottontail	*Sylvilagus floridanus*		X
desert cottontail	*Sylvilagus audubonii*	X	
raccoon	*Procyon lotor*		X
opossum	*Didelphis virginianus*		X
armadillo	*Dasypus novemcinctus*	X	
porcupine	*Erethizon dorsatum*	X	
plains pocket gopher	*Geomys bursarius*	X	X
ground squirrel	*Spermophilus spp.*	X	X
prairie dog	*Cynomys ludovicianus*	X	
kangaroo rat	*Dipodomys ordii*	X	
hispid cotton rat	*Sigmodon hispidus*	X	X
pocket mice	*Perognathus spp.*	X	X
white -footed mice	*Peromyscus leucopus*	X	X
mole	*Scalopus aquaticus*		X
prairie vole	*Microtus ochrogaster*		X
least shrew	*Cyrptotis parva*		X
Short-tailed shrew	*Blarina hylophaga*		X
bats	*Chiroptera*		X

Area of Primary Occurrence
[1] High Plains [2] Woodlands

in sandy streamside and dune areas. These bottomlands also support elm (*Ulmus americanus*), oak (*Quercus harvdi*), cottonwood (*Populus deltoides*), and willow (*Salix nigra*) scattered long tributaries.

Vast herds of buffalo utilized the Prairie Plains with deer inhabiting the wooded areas along streams. Included in the diverse ecological settings of the Plains are the Smoky Hills, Red Hills, and Flint Hills of Kansas; the Gypsum hills, Wichita Mountains, and Red Bed Plains of Oklahoma; and Lower Plains and Mountain Basin, Blackland Prairie, Grand Prairie, and the Gulf Coastal Plain of Texas. In the western portion of the Prairie Plains an ecotone exists between the Short-grass Plains and the Tall-grass Prairie. On the floodplains cottonwoods and willow persisted and in isolated areas on the uplands post oak-blackjack forests are present. In Oklahoma, the Caddo Canyons support remnants of isolated Eastern forest species such as maple, walnut, elm, and Kentucky Coffee Bean. Oak woodland and grasses border the canyons. The eastern portion of the Prairie Plains contain tall-grasses such as Little Bluestem (*Antorpogon scopparius*), Sideoats Gramma (*Bouteloua curtipendula*), and Switch Grass (*Panicum vergatum*).

Adjacent to this region is flat to rolling terrain with scattered hills characterized as Savannah composed of tall-grass prairie interspersed with post oak-blackjack forests and mesquite Savannah of varying densities. The diverse Edwards Plateau vegetation consists of grasslands in the West to scruboak, juniper, and chaparral on the high slopes and deciduous forest in the lower valley bottoms of the eastern margins. The bottomlands support trees and wetland plants on the flood plains. Fauna include buffalo and deer in the upland forests.

Finally, the eastern most portions of the study area, consisting of the Cherokee Lowlands, Ozark Plateau and Ouchita Mountains, is characterized by woodland vegetation dominated by dense oak-hickory forest with oak-hickory pine. The trees on the uplands and slopes include oak, hickory, and elm, while in protected areas maple, redbud, dogwood, linden are common. Birch, elm, cottonwood and sycamore occur in open forest and line stream banks. In eastern Oklahoma and Texas, cypress bottoms forest dominate. Like the vegetation, the fauna is equally diverse including abundant deer, beaver, mink, fox, woodchuck, rabbits, hawk, turkey, pigeons, and fish.

Paleoenvironment

The previous environmental, ecological, and biotic information is provided as an introduction to the contemporary diversity in the study area. It is reasonable to expect that such diversity existed in the past. An understanding of the nature of environmental, biological, and ecological changes is essential for reconstructing prehistoric human behavior. The geological epochs associated with Paleoindian period, the Late Pleistocene and Early Holocene, are marked by climatological changes associated with the last deglaciation producing profound effects in the flora and fauna at a continental scale (Graham *et al.* 1996). Species composition changed as a result of alteration in species ranges and extinction of some Pleistocene biota. Numerous syntheses incorporating biological, ecological, paleontological, and archaeological data have been amassed largely as a result of two major controversial issues surrounding the Pleistocene-Holocene transition: 1) the extinction of megafauna (Agenbroad *et al* 1990; Grayson 1988; Martin and Klein 1984; Mead and Meltzer 1985; and Martin and Wright 1967), and 2) the entry of *Homo sapiens sapiens* into the New World (Bonnichsen and Turnmire 1991; Bryan 1986; Carlisle1988; Dillehay and Meltzer 1991; Dort and Jones 1968; Shutler 1983; West 1996).

The latest Pleistocene, between 14,000 BP and 10,000 BP, represents a time when areas of the woodland and parkland regions began to disappear as indicated by pollen records (Figure 3.2) showing a rapid decline in the percentage of pine pollen and total loss of spruce pollen by 10,000 years ago (Bryant and Shafer 1977; Fredlund and Jaumann 1987; Grueger 1973; Jacobson et al 1987; McMillan and Klippel 1981).

These shifts occurred due to warmer and drier conditions resulting from reduction in the available ground water and increased evaporation rates caused by elevated summer temperatures. Several stratigraphic sequences on the Southern Plains show a shift from streams between 13,000 BP-11,000 BP, to open ponds and lakes between 11,000-10,000 BP, and marsh environments with little or no standing water after 10,000 BP (Haynes 1993; Holliday 1997; E. Johnson and Holliday 1995). Overall, the volume of permanent surface water declined during the early Holocene.

Pollen records from eastern Kansas at Muscotah Marsh (Fredlund and Jaumann 1987; Grueger 1973) indicate the demise of spruce forests at 12,000 BP represented by a drop in the relative frequency in *Picea*. A diversity of deciduous AP pollen is represented by *Carylus, Salix, Quercus, Ulmus, Carpinus, Fraxinus*, as well as NAP pollen (Poceae and *Ambrosia*). By 10, 500 BP at Muscotah Marsh, spruce is absent with a continuous rise in deciduous AP pollen until 9,000 expansion of grasslands (Wright 1968). In Oklahoma, at the Domebo site, Wilson (1966) records an NAP dominated record between 11,000 and 9,000 BP. At 11,000 BP the record was composed of 45% Poceae and 25% Asteraceae. These percentages continue to increase at 10,000 with *Pinus, Quercus, Carylus, and Ulmus* dropping out of the pollen record. Based on peat bog pollen at Boriak, Grouse, and Solfje, Bryant and Holloway (1977) noted a shift in Central and Eastern Texas from an open woodland deciduous environment consisting of spruce, maple, hazelnut and birch to an increase in herbs consistent with a parkland environment between 16,000 -10, 000 BP. The pollen columns at Boriak and Grouse beginning at 10,000 BP show a postglacial progression toward drier conditions, distinguished by a gradual loss of tree pollen (L. Johnson 1989). This resulted in the establishment of the essentially modern Post-Oak Savannah vegetation.

The response to vegetational changes is supported by the fauna records documented from paleontological and archaeological sites. Fauna responded to climatic change during the Late Pleistocene and early Holocene especially as a result of increasing seasonality. The colder, moister and more equable climate characterized by reduced seasonal extremes in temperature and effective moisture in the Pleistocene enabled species with "disparate ecologies to coexist" (Graham 1979, 1986). Climatic equability characterized by "low seasonality permitted plants and animals to have broader ranges than they have today and these broader ranges resulted in overlaps of species ranges that do not occur now. This created very complex Pleistocene community structures in North America [lacking] modern analogs" (Martin and Martin 1987:123). Because climatic extremes were not so severe in the Pleistocene, another limiting factor was probably of greater importance. Graham and Mead (1987) suggest that microenvironmental differentiation played an important role in supporting Late Pleistocene communities such as the difference in environmental diversity between riparian and upland habitats.

During the Late Glacial, Lundelius (1974) suggested a more humid climate and brushy environment based on the absence of woodland species and the presence of grazers suggestive of open areas. This trend continued between 12,000 - 11,000 BP at the Domebo locality with species indicative of open, dry habitat (bison, pocket mouse, northern grasshopper mouse) and lacking woodland adapted species. The environment, however, was still cooler and moisture as evidenced at Domebo by the representation of northern species such as the heather vole and pygmy shrew.

Between 12,000 BP and 10,000 BP the Pleistocene communities dissolve with the extinction of diverse fauna and there is an increase in specialized grazers such as bison and antelope (Martin and Martin 1987; Mead and Meltzer 1984; Graham and Mead 1987). In Stratum 1 (11,000 BP) at Lubbock Lake a diversity of extinct megafauna including *camelops, mammuthus, equus, platygonus*, and *bison* are documented. By 10,000 BP-8,600 BP (Plainview and Firstview times) these species are no longer present (E. Johnson 1987). This phenomenon also occurs at Rex Rodgers (Willey et al. 1978) located in northwest Texas and Domebo (Leonhardy 1966) located in west-central Oklahoma.

By the early Holocene, "environments were distinctly different from those of the Pleistocene, and the Pleistocene conditions, especially the existence of disharmonious faunas and extinct megafauna, had essentially been terminated by 10 ka" (Graham and Mead 1987:391). During this change to warmer, more continental climate, the paleontological and archaeological record indicates the reorganization of plant and animal communities (Graham 1986; Graham and Lundelius 1994). According to Martin (1987) increased seasonality resulted in a decline of overall biotic diversity. This included the loss of large mammals such as horses, camels, and proboscidians. There is little evidence that extinct taxa survived beyond the end of the Clovis period (Graham and Mead 1987; but see Frison 1997).

The exact cause of extinction has centered on two primary factors: 1) over predation by humans and 2) climate alteration. Multiple climatic hypotheses have been proposed. Following Graham and Mead (1987; see also Guthrie 1982), habitat destruction most likely was the ultimate factor in the Pleistocene extinctions producing effects of decreasing nutritional value of grasses and reorganization of communities that created different ecological barriers. Many smaller mammalian fauna survived into the Holocene by shifting their ranges.

Graham *et al.* (1996:1601) makes the important distinction that the change in fauna distribution was not a simple, synchronic northward shift of communities but "individual species dispersed diachronically in different directions and at various rates". While the regional climate determined overall characteristics of fauna distribution, the boundaries of biotic biomes, both in the Pleistocene and Holocene, are fixed on physical parameters such as rain shadows, topography, and river drainages that are relatively constant geologically (Martin and Martin 1987).

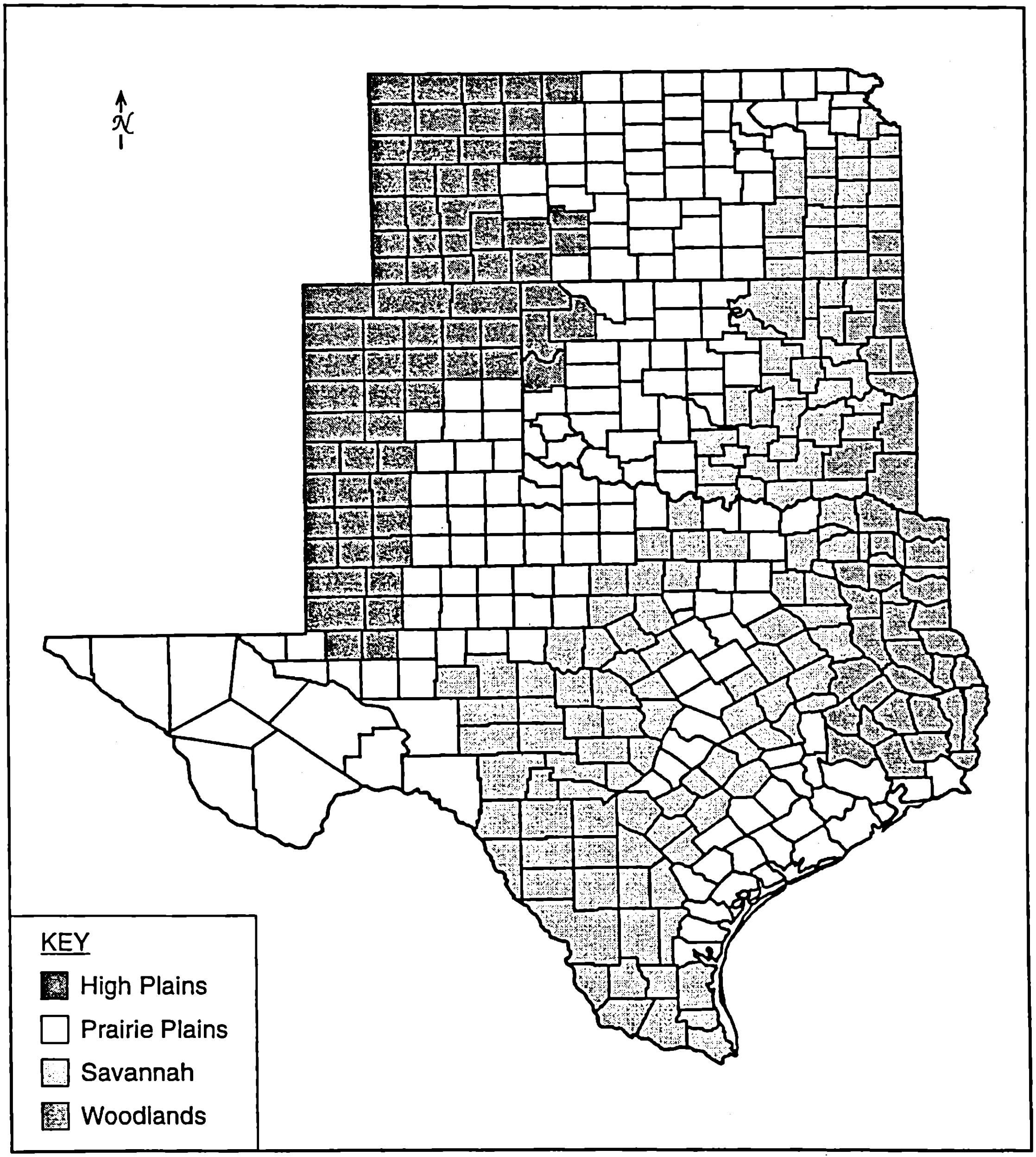


Figure 3.1. Map of the Four Physiographic Regions

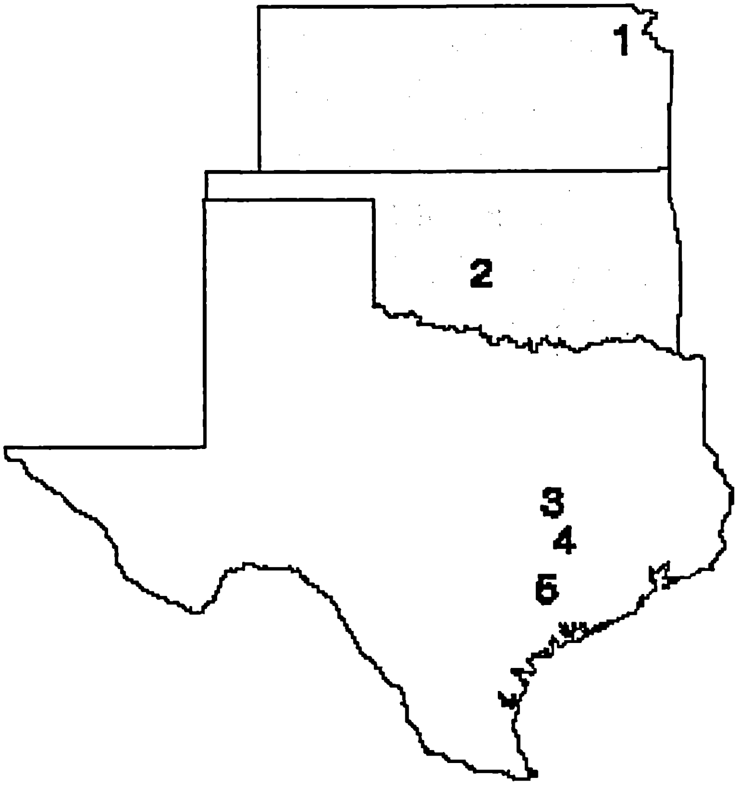


Figure 3.2. Distribution of Bog and Marsh Sites for Pollen Record: (1) Muscotah Marsh, Kansas; (2) Domebo, Oklahoma; (3) Gause, Texas; (4) Boriak, Texas; (5) Solfje, Texas.

CHAPTER 4 - METHODOLOGY

If research is limited only to recognized sites, then much of the record will go unused. The problem is that there is much to be learned from the nonsite regional view of the....archaeological record which is essentially independent of, but complementary to, specific site analysis.

Hofman, 1991:12

The study area of Kansas, Oklahoma, and Texas was selected for several specific reasons. The diversity of physiographic regions existing in the area offers the opportunity to compare and contrast Paleoindian land use in the open western High Plains, the Prairie Plains, the Savannah, and the eastern deciduous Woodlands. In addition, the study area boundaries encompass many lithic resources utilized by the Clovis, Folsom, and Cody peoples. As noted by Hofman (1991:12) the size appropriate for regional lithic studies "should minimally include the area(s) within which lithic materials are derived (whether acquisition is through trade, logistical moves, or embedded into group movement), modified into tools, utilized, recycled, and lost or discarded". Furthermore, information pertaining to projectile point occurrences in Kansas, Oklahoma, and Texas have been documented, but have not yet been synthesized into a regional study. As previously mentioned, the area was divided into four physiographic regions based on modern physiographic maps. Even though each physiographic region is not ecologically homogenous or fixed, various microenvironments have not been differentiated due to the scale of this analysis and the nature of existing archaeological and paleoecological evidence.

Information on Clovis, Folsom, and Cody, projectile points have been obtained from institutional and individual collections, published accounts of projectile point occurrences (Table 4.1) and published projectile point surveys in the states of Kansas, Oklahoma,and Texas (Table 4.2). As noted in Table 4.2 not all of the systematic surveys were state-wide. This is especially true for Texas.

Table 4.2. Selected Primary Sources of Paleoindian Projectile Point Finds in Kansas, Oklahoma, and Texas.

STATE	PUBLICATION
Kansas	Glover 1974
Kansas	Holen 1989
Kansas	Schmits 1987
Kansas	Sperry 1974
Oklahoma	White 1981,1987
Oklahoma	Wyckof and Taylor 1984a, 1984b
Texas	Barber 1966
Texas	Blaine 1968
Texas	Brown 1994
Texas	Chandler 1982, 1983, 1994
Texas	Chandler and Hindes 1993
Texas	Crook and Harris 1955
Texas	Duffield 1995
Texas	Flaigg 1995
Texas	Fox and Hester
Texas	Hudgins and Patterson 1983
Texas	Jones 1957
Texas	Lintz 1984
Texas	Long 1977
Texas	Lorrain 1978
Texas	Mallouf 1981
Texas	Orchard and Campbell 1954
Texas	Patterson 1983. 1986
Texas	Patterson and Hudgins 1985, 1991
Texas	Pertula 1986, 1993
Texas	Polyak and Williams 1986
Texas	Preston 1972
Texas	Prewitt 1983
Texas	Richner and Bagot 1978
Texas	Ring 1994
Texas	Scurlock and Davis 1962
Texas	Skiles *et al.* 1980
Texas	Skinner *et al.* 1969
Texas	Weir 1956

TABLE 4.2. Published Projectile Point Surveys by State and Paleoindian Complex

COMPLEX/ STATE	PUBLICATION
CLOVIS	
Kansas	Hofman and Hesse 1996
Kansas	Johnson and Logan 1990
Kansas	Wetherhill 1995
Oklahoma	Hofman 1991
Oklahoma	Hofman and Wyckoff 1991
Oklahoma	Wyckoff and Czaplewski 1997
Texas	Hofman 1991
Texas	Meltzer and Bever 1995
Texas	Prewitt 1995
FOLSOM	
Kansas	Hofman 1994
Kansas	Hofman and Blackmar 1998
Kansas	Wetherhill 1995
Oklahoma	Hofman 1993
Oklahoma	Hofman and Wyckoff 1987
Texas	Hofman 1995
Texas	Largent et al 1991
Texas	Largent 1995
Texas	Prewitt 1995
Texas	Story 1990
Texas	Thurmond 1990
CODY	
Kansas	Glover 1974
Kansas	Wetherhill 1995
Oklahoma	Blackmar and Hofman 1997
Texas	L. Johnson 1989
Texas	Prewitt 1995
Texas	Story 1990

A large portion of this data is in the form of isolated projectile points and systematic surface collections. Traditionally archaeologists have not been enthusiastic about incorporating surface derived information into analyses due to the perception that such information is less accurate and therefore less valuable than "excavated site" data. However, it has been argued that data derived from both types of methods are complementary (Hofman 1991). As stated by Dunnell and Dancy (1983:272):

> A far more useful, less biased model of the archaeological record can be constructed if the objective of data collection is broadly conceived as the recovery of artifacts as opposed to the discovery of sites. Adopting this view, the archaeological record is most usefully conceived as a more or less continuous distribution of artifacts over the land surface with highly variable density characteristics. Sites in this context represent only a part of the total recorded, explicitly defined by density characteristics...Variability in artifact density is a reflection of the character and frequency of land use and as such is one of the more important variable that could be measured.

A form was developed to record information for all documented points including state, county, collection or site name, material type, site type, context in which it was found, and point location (e.g., Hofman 1994; Meltzer 1987). A modified version of this form including information on the state, county, area, physiographic region, number of points documented for each complex, and total number of points for each county is given in Appendix A. Cross-checking between primary reports of projectile point occurrences and surveys were undertaken to ensure duplication did not occur. In the case of the Cody complex, Cody knives were documented in addition to projectile points since by themselves are a defining characteristic of the Cody Complex (Figure 3.3). The county served as the useful spatial unit for assessing the distribution of points across the states. Finer locational information is often not available from surface collections. Counties are mappable units and can be clustered into physiographical regions (Meltzer and Bever 1995). Following Meltzer and Bever (1995), the study of point distribution is based primarily on the frequency and relative density of projectile points for each Paleoindian complex by county. Maps dividing the states into the four physiographic regions were created with the frequency of points of each cultural complex plotted (Figure 4.1-4.3). Densities of Clovis, Folsom, and Cody points were mapped by grouping data into the following categories: no points reported from a county; one point from a county; between two and nine points; and ten or more points within a single county (Figure 4.4-4.6).

The investigation was accomplished using two primary modes of analysis: 1) visual inspection and 2) quantitative analysis. Visual examination of spatial patterning of graphically displayed data is commonly a successful mode of spatial analysis (Hiatala 1984). Visual aids included frequency maps and density maps of the documented occurrence of Clovis, Folsom, and Cody projectile points. As a technique to standardize frequency by physiographic area, the artifact frequency count for each physiographic area was standardized by the size of each area (cf. Turner and Klippel 1989). This was accomplished by taking the frequency of projectile points for each Paleoindian complex and dividing it by the total area in km^2 for each physiographic region. This was then multiplied by a factor of 100,000 (Table 4.3).

Quantitative applications were utilized as basic pattern recognition techniques. Comparison between the Clovis, Folsom, and Cody complexes were conducted by density of projectile points utilizing frequency and ubiquity. Using the county as the sample unit, ubiquity or presence analysis provides a technique to deal with the problem of recovery bias allowing systematic and standardized comparisons between the regional areas. As stated by Popper (1988:60-61), in the context of her paleobotanical study,

> This method disregards the absolute count of a taxon and instead looks at the number of samples in which the taxon appears within a group of samples. Each taxon is scored present or absent in each sample. The taxon is considered present whether the sample contains1 remain of the taxon or 100, thereby giving the same weight to 1 or 100. The frequency score of a taxon is the number of samples in which the taxon is present expressed as a percentage of the total number of samples in the group....An important characteristic of ubiquity is that the score of one taxon does not affect the score of another, and thus the scores of different taxa can be evaluated independently.

For this study, ubiquity analysis provided a less biased comparison of point distribution between regions because samples were collected by different people utilizing different methods. Both highly focused site excavated samples and more sporadic non-site samples were incorporated. For example, intensive research at a specific site may produce ten projectile points as might intensive study of specific private collections whereas several isolated points may be recovered in another county. Information from other counties may be based on no systematic effort by professional archaeologists. In both cases, the nature and intensity of land use may have been identical. In an effort to evaluate the statistical probability of the recognized correlations happening by chance, Chi Square tests were employed.

TABLE 4.3. Standardized Frequency of Types By Region.

Region/Cultural Complex	**Percent of Area (km^2)**	**Frequency of Point Occurrence by County**	**Standard Frequency (Frequency/Area x 100,000)**
High Plains	186,050		
Clovis		134	72
Folsom		214	115
Cody		82	44
Prairie Plains	486,052		
Clovis		254	52
Folsom		401	83
Cody		110	23
Savannah	305,317		
Clovis		141	46
Folsom		100	33
Cody		73	24
Woodlands	89,648		
Clovis		41	46
Folsom		5	6
Cody		60	67

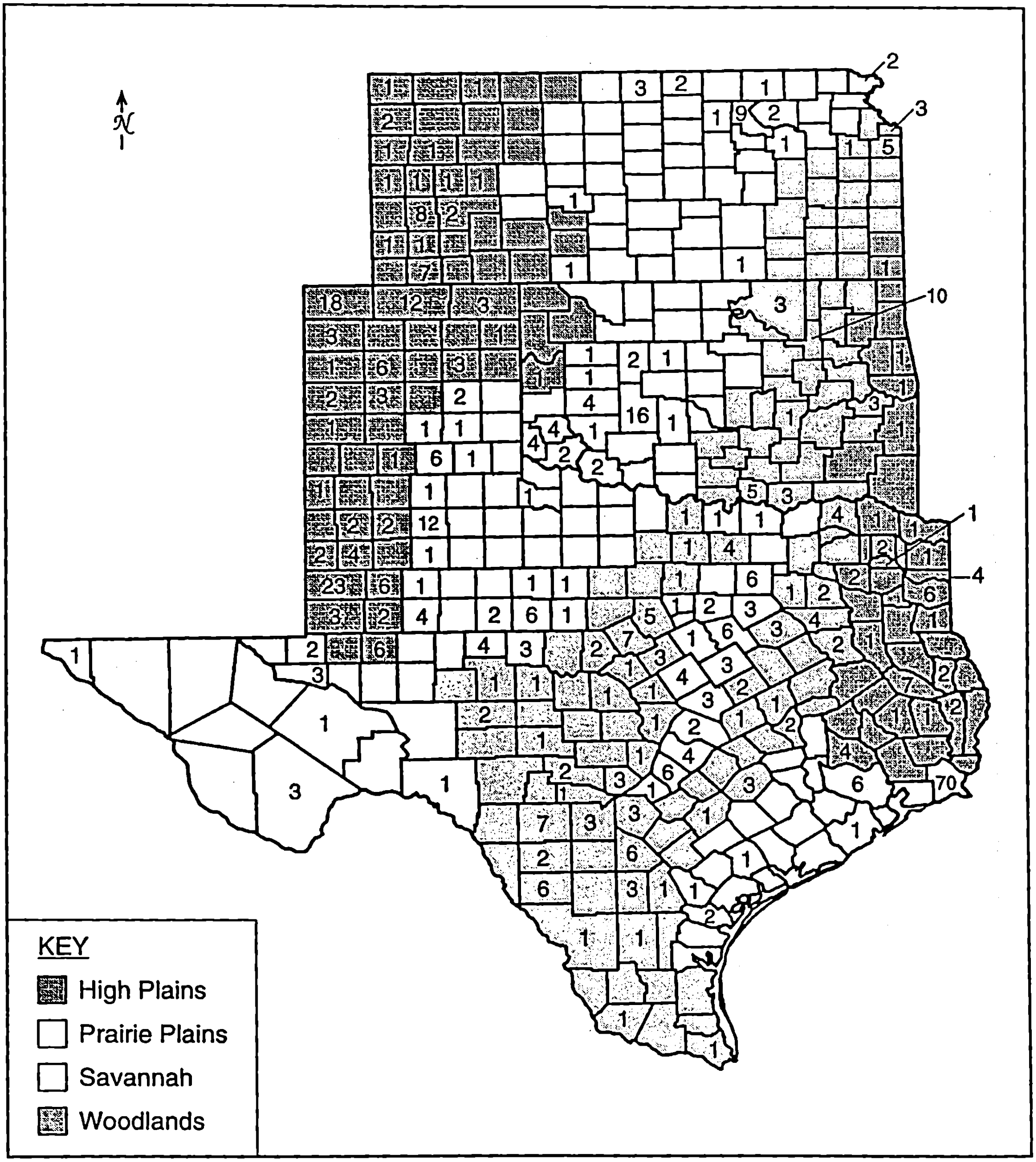


Figure 4.1. Clovis Projectile Point Distribution Map

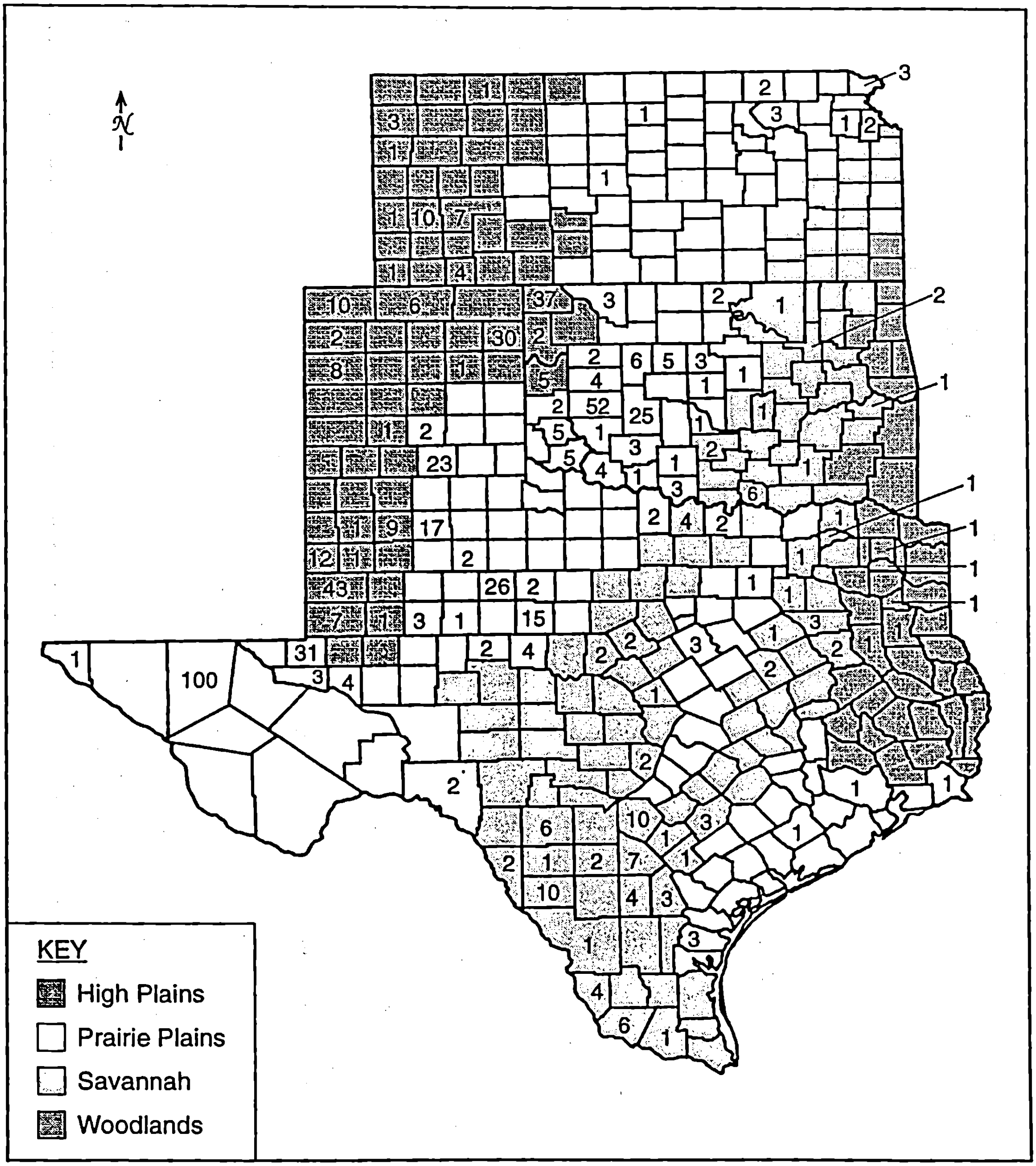


Figure 4.2. Folsom Projectile Point Distribution Map

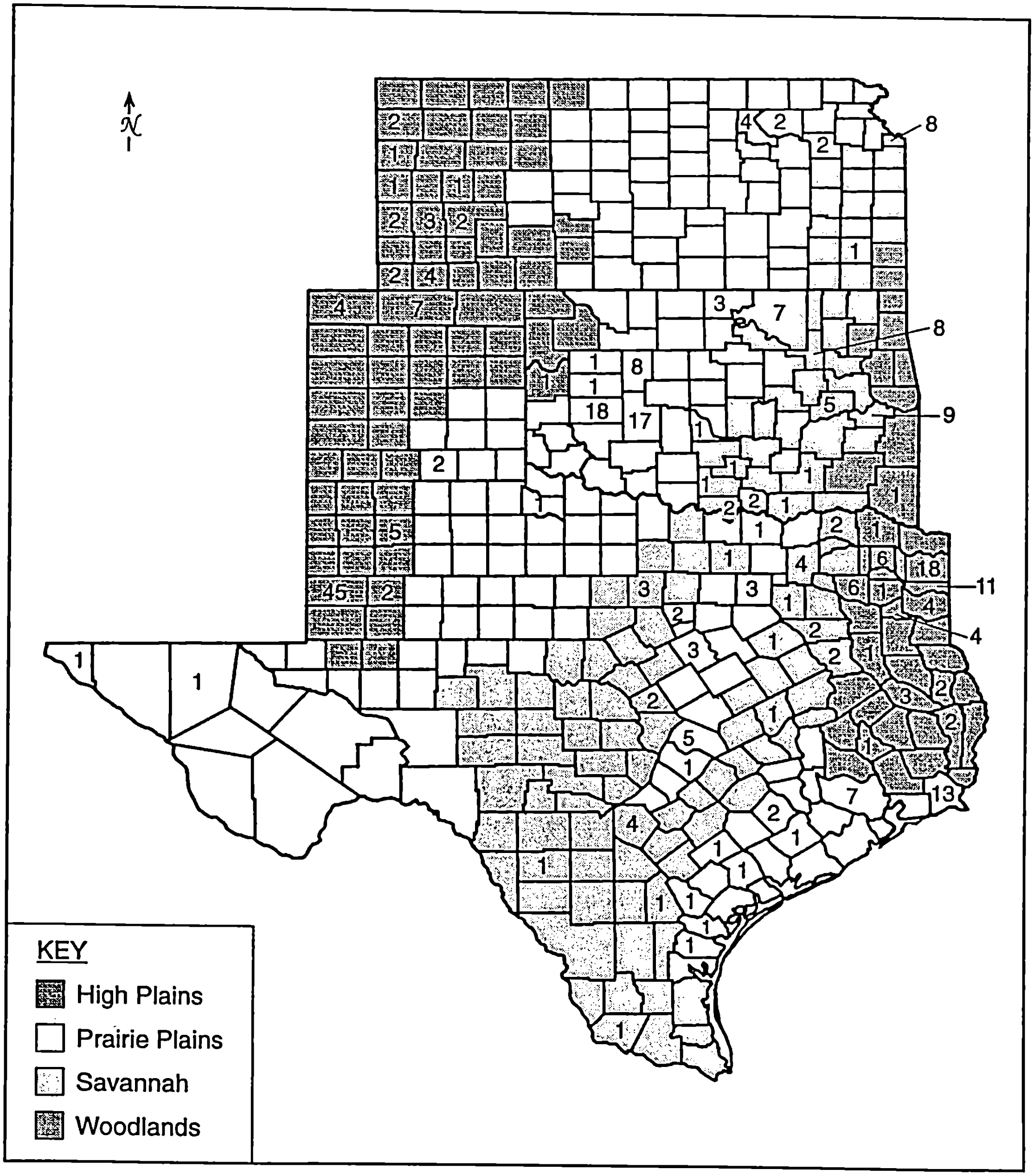


Figure 4.3. Cody Projectile Point Distribution Map

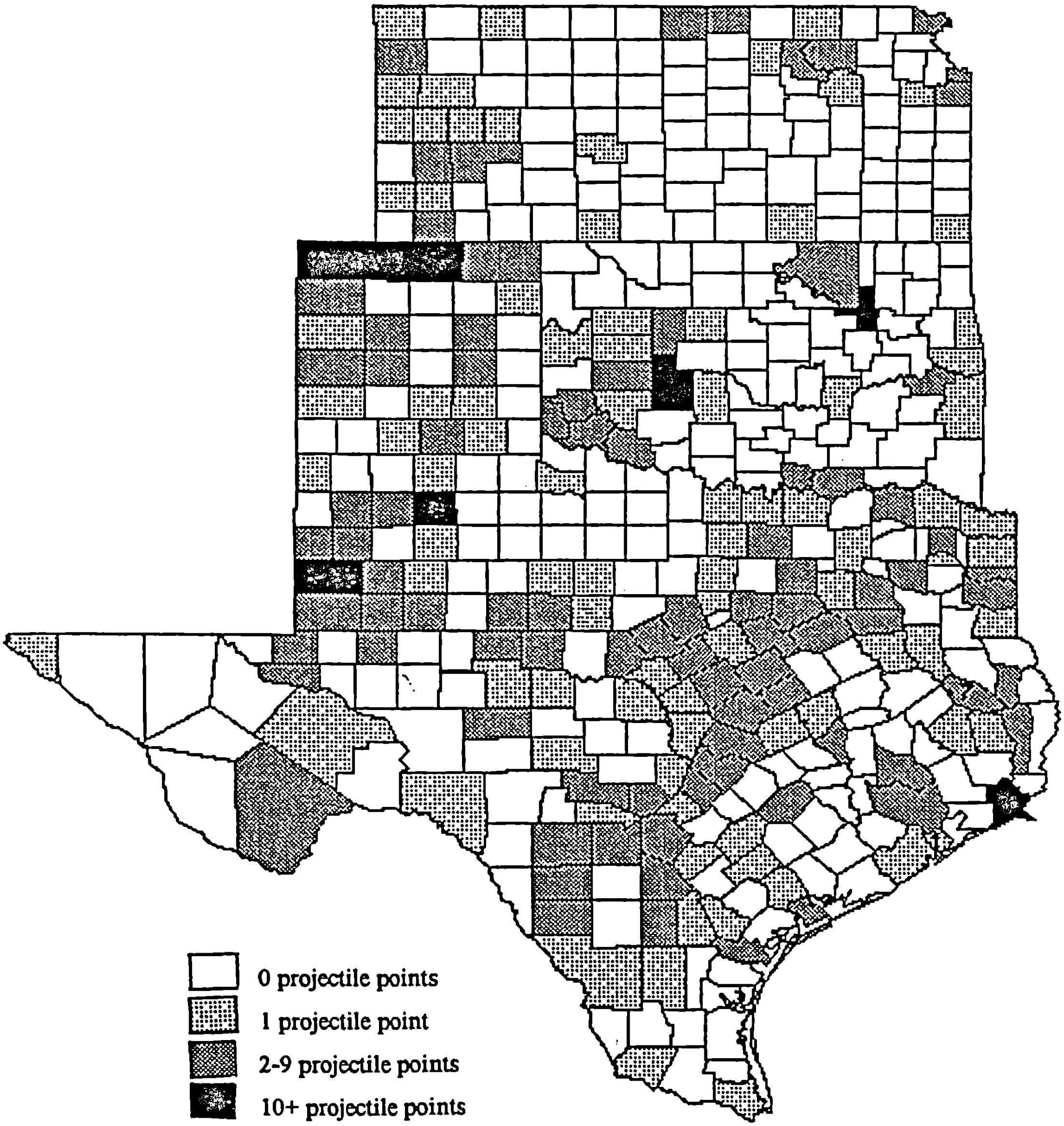


Figure 4.4. Clovis Projectile Point Density Map

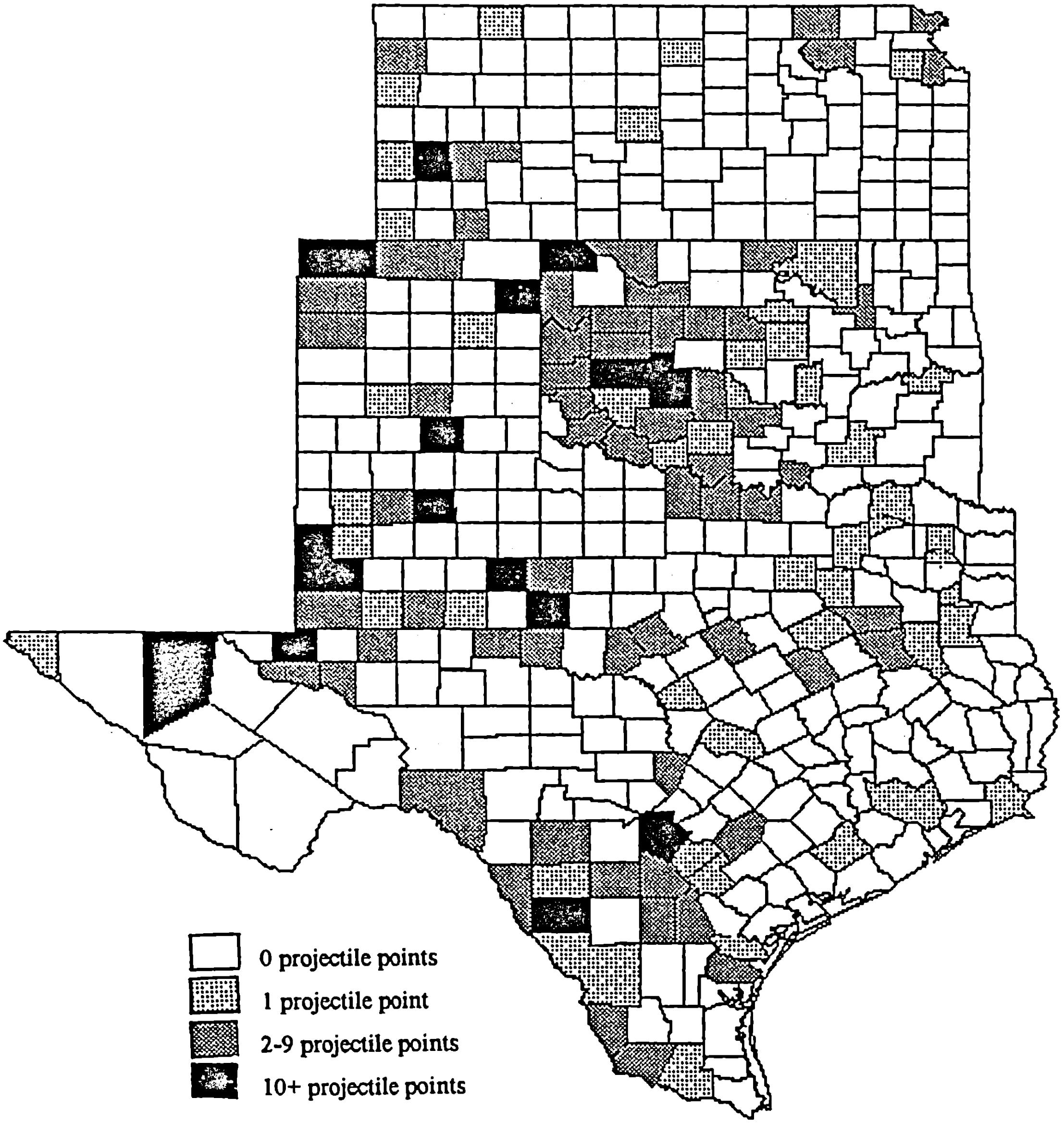


Figure 4.5. Folsom Projectile Point Density Map

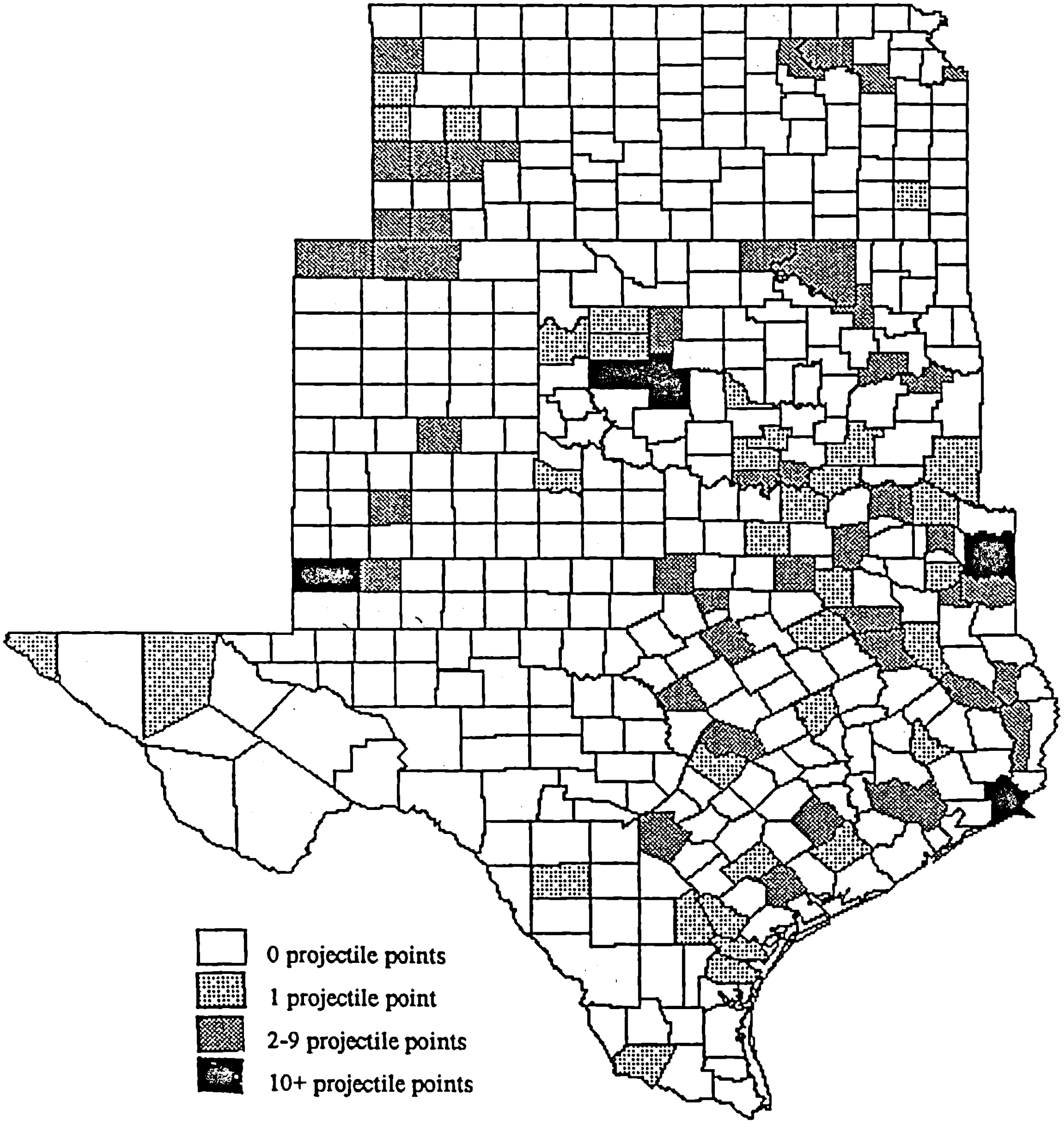


Figure 4.6. Cody Projectile Point Density Map

CHAPTER 5 - SUMMARY CHARACTERISTICS OF THE DATABASE AND PATTERN RECOGNITION ANALYSIS

The analytical task of archaeologists is to explain the density and character of the more or less continuous distribution of artifacts.
Dunnell 1992:34

Database Characteristic Summary

Kansas, Oklahoma, and Texas encompass a total of 1,067,067 km^2 (411,995 mi^2) divided into 436 counties. Table 5.1 illustrates the breakdown of the counties and area in km^2 by the four physiographic regions. The Prairie Plains accounts for nearly half of the total area followed by the Savannah, High Plains, and the Woodlands.

TABLE 5.1. Summary of Physiographic Regions

REGION	AREA (km^2)	% TOTAL AREA	TOTAL COUNTIES
High Plains	186,050	17	72
Prairie Plains	486,052	46	188
Savannah	305,317	29	132
Woodlands	89,648	8	44
TOTALS	1,067,067	100	436

Within the region, a total of 1,615 Paleoindian projectile points representing the Clovis, Folsom, and Cody complexes have been documented (Figure 5.1). The vast majority of these points (80%) are represented as isolated or surface scatter finds rather than from excavated contexts. The total percentages for all complexes by state are as follows: 66% (n=1065) are documented from Texas, 25% (n=411) from Oklahoma, and 9% (n=139) from Kansas. The frequency of points by cultural complex reveals nearly half ,45% , (n=720) are Folsom projectile points, 35% (n=570) are Clovis projectile points, and 20% (n=325) are Cody projectile points (Figure 5.1).

The total frequency of all projectile points (n=1,615) by physiographic region reveals close to half, 47% (n=765), of the points are from the Prairie Plains; 27% (n=430) are from the High Plains; 19% (n=314) are from the Savannah; and 7% (n=106) are located in the Woodland physiographic region (Figure 5.2).

Pattern Recognition

The projectile point frequency by physiographic region for each complex was recorded. The distribution of Clovis points mirrors the total distribution with the highest number of Clovis points documented from the Prairie Plains (45%, n=254) followed by the High Plains (24%, n=134), the Savannah (25%, n=141) and woodlands (7%, n=41) (Figure 4.1, 5.3). More than half (56%, n=401) of Folsom points are from the Prairie Plains, 30% (n=214) from the High Plains, 14% (n=100) from the Savannah, and less than 1% (n=5) are from the Woodlands (Figure 4.2, 5.3). Following the Clovis and Folsom distribution, the majority of Cody points are from the Prairie Plains (34%, n=110) followed by the High Plains (25%, n=82), the Savannah (22%, n=73), and the woodlands(19%, n=60) (Figure 4.3, 5.3).

Figure 5.3 displays these frequencies with the three complexes combined. The majority of points are located in the Prairie Plains and High Plains. The fewest points occur in the Woodlands. Figure 5.4 illustrates the percentage of each physiographic region representation of the total area with the percent of Clovis, Folsom, and Cody points within each region. As shown on Figure 5.4, the High Plains and Prairie Plains have proportionally more projectile points for their size than do the Savannah and Woodlands.

Figures 4.4 - 4.6 were made to illustrate the grouped density of projectile point occurrences by counties. As shown on Table 5.2, the density for each Paleoindian complex by projectile point occurrence is as follows: 88 counties (20%) in the study area contain one Clovis point; 46 (11%) of the counties contain one Folsom point; and

34 (8%) of all counties contain a single Cody projectile point. The counties that contain from two to nine points include 88 (20%) for Clovis; 62 (14%) for Folsom, and 44 (10%) counties with two to nine Cody points/knives. Far fewer counties contain 10 or more projectile points; only 7 (2%) for the Clovis complex, 16 (4%) for Folsom, and 6 (1%) for the Cody complex.

TABLE 5.2. Density of Clovis, Folsom, and Cody Projectile Points by Counties within Kansas, Oklahoma, and Texas.

Complex/State	Frequency of 1 point/county	Frequency between 2 to 9 points/county	Frequency of 10 or greater points/ county
CLOVIS			
Kansas	18	11	0
Oklahoma	10	11	4
Texas	60	66	3
	88 (20%)	**88 (20%)**	7 (2%)
FOLSOM			
Kansas	7	7	1
Oklahoma	10	20	4
Texas	29	35	11
	46 (11%)	62 (14%)	16 (4%)
CODY			
Kansas	4	10	0
Oklahoma	9	10	2
Texas	21	24	4
	34 (8%)	44 (10%)	6 (1%)

Total Counties = 436

Table 5.3 displays the counties by region containing 10 or more projectile points. Gaines county in Texas and Caddo county in Oklahoma are the only counties where 10 or more points are represented for all three Paleoindian complexes. Jefferson county contains 10 or more Clovis and Cody points. This is largely from one site, McFaddin Beach. Washita county in Oklahoma yielded 10 or more Folsom and Cody points. Cimarron county in Oklahoma and Crosby county in Texas have 10 or more Folsom and Clovis points. In addition to McFaddin Beach, several sites or localities within a specific county have 10 or more points of a specific complex represented. These include Cedar Creek locality (Caddo county, OK); Bethel Locality (Caddo county, OK); Cooper (Harper county, OK); Lipscomb (Lipscomb county, TX); Lake Theo (Briscoe county, TX); Chispa Creek (Culberson county, TX); Adair Steadman (Fisher county, TX); Shifting Sands (Winkler county, TX); Pavo Real (Bexar county, TX); and Seminole Rose (Gaines county, TX) (Table 5.3). The density by physiographic regions for counties with 10 or more projectile points by complex show the High Plains and Prairie Plains containing the majority of counties for both Clovis and Folsom while the Woodlands and Prairie Plains account for the majority of counties with 10 or more Cody points.

The ubiquity of Clovis, Folsom and Cody projectile points by county within the physiographic regions is illustrated in Table 5.4. The percentage of counties with point occurrences is greatest in the High Plains for Clovis and Folsom. Following the High Plains (51%) for Clovis, is the Woodlands (45%), Savannah (42%), and the Prairie Plains (38%). The Prairie Plains (29%) and Savannah (28%) follow the High Plains (36%) for Folsom with the Woodlands much lower (11%). The Woodland Cody ubiquity (32%) is highest followed by the High Plains (21%), Savannah (20%), and the Prairie Plains (15%).

As illustrated in Figure 5.5, standardized frequency of types by region also indicates the highest point occurrence in the Woodlands for Cody contrasted with the lowest point occurrence in the Woodlands for Folsom. The High Plains again has the most Clovis and Folsom representation as was also shown by ubiquity. However, the Prairie Plains standard frequency for Clovis (52) is slightly more than the Savannah and Woodlands each with a standard frequency of 46 (Table 4.3). For Folsom, standard frequency reveals a greater discrepancy between the Prairie Plains (83) and Savannah (33) (Table 4.2). Standard frequency matches the ubiquity of Cody points which is highest in the Woodlands, followed by the High Plains, Savannah, and the Prairie Plains.

TABLE 5.3. Counties Containing Ten or More Clovis, Folsom, Cody Projectile Points.

COMPLEX	STATE	COUNTY	REGION	TOTAL # PTS	SITE/LOCALITY[1]
CLOVIS	Oklahoma	Cimarron	High Plains	18	
	Oklahoma	Texas	High Plains	12	
	Oklahoma	Caddo	Praire Plains	16	
	Oklahoma	Tulsa	Savannah	10	
	Texas	Gaines	High Plains	23	
	Texas	Crosby	Prairie Plains	12	
	Texas	Jefferson	Prairie Plains	70	McFaddin Beach
FOLSOM	Kansas	Kearney	High Plains	10	
	Oklahoma	Cimarrron	High Plains	10	
	Oklahoma	Harper	High Plains	37	Cooper
	Oklahoma	Caddo	Prairie Plains	25	Bethel locality
	Oklahoma	Washita	Prarie Plains	52	Cedar Creek
	Texas	Gaines	High Plains	43	
	Texas	Lipscomb	High Plains	30	Lipscomb
	Texas	Yoakum	High Plains	12	
	Texas	Briscoe	Prairie Plains	23	Lake Theo
	Texas	Crosby	Prairie Plains	17	
	Texas	Culberson	Prairie Plains	100	Chispa Creek
	Texas	Fisher	Prairie Plains	26	Adair Steadman
	Texas	Taylor	Prairie Plains	16	
	Texas	Winkler	Prairie Plains	31	Shifting Sands
	Texas	Bexar	Savannah	10	Pavo Real
	Texas	Dimmitt	Savannah	10	
CODY	Oklahoma	Caddo	Praire Plains	17	
	Oklahoma	Washita	Prairie Plains	18	Cedar Creek
	Texas	Gaines	High Plains	45	Seminole Rose
	Texas	Jefferson	Prarie Plains	13	McFaddin Beach
	Texas	Cass	Woodlands	18	
	Texas	Marion	Woodlands	11	

[1] site/locality that accounts for the majority of the points in the county.

Simple descriptive comparisons appear to indicate roughly the same pattern of point distribution (Figure 5.3) reflecting greater use of land in the western Plains and Prairie and less evidence for Eastern Savannah and Woodland occupation of the region. However, by considering density, ubiquity, and standard frequency by size

TABLE 5.4 Ubiquity of Clovis, Folsom, and Cody Projectile Points by County Within Physiographic Regions.

REGION/CULTURAL COMPLEX	TOTAL NUMBER OF COUNTIES/REGION	FREQUENCY OF POINT OCCURRENCE	UBIQUITY[1]
High Plains	72		
Clovis		37	51
Folsom		26	36
Cody		15	21
Prairie Plains	188		
Clovis		71	38
Folsom		54	29
Cody		29	15
Savannah	132		
Clovis		55	42
Folsom		37	28
Cody		26	20
Woodlands	44		
Clovis		20	45
Folsom		5	11
Cody		14	32

[1] Ubiquity is derived by the number of counties within a region/total number of counties within a region

of each physiographic area, it is evident that emphases on specific areas varied among these Paleoindian complexes. Clovis land use on the High Plains appears high but is about equally intensive between the three other regions when standardized frequency and ubiquity are considered. Folsom land use is more intense in the High Plains and Prairie Plains with little evidence in the Woodlands. Cody projectile point distribution is consistently highest in the Woodlands but a secondary preference toward the High Plains is also indicated. Chi-Square analyses of these patterns indicate they almost certainly are not the result of chance (5.5-5.7). Determination of whether these patterns are the result of differences in prehistoric behavior or sampling factors must await further study.

TABLE 5.5 . Crosstabulation of Clovis, Folsom, and Cody Projectile Point Frequencies From Four Physiographic Regions.

	CLOVIS	FOLSOM	CODY	TOTALS
HIGH PLAINS	o=129 e=151.76 x^2=3.41	o=205 e=141.70 x^2=.07	o=82 e=86.53 x^2=.24	430
PRAIRIE PLAINS	o=259 e=270 x^2=.45	o=410 e=341.05 x^2=13.94	o=110 e=153.95 x^2=12.55	765
SAVANNAH	o=141 e=110.82 x^2=8.22	o=100 e=139.99 x^2=11.42	o=73 e=63.19 x^2=1.52	314
WOODLANDS	o=41 e=37.41 x^2=.35	o=5 e=47.26 x^2=37.79	o=60 e=21.33 x^2=70.09	106
TOTALS	570	720	325	1,615

df= 6; total x^2= 160.04; $p<.001$

TABLE 5.6. Crosstabulation of Standardized Frequencies of Clovis, Folsom, and Cody Projectile Points from Four Physiographic Regions.

	CLOVIS	FOLSOM	CODY	TOTALS
HIGH PLAINS	o=72 e=81.66 x^2=1.14	o=115 e=89.6 x^2=7.2	o=44 e=59.73 x^2=4.14	231
PRAIRIE PLAINS	o=52 e=55.86 x^2=.266	o=83 e=61.29 x^2=7.69	o=23 e=40.86 x^2=7.81	158
SAVANNAH	o=46 e=36.41 x^2=2.53	o=33 e=39.95 x^2=1.21	o=24 e=26.64 x^2=.261	103
WOODLANDS	o=46 e=42.07 x^2=.37	o=119 e=46.20 x^2=34.94	o=67 e=30.77 x^2=42.66	119
TOTALS	216	237	158	611

df=6; x^2=110.21; $p<.001$

TABLE 5.7. Crosstabulation of Clovis, Folsom, and Cody Projectile Point Ubiquity from Four Physiographic Regions.

	CLOVIS	**FOLSOM**	**CODY**	TOTALS
HIGH PLAINS	o=51 e=51.65 x^2=.008	o=36 e=30.52 x^2=.98	o=21 e=25.83 x^2=.90	108
PRAIRIE PLAINS	o=38 e=39.22 x^2=.038	o=29 e=23.17 x^2=1.47	o=15 e=19.61 x^2=1.08	82
SAVANNAH	o=42 e=43.04 x^2=.025	o=28 e=25.43 x^2=.26	o=20 e=21.52 x^2=1.07	90
WOODLANDS	o=45 e=42.09 x^2=.20	o=11 e=24.87 x^2=7.74	o=32 e=21.04 x^2=5.71	88
TOTALS	176	104	88	368

df=6; x^2=19.492; $p < .01$

Biases

Before interpretations can be made in regard to these data, it is necessary to outline potential biases that may contribute to the patterns observed. These biases take two primary forms: 1) sampling and 2) landscape geomorphic history.

Sampling bias concerns include whether or not the patterns are a reflection of archaeological sampling and reporting or actual patterns of intensive use of land by Clovis, Folsom, and Cody peoples. Two sampling factors include whether or not artifacts from all three complexes were consistently recorded, and whether all areas were equally well studied. Some regions in the study area have been systematically sampled by professional and/or avocational archaeologists. These areas include northeastern Kansas, west-central Kansas; Caddo and Washita counties in Oklahoma, and the Arkansas River basin in northern and eastern Oklahoma; the Texas Gulf Coastal region, and the Llano Estacado. The areas containing scant representation of all three Paleoindian complexes include the Llano Basin, Edwards Plateau, and the northern portion of the Lower Plains in Texas; the Sandstone Hills of Oklahoma; and the central and southeastern regions in Kansas. The low frequency of points in each of these areas probably reflect at least in part the lack of systematic research and documentation.

The manner in which archaeologists have obtained data for compiling projectile point surveys may lead to bias. For example, Prewitt (1995) and Largent (1995) used only published accounts of points from journals and monographs. Prewitt's data did not include data from original type descriptions or from synthetic surveys (in an attempt not to duplicate counts). Meltzer and Bever (1995) and Hofman (1991, 1994) utilized published accounts of points and accessed previously unreported points from private collections. However, their methodology was quite different in regard to obtaining information from private collections. Much of Meltzer's information came from mail-in ballots from collectors while Hofman recorded the information directly from private collections. This highlights potential problems of typological assignment and recognition. It is well recognized that much variability exists among certain point types and people often are not in agreement as to the category designation of a particular point. It may be difficult to assess the point type from merely a drawing of the point and reliance on the original point type designation must be accepted or else the point is not included in the database.

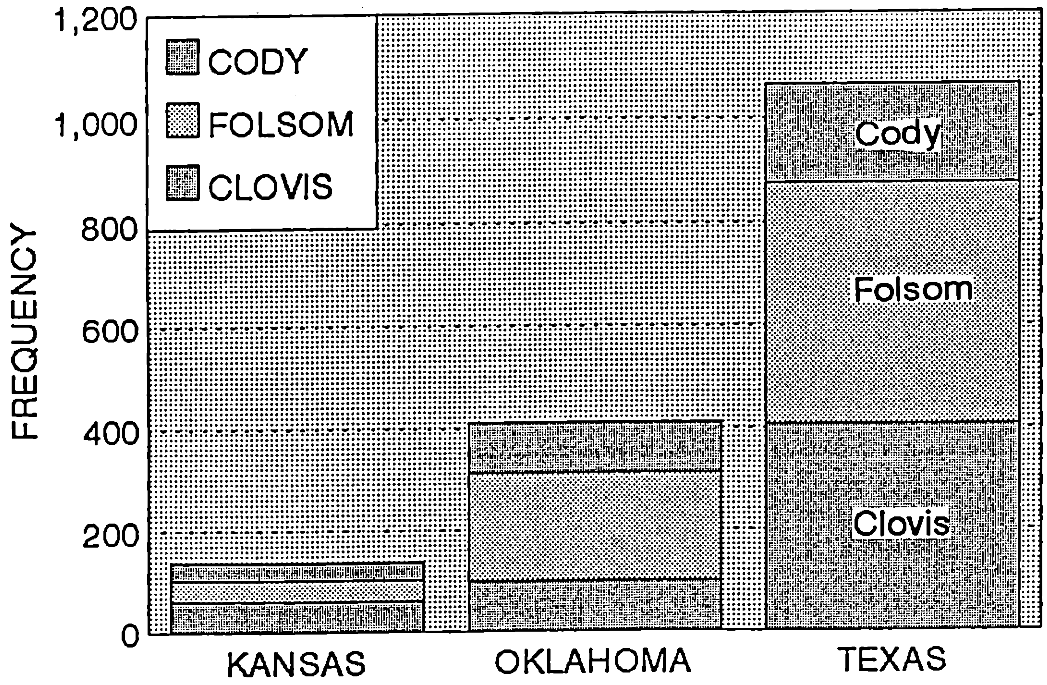
The very limited occurrence of Folsom points in the Woodlands region of the study area is probably not due to problems of sampling, typological assignment or recognition. Intensive recording of several collections in the lower Kansas River Valley (Wetherill 1995), the Arkansas Valley in Oklahoma (Hofman 1993; Hofman and Wyckoff 1991; Wyckoff 1993), and eastern Texas (Story 1990; L. Johnson 1989) support the argument that Folsom is indeed rare in the region, while artifact types of comparable age (Clovis, Dalton, Cody) are fairly common.

Geomorphic factors including site recognition and site formation processes may bias the observed patterns. The visibility of sites and isolates is affected by many factors. The amount of ground cover and modern land use practices (and population) differ radically between environmental regions. This may in part explain the lower number of counties in the Savannah and Woodlands with evidence of Paleoindian projectile points. The absence of Paleoindian evidence for occupation of rockshelters may also be a geoarchaeological issue and not entirely the selection against the use of rockshelters by Paleoindians. By analyzing rates and processes of degradation in rockshelters, Collins (1991:174) states,

> a significant proportion of rockshelter deposits from earlier time periods are obscured by shelter collapse and degradation.. The direct implication for Paleoindian research in the Americas is that a significant proportion of limestone shelters suitable for habitation 8-12 millennia ago may be partially or totally degraded today.

Furthermore, it has been recognized that many Paleoindian sites are deeply buried (Collins 1991; Ferring 1994; W.C. Johnson and Logan 1990; Mandel 1992), or heavily eroded (Holliday 1997). For example, thick alluvial fills covered Aubrey (Ferring

1994), Domebo (Leonhardy 1966) and McLean (Ray and Bryan 1938) which suggest that many early sites are deeply buried. Contributing to the issue of visibility on the High Plains is the presence of extensive sand dunes around playa basins where Paleoindian material may occur (Holliday 1997; Wendorf and Hester 1975). The progress of Paleoindian investigations depends on the integration of geoarchaeological research at both the site and regional scales (Holliday 1996; W.C. Johnson and Logan 1990).



Kansas n=139; Oklahoma n=411; Texas n=1065

Figure 5.1. Paleoindian Point Types by State

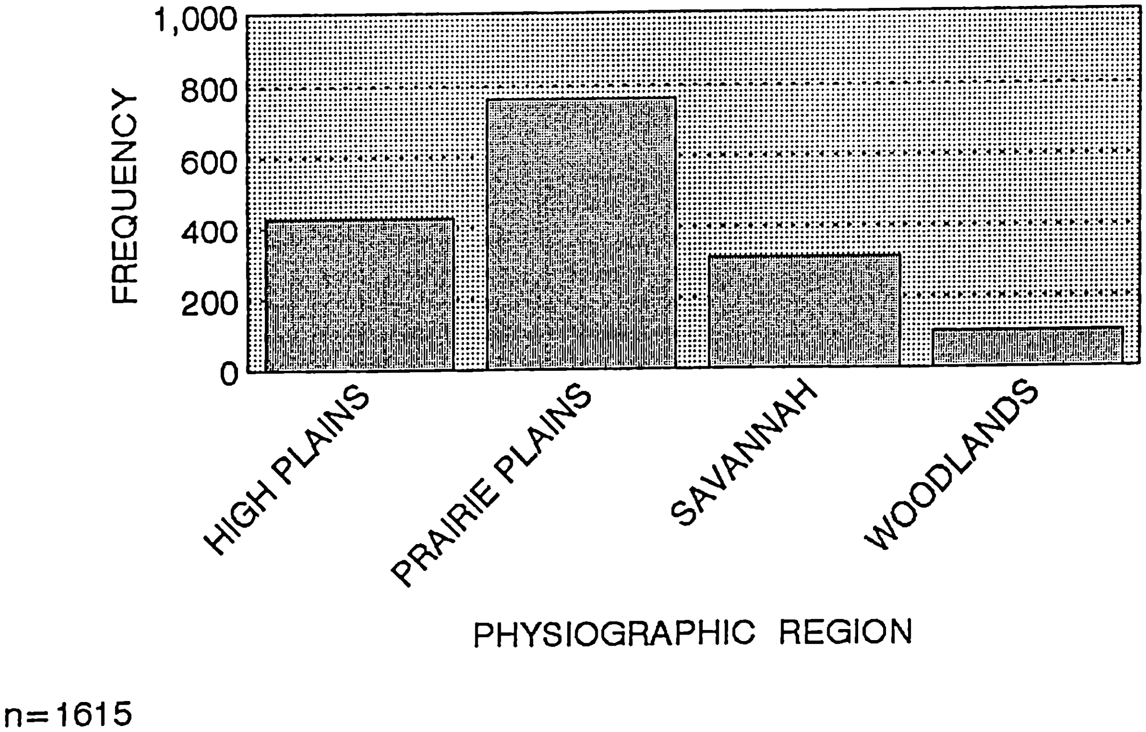
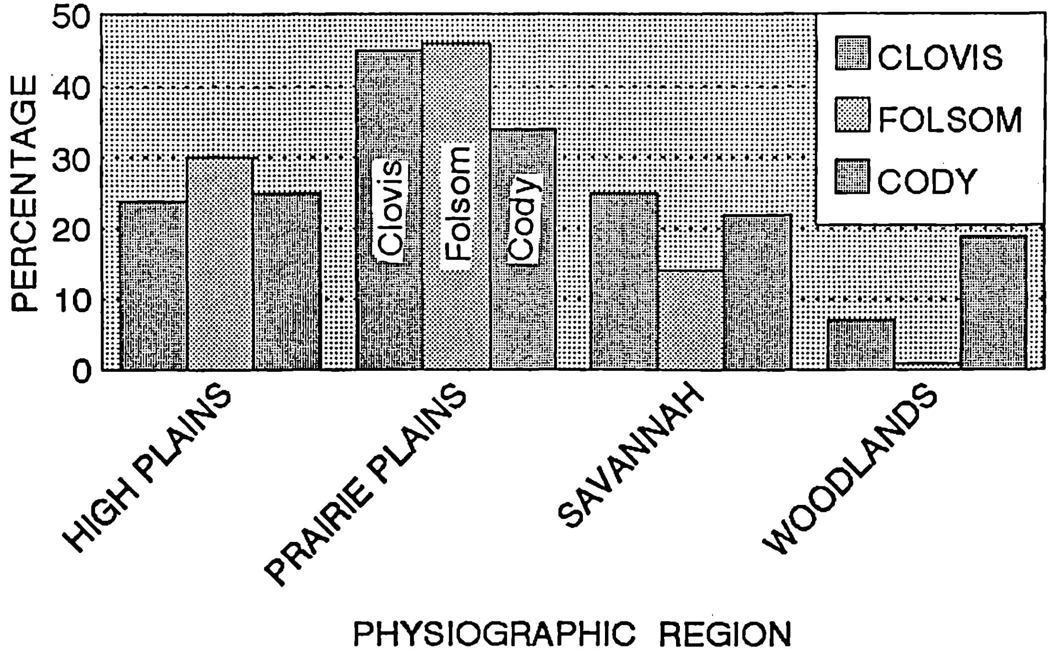
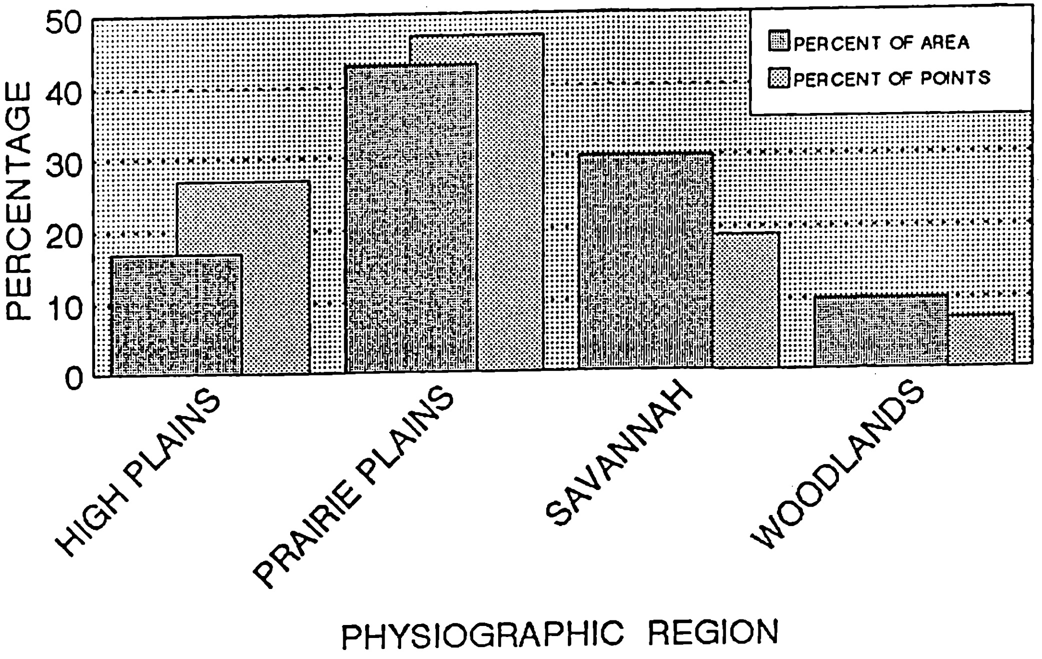


Figure 5.2. Total Points by Region



total n=1615; Clovis=570; Folsom=720; Cody=325

Figure 5.3. Regional Percentages of Clovis, Folsom, and Cody Projectile Point Frequencies



n=1615

Figure 5.4. Regional Percentages of Clovis, Folsom, and Cody Projectile Point Frequencies by Percent of Area

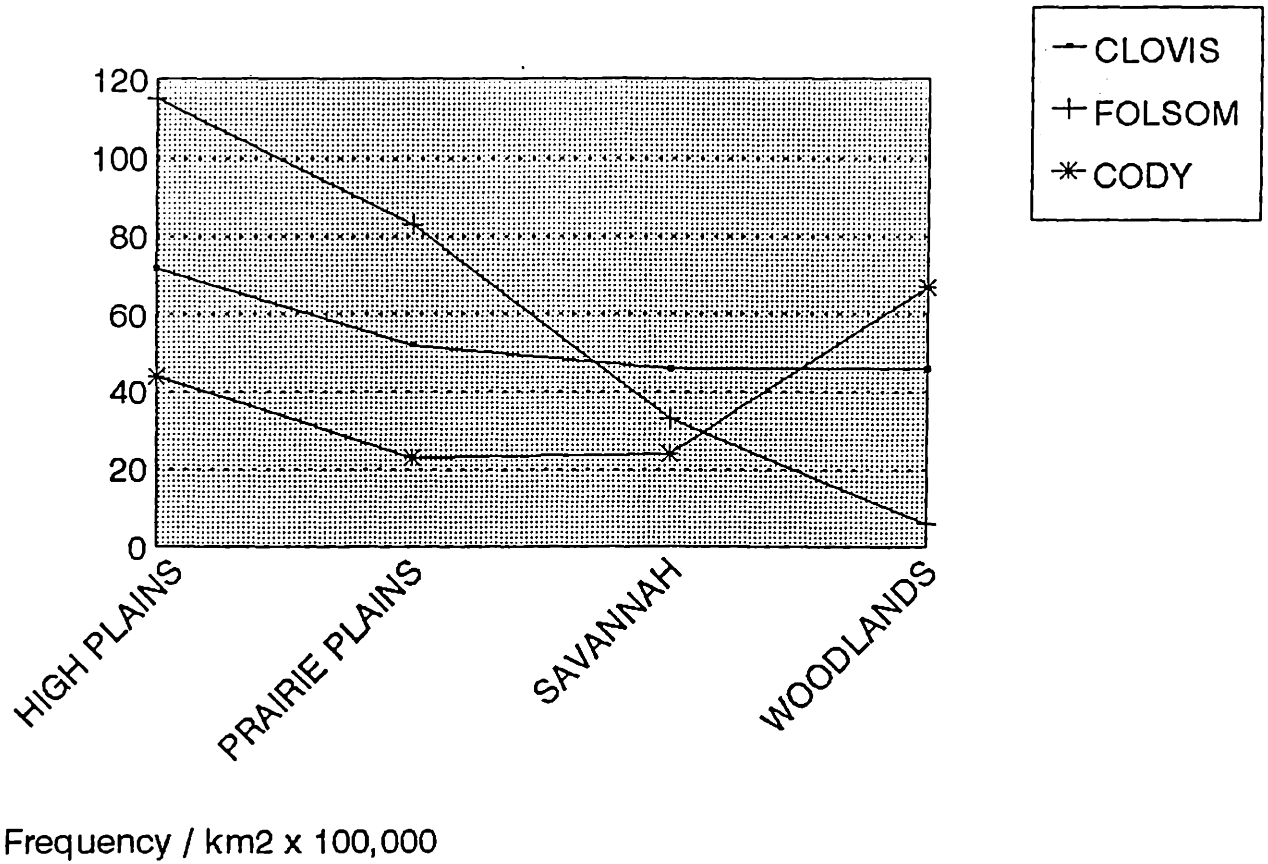


Figure 5.5. Standardized Frequency of Types by Region

CHAPTER 6 - DISCUSSION

The North American Paleoindian: A Wealth of Data But Still Much to Learn
Frison 1991:1

Several models have been proposed that address Paleoindian subsistence strategies, technology, and mobility patterns. Traditionally, the interpretations of Paleoindian economies have emphasized a specialization toward large herbivorous mammals (Jennings 1974; Sellards 1952;Willey 1966; Wormington 1957). An alternative view is that much variability existed during the Paleoindian period (Frison 1993; Frison and Bonnichsen 1996; Dillehay 1986). It may be that while not all of the recognized Paleoindian complexes had a specialization toward "big-game", several groups may have been specialists (Hofman 1995; Hofman and Todd 1995; Kelly and Todd 1988). Specifically, Kelly and Todd (1988) suggest that both Clovis and Folsom utilized an economy that was species-focused. Support for this position includes a widespread highly developed technology and evidence for long distance movement of high quality lithics. They suggest that selection of a specific environment was not the most critical factor conditioning behavior, but rather the species being hunted. On the other hand, Meltzer (1988) has argued that Clovis people were mainly generalists exploiting a variety of resources. In other words, economic behavior and land use organization was not tethered to a specific species. The traditional position that Cody peoples were High Plains bison specialists (Bonnischsen et al. 1987) has been modified. It has been proposed that in times of environmental stress these peoples occasionally utilized the Woodland environment (Greiser 1985; L. Johnson 1989). There is also evidence that Cody peoples moved off the High Plains into the mountain-foothills of the northern Plains (Frison and Bonnichsen 1996). Frison and Bonnichsen (1996:305) note, "the Cody cultural complex appears in some foothill-mountain Paleoindian sites and seems to be the exception to the dichotomy in subsistence observed between foothill-mountain and open Plains." This raises the question of whether Cody represents multiple adaptations within one culture or if multiple groups are included in the Cody technological complex.

The questions considered in this study include: 1) Were Clovis primarily specialists in non-bison species due to different environmental conditions and available species, or did they have a general foraging adaptation? 2) Were Folsom and Cody specialized Plains bison hunters? 3) Were Cody people Woodland "interlopers" as suggested by L. Johnson (1989), or were the Woodlands a regular component of their economic territory? and 4) Did the Cody complex represent more than a single cultural group?

If Clovis people were generalists and Folsom and Cody were bison hunting specialists then their artifact distributions should be distinctive. If Folsom and Cody were bison hunting specialists then the occurrence of these projectile points should correspond with that of bison during the respective periods. If the occurrence of Folsom and Cody in the woodlands is significant then this would not support the notion of an economic specialization focused primarily on bison. There is no compelling evidence of bison populations comprising a significant portion of the fauna in the woodlands at any time in prehistory (although see Dillehay 1974; Flynn 1986; McDonald 1981; Neumann 1983).

From this study, Clovis projectile point distribution patterns both in terms of frequency, standard frequency, and ubiquity indicate near equal usage of the High Plains, Prairie Plains, Savannah and the Woodlands. Clovis people utilized multiple environments within the study area as well as throughout other parts of eastern North America (Stanford 1991). The potential and effectiveness of an apparent widespread homogenous occupation may be related to the choice of subsistence strategy. As proposed by Webb and Rindos (1997) subsistence specialization would tether people to a restricted area resulting in an increase in population rather than dispersing a low density of people across the landscape. Webb and Rindos (1997:239) state:

> The less 'efficiently' a population was able to extract energy from its environment, the greater its potential rate of dispersal. Although extractive 'inefficiency' or 'maladaptation' fails to build up dense local populations it is the 'optimally efficient' or 'best adaptation' strategy for colonisation of virgin territory because it spreads people over the landscape rapidly, thinly.

While the ability to exploit many diverse environments may not support the notion of specialization on a single large mammal such as mammoth, this does not exclude 'big-game' procurement from the subsistence strategy. In fact, it would appear that Clovis were mammoth specialists if *only* excavated sites in the study were examined, because all of these sites contain evidence of Clovis associated with mammoth. However, several sites have evidence of bison and other small game (Hester *et al.* 1972; Ferring 1990; E. Johnson 1987). Furthermore, eastern Clovis sites such as Kimmswick in Missouri indicate the use of mastodon. Thus, from the site record it appears that Clovis did procure big game animals. However, it remains unclear whether or not this prey selection indicates a species-specific adaptation or random opportunities and chance encounters. The ubiquitous distribution would support a more oppportunistic/ generalistic strategy as proposed by Meltzer (1988). This may be because

> by opportunistically exploiting herbivores whenever possible, Clovis people appear to have been able to pursue similar hunting strategies in different locations. This had the effect of homogenising inter-regional environmental differences. Opportunistic exploitation whenever possible of a rare, widely-dispersed but high-yield food resource led to an extractive *mode* that maximised human movement over unfamiliar territory (Webb and Rindos 1997:245).

The distribution of Folsom projectile points is consistently highest in the High Plains and the Prairie Plains. The infrequent occurrence of Folsom in the Woodlands by frequency, standard frequency and ubiquity is statistically significant (Table 5.5-5.7). Unlike Clovis, the driving force behind Folsom economy and mobility patterns may be explicitly linked to bison. Hofman's (1995) examination of Southern Plains

Folsom lithic material uililization seems to support this as well. Hofman (1995:12) writes, "It was apparently some other source, most likely bison, which served to focus Folsom activity on the Southern plains. This is suggested because the abundance of Folsom evidence occurs in areas where bison were common but where quality lithics were not." Thus, both projectile point distribution and lithic material use (at least on the High Plains) indicates the Folsom distribution strongly correlated with the range of Pleistocene bison. A species-focused economy for Folsom would support the model proposed by Kelly and Todd (1988).

Bison were a predictable and reliable resource. The movement of bison herds was determined by water availability, forage conditions, and snow cover (Bamforth 1988; Frison 1974). Herd aggregations would occur when forage and water was restricted as well as in severe winters (Bamforth 1988). This would at times serve to encourage movement of herds off the High Plains in particular seasons. Bamforth (1988:52) writes "specific movements by a given herd are often calculated to bring them to areas where they expect to find food and water, with calculation often made by knowledge of the distribution of rainfall and previous grazed areas in a home range." Even though MacDonald (1981) states that *Bison bison antiquus* and *Bison bison occidentalis* were generalized feeders utilizing both grazing and browsing strategies and suited to a Savannah environment their paleontological and archaeological distribution concentrates them in the grassland environment of the High Plains (Kost 1987; Martin 1987; McDonald 1981; Wyckoff and Dalquest 1997) (Figure 6.1). This corresponds well with the distribution of Folsom point occurrences.

While Cody has also been interpreted as High plains bison hunters this study suggests more complexity. The distribution of Cody artifacts indicate a high concentration in the Woodlands both in terms of frequency, standard frequency, and ubiquity . This correlation is not due to chance as supported by Chi-Square analyses (Table 5.5-5.7). While B*ison bison antiquus* may have been present in the Woodlands by Cody times due to early Holocene climatic change (Dillehay 1974; Flynn 1982;

Munson 1990), it was not a substantial component of any known woodland fauna. The theory proposed by L. Johnson (1989) that Cody people were adapted specifically to the High Plains and occasionally visited the Woodland region is not supported. Cody people appear to have been frequent and regular inhabitants of the Woodlands. The question then becomes does the Cody technological complex represent multiple adaptations; one adapted to big game and the other more representative of a 'broad-spectrum' subsistence strategy probably including deer? If so, then does the Cody complex represent two distinct Paleoindian complexes? Frison and Bonnichsen (1996:305) indicate yet another Cody adaptation to the mountain-foothills:

> We argue that past climates affected the many and rapidly changing landforms and environments on the Plains and in the mountains, creating new opportunities for adaptive strategies. Human groups responded to these changing environments by creating mutually exclusive subsistence strategies to best exploit the different economic possibilities. The resulting human adaptive patterns are reflected in the archaeological record as a series of co-traditions.

The variation revealed by Bradley and Frison (1987), Bradley and Stanford (1987), Wheat (1972, 1979), and Knudson's (1983), technological analyses of Alberta, Scottsbluff, Eden, Kersey, and Firstview points *may* support distinct cultural groups included within the Cody technological complex. However, the technological variation may be the result of chronological change, individual craftsmanship, material choice, and reworking and, therefore, only one cultural tradition may be represented (Bradley and Frison 1987). It may be that Scottsbluff, Eden, Firstview, and Kersy "represent various bands within the same cultural complex" (Greiser 1985:70). Or alternatively, perhaps the same group of people seasonally utilized the Woodland as part of a larger annual round. In order to test the above scenarios, it will be necessary to conduct detailed analyses on lithic material use and to examine entire tool assemblages.

If the Woodland Cody complex is separate from the High Plains Cody complex, then more local material would be expected to be utilized with limited frequency of western exotic materials. In either case, tools manufactured from exotic material would be expected to be heavily reworked. Cody Woodland tool kits would be expected to have a higher percentage of woodworking tools that might compare more closely with Dalton complex tool kits (Morse 1971, 1997) rather than Folsom. A High Plains adapted Cody tool assemblage would be expected to be similar to a Folsom tool assemblage and not Dalton. Based on comparisons of Paleoindian tool types from seven Paleoindian complexes at the Hell Gap site in eastern Wyoming and elsewhere including Clovis, Folsom, and Cody, Irwin and Wormington (1970) found that knives are most common in the Cody tool kit. Furthermore, Cody as well as other late Paleoindian complexes contained more specialized tools than either Clovis or Folsom.

These issues raise questions as to the origin of Cody. Did Cody develop in the Woodlands and due to population pressure move onto the High Plains? Or, did Cody spread into the Woodland following bison or other prey species? These questions will require further research including improved chronological control and assemblage studies from both regions.

In summary, this study recognizes distinctive patterns in Clovis, Folsom, and Cody Paleoindian projectile point distributions. The revealed projectile point distributions support the argument that Clovis adaptation may have been independent of geographical region; whereas Folsom was more regionally focused. The distinctive Cody distribution includes a strong link to the Woodland environment.

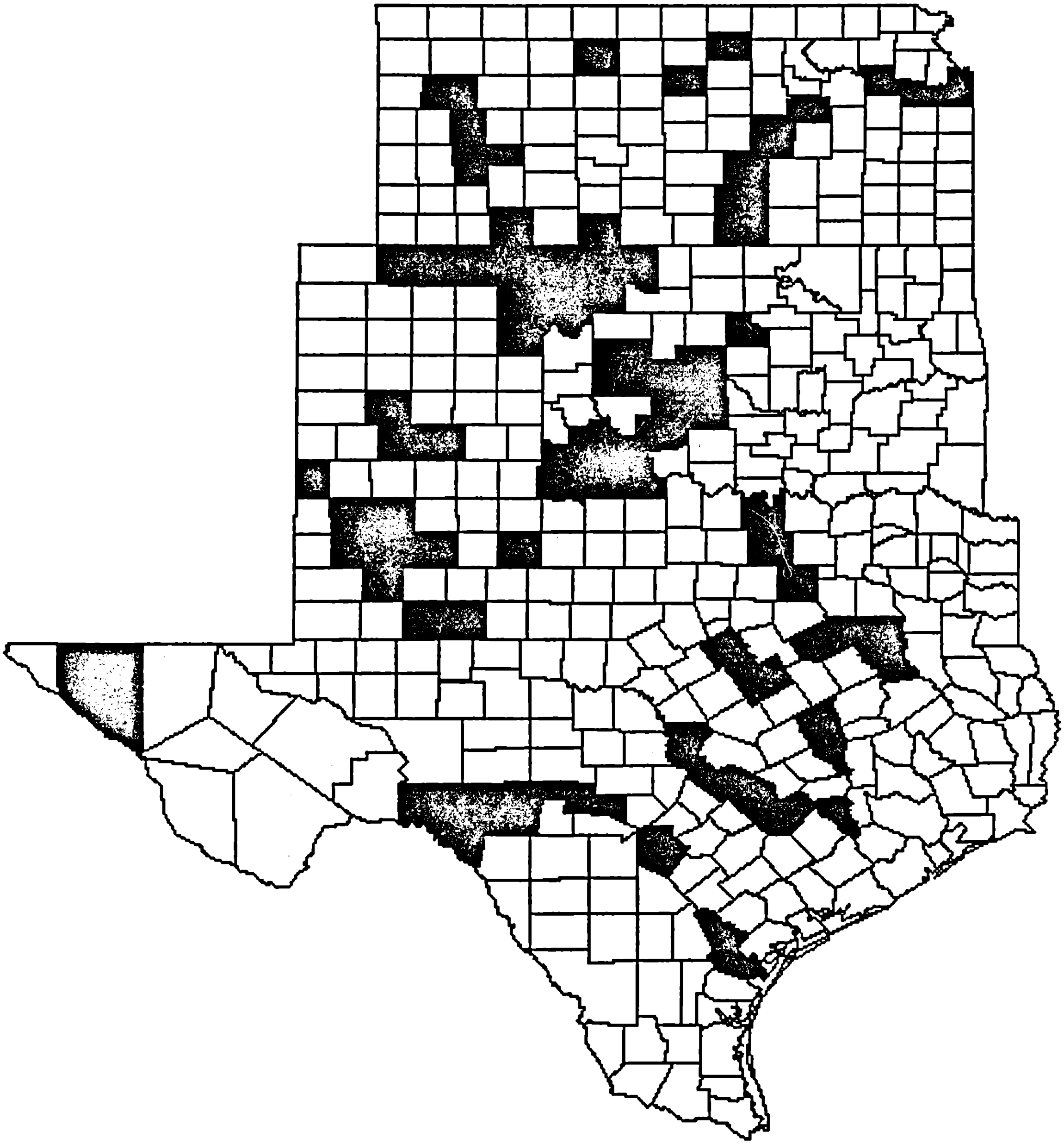


Figure 6.1. Pleistocene Bison Distribution in the Study Area.
(Sources: Kost 1987; McDonald 1981; Martin 1987; Wyckoff and Dalquest 1997)

CHAPTER 7 - CONCLUSION

One of the most important aspects of science is the realistic recognition of our own ignorance, and the pursuit of knowledge in order to reduce that ignorance in areas judged to be germane to our field. Success in this venture is central to the growth of science.

L. Binford 1991:276

After 70 years of research devoted to Paleoindian studies, several alternative models concerning Paleoindian economies, social organization, and mobility pattern have been developed. Answers to such questions remain elusive due in part to the emphasis on site-specific studies. This study provides a regional analysis of Paleoindian land use that complements specific site investigations. This analysis of Clovis, Folsom, and Cody projectile point distributions suggest significant variability existed among Paleoindian groups in terms of land use patterns. Due to the ephemeral nature of the Paleoindian record, the incorporation of isolated or scattered surface finds are critical to accurately reconstruct Paleoindian mobility patterns. Therefore, it is necessary to utilize a nonsite approach to the archaeological record. As most eloquently stated by Dunnell (1992:34) this nonsite view is not a "different interpretation of the discipline's subject matter but a different view of what the subject matter is."

In order to test the findings in this study, several directions for future research can be explored at multiple scales. At a coarse-grained regional scale, studies addressing Paleoindian land use by the distribution of projectile points from the northern Plains, the central Plains, and the southeast need to be conducted and integrated. Within the study area, finer scale locational setting analyses needs to be directed within the High Plains, Prairie Plains, Savannah, and the Woodlands. Each of these regions exhibit high biotic diversity exhibited by microenvironments that need to be analyzed in detail. A primary target would be to systematically survey groups of counties presently lacking any accounts of Paleoindian points. Furthermore, it is critical that individual collections be targeted. The information contained in these collection needs to be studied and documented. Education as to the significance of surface collected information for Paleoindian studies should be directed toward both professional and avocational archaeologists. Reinvestigation of sites and assemblages will also add to regional land use analyses.

Integration of the impact of geomorphic factors in artifact and site distribution and recovery is necessary as well. Geoarchaeological research aimed specifically at predicting where sites would be likely to occur containing Paleoindian age material is of key importance (Mandel 1992). This may be enhanced by the use of Geographical Information Systems (Kvamme 1996) and paleontological data sets (Graham *et al.* 1996). Other fundamental issues to pursue include refinement of the timing and nature of the paleoenvironment, precise dating, typological studies, lithic material source studies (Banks 1990), and lithic studies including breakage patterns and use wear studies to evaluate artifact use.

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Appendix A.
Paleoindian Projectile Point Data

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
KS	Cheyene	1,021	High Plains	1			1
KS	Clark	975	High Plains				0
KS	Decatur	894	High Plains	1	1		2
KS	Edwards	620	High Plains				0
KS	Finney	1,302	High Plains	2	7	2	11
KS	Ford	1,099	High Plains				0
KS	Gove	1,072	High Plains				0
KS	Graham	898	High Plains				0
KS	Grant	575	High Plains	1			1
KS	Gray	868	High Plains				0
KS	Greeley	778	High Plains	1		1	2
KS	Hamilton	998	High Plains		1	2	3
KS	Haskell	578	High Plains				0
KS	Kearney	868	High Plains	8	10	3	21
KS	Kiowa	723	High Plains				0
KS	Lane	717	High Plains	1			1
KS	Logan	1073	High Plains	1			1
KS	Meade	979	High Plains				0
KS	Morton	731	High Plains		1	2	3
KS	Norton	873	High Plains				0
KS	Phillips	887	High Plains				0
KS	Rawlins	1069	High Plains				0
KS	Scott	718	High Plains	1		1	2
KS	Seward	640	High Plains		4		4
KS	Sheridan	896	High Plains				0
KS	Sherman	1,057	High Plains	2	3	2	7
KS	Stanton	681	High Plains	1			1
KS	Stevens	727	High Plains	7		4	11
KS	Thomas	1,075	High Plains				0
KS	Trego	890	High Plains				0
KS	Wallace	914	High Plains	1	1	1	3
KS	Wichita	719	High Plains	1			1
KS	Atchison	431	Prairie/Plains				0
KS	Barber	1,136	Prairie/Plains				0
KS	Barton	895	Prairie/Plains		1		1
KS	Brown	572	Prairie/Plains				0
KS	Butler	1,443	Prairie/Plains				0
KS	Chase	777	Prairie/Plains				0
KS	Chautauqua	644	Prairie/Plains				0
KS	Clay	632	Prairie/Plains	1			1
KS	Cloud	718	Prairie/Plains				0
KS	Comanche	789	Prairie/Plains	1			1
KS	Cowley	1128	Prairie/Plains	1			1
KS	Dickinson	852	Prairie/Plains				0
KS	Doniphan	388	Prairie/Plains	2	3		5
KS	Elk	650	Prairie/Plains				0
KS	Ellis	900	Prairie/Plains				0
KS	Ellsworth	717	Prairie/Plains				0
KS	Geary	377	Prairie/Plains				0
KS	Greenwood	1,135	Prairie/Plains				0
KS	Harper	802	Prairie/Plains				0
KS	Harvey	540	Prairie/Plains				0
KS	Hodgeman	860	Prairie/Plains				0
KS	Jackson	658	Prairie/Plains				0
KS	Jefferson	535	Prairie/Plains		1		1
KS	Jewell	910	Prairie/Plains	3			3
KS	Kingman	865	Prairie/Plains				0

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
KS	Lincoln	720	Prairie/Plains				0
KS	Lyon	844	Prairie/Plains				0
KS	Marion	944	Prairie/Plains				0
KS	Marshall	878	Prairie/Plains	1	2		3
KS	McPherson	900	Prairie/Plains				0
KS	Mitchell	717	Prairie/Plains		1		1
KS	Morris	693	Prairie/Plains				0
KS	Nemaha	719	Prairie/Plains				0
KS	Ness	1,074	Prairie/Plains				0
KS	Osborne	882	Prairie/Plains				0
KS	Ottowa	721	Prairie/Plains				0
KS	Pawnee	755	Prairie/Plains	1			1
KS	Pottowatomie	828	Prairie/Plains	2	3	2	7
KS	Pratt	735	Prairie/Plains				0
KS	Reno	1,259	Prairie/Plains				0
KS	Republic	719	Prairie/Plains	2			2
KS	Rice	728	Prairie/Plains				0
KS	Riley	593	Prairie/Plains	9		4	13
KS	Rooks	888	Prairie/Plains				0
KS	Rush	718	Prairie/Plains				0
KS	Russell	869	Prairie/Plains				0
KS	Saline	721	Prairie/Plains				0
KS	Sedgewick	1,007	Prairie/Plains				0
KS	Shawnee	549	Prairie/Plains			2	2
KS	Smith	897	Prairie/Plains				0
KS	Stafford	788	Prairie/Plains				0
KS	Sumner	1,183	Prairie/Plains				0
KS	Wabaunsee	797	Prairie/Plains	1			1
KS	Washington	898	Prairie/Plains				0
KS	Allen	505	Savannah				0
KS	Anderson	584	Savannah				0
KS	Bourbon	638	Savannah				0
KS	Coffey	615	Savannah				0
KS	Douglas	461	Savannah	1			1
KS	Franklin	577	Savannah				0
KS	Johnson	478	Savannah	5			5
KS	Labette	653	Savannah				0
KS	Leavenworth	463	Savannah		2		2
KS	Linn	601	Savannah				0
KS	Miami	590	Savannah				0
KS	Montgomery	646	Savannah				0
KS	Neosho	576	Savannah			1	1
KS	Osage	695	Savannah				0
KS	Wilson	575	Savannah				0
KS	Woodson	498	Savannah				0
KS	Wyandotte	149	Savannah	3		8	11
KS	Cherokee	590	Eastern Woodlands	1			1
KS	Crawford	595	Eastern Woodlands				0
OK	Beaver	1,808	High Plains	3			3
OK	Cimarron	1,842	High Plains	18	10	4	32
OK	Ellis	1,232	High Plains		2		2
OK	Harper	1,039	High Plains		37		37
OK	Roger Mills	1,146	High Plains	1	5	1	7
OK	Texas	2,040	High Plains	12	6	7	25
OK	Woodward	1,242	High Plains				0
OK	Alfalfa	864	Prairie/Plains				0
OK	Beckham	904	Prairie/Plains		2		2

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
OK	Blaine	920	Prairie/Plains	2	5	8	15
OK	Caddo	1,286	Prairie/Plains	16	25	17	58
OK	Canadian	901	Prairie/Plains				0
OK	Cleveland	529	Prairie/Plains				0
OK	Comanche	1,076	Prairie/Plains		3		3
OK	Cotton	656	Prairie/Plains		1		1
OK	Custer	981	Prairie/Plains	1	4	1	6
OK	Dewey	1,007	Prairie/Plains	1	2	1	4
OK	Garfield	1,060	Prairie/Plains				0
OK	Grady	1,106	Prairie/Plains	1	8		9
OK	Grant	1,004	Prairie/Plains				0
OK	Greer	638	Prairie/Plains	4	5		9
OK	Harmon	537	Prairie/Plains	4			4
OK	Jackson	817	Prairie/Plains	2	5		7
OK	Jefferson	769	Prairie/Plains		3		3
OK	Kay	921	Prairie/Plains		2	3	5
OK	Kingfisher	906	Prairie/Plains	1	5		6
OK	Kiowa	1,019	Prairie/Plains	1	1		2
OK	Lincoln	964	Prairie/Plains		1		1
OK	Logan	748	Prairie/Plains		3		3
OK	Major	958	Prairie/Plains				0
OK	McClain	582	Prairie/Plains		1	1	2
OK	Noble	736	Prairie/Plains				0
OK	Oklahoma	708	Prairie/Plains		1		1
OK	Payne	691	Prairie/Plains				0
OK	Stephens	884	Prairie/Plains		1		1
OK	Tillman	904	Prairie/Plains	2	4		6
OK	Washita	1,006	Prairie/Plains	4	52	18	74
OK	Woods	1,291	Prairie/Plains		3		3
OK	Atoka	980	Savannah		1	1	2
OK	Bryan	902	Savannah	3		1	4
OK	Carter	828	Savannah			1	1
OK	Choctaw	762	Savannah				0
OK	Coal	520	Savannah				0
OK	Craig	763	Savannah				0
OK	Creek	930	Savannah				0
OK	Garvin	813	Savannah		2		2
OK	Haskell	570	Savannah	3	1	9	13
OK	Hughes	806	Savannah	1			1
OK	Johnston	639	Savannah				0
OK	Latimer	728	Savannah				0
OK	Love	519	Savannah			2	2
OK	Marshall	372	Savannah	5	5	2	12
OK	McIntosh	599	Savannah			6	6
OK	Murray	420	Savannah			1	1
OK	Muskogee	815	Savannah				0
OK	Nowata	540	Savannah				0
OK	Okfuskee	628	Savannah				0
OK	Okmulgee	698	Savannah				0
OK	Osage	2,265	Savannah	3	1	7	11
OK	Pawnee	551	Savannah				0
OK	Pittsburgh	1,251	Savannah				0
OK	Pontotoc	717	Savannah				0
OK	Pottowatomie	783	Savannah				0
OK	Rogers	683	Savannah				0
OK	Seminole	639	Savannah		1		1
OK	Tulsa	572	Savannah	10	2	8	20

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
OK	Wagoner	559	Savannah				0
OK	Washington	423	Savannah				0
OK	Adair	577	Eastern Woodlands	1			1
OK	Cherokee	748	Eastern Woodlands				0
OK	Delawart	720	Eastern Woodlands				0
OK	Leflore	1,585	Eastern Woodlands	1			1
OK	Mayes	644	Eastern Woodlands				0
OK	McCurtain	1,826	Eastern Woodlands			1	1
OK	Ottawa	465	Eastern Woodlands				0
OK	Pushmatahoe	1,417	Eastern Woodlands				0
OK	Sequoyah	678	Eastern Woodlands	1			1
TX	Andrews	1,501	High Plains	3	7		10
TX	Bailey	826	High Plains	1			1
TX	Carson	924	High Plains				0
TX	Castro	899	High Plains				0
TX	Cochran	775	High Plains				0
TX	Dallam	1,505	High Plains	3	2		5
TX	Dawson	903	High Plains	6		2	8
TX	Deaf Smith	1,497	High Plains	1			1
TX	Ector	903	High Plains				0
TX	Gaines	1,504	High Plains	23	43	45	111
TX	Hale	1,005	High Plains				0
TX	Hansford	921	High Plains				0
TX	Hartley	1,462	High Plains	1	9		10
TX	Hemphill	903	High Plains				0
TX	Hockley	908	High Plains	2	1		3
TX	Hutchinson	872	High Plains				0
TX	Lamb	1,013	High Plains				0
TX	Lipscomb	933	High Plains	1	30		31
TX	Lubbock	900	High Plains	2	9	5	16
TX	Lynn	888	High Plains				0
TX	Martin	914	High Plains	2	1		3
TX	Midland	902	High Plains	5	9		14
TX	Moore	905	High Plains	6			6
TX	Ochiltree	919	High Plains				0
TX	Odlham	1,485	High Plains	2			2
TX	Parmer	885	High Plains				0
TX	Potter	902	High Plains	3			3
TX	Randall	917	High Plains		1		1
TX	Roberts	1187	High Plains	3	1		4
TX	Sherman	923	High Plains				0
TX	Swisher	902	High Plains	1			1
TX	Terry	887	High Plains	4	1		5
TX	Yoakum	800	High Plains	2	12		14
TX	Aransas	280	Prairie/Plains				0
TX	Archer	907	Prairie/Plains				0
TX	Armstrong	909	Prairie/Plains	1	2		3
TX	Austin	656	Prairie/Plains				0
TX	Baylor	862	Prairie/Plains				0
TX	Bee	880	Prairie/Plains	1		1	2
TX	Bell	1,055	Prairie/Plains	3			3
TX	Borden	900	Prairie/Plains	1			1
TX	Bosque	989	Prairie/Plains	1	3	3	7
TX	Brazoria	1,407	Prairie/Plains	1			1
TX	Brewster	6,169	Prairie/Plains	3			3
TX	Briscoe	887	Prairie/Plains	8	23	2	33
TX	Calhoun	540	Prairie/Plains	3			3

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
TX	Callahan	899	Prairie/Plains	1			1
TX	Chambers	616	Prairie/Plains				0
TX	Childress	707	Prairie/Plains				0
TX	Clay	1,086	Prairie/Plains		2		2
TX	Coke	908	Prairie/Plains	4	2		6
TX	Collin	851	Prairie/Plains				0
TX	Collingsworth	909	Prairie/Plains				0
TX	Colorado	965	Prairie/Plains			2	2
TX	Comal	555	Prairie/Plains	1			1
TX	Cooke	893	Prairie/Plains	1	2		3
TX	Coryell	1,057	Prairie/Plains	4			4
TX	Cottle	895	Prairie/Plains				0
TX	Crane	782	Prairie/Plains		4		4
TX	Crockett	2,806	Prairie/Plains				0
TX	Crosby	899	Prairie/Plains	12	17		29
TX	Culberson	3,815	Prairie/Plains		100	1	101
TX	Dallas	880	Prairie/Plains	6	1	3	10
TX	De Witt	910	Prairie/Plains	1		1	2
TX	Dickens	907	Prairie/Plains				0
TX	Donley	929	Prairie/Plains	1			1
TX	Ellis	939	Prairie/Plains	3			3
TX	El Paso	1,014	Prairie/Plains	1	1	1	3
TX	Fannin	895	Prairie/Plains				0
TX	Fisher	897	Prairie/Plains		26		26
TX	Floyd	992	Prairie/Plains	1			1
TX	Foard	703	Prairie/Plains	1		1	2
TX	Fort Bend	876	Prairie/Plains				0
TX	Galveston	399	Prairie/Plains	1			1
TX	Garza	895	Prairie/Plains	1			1
TX	Glasscock	900	Prairie/Plains				0
TX	Goliad	859	Prairie/Plains				0
TX	Gray	921	Prairie/Plains	2			2
TX	Grayson	934	Prairie/Plains	1		1	2
TX	Grimes	799	Prairie/Plains				0
TX	Hall	877	Prairie/Plains	1			1
TX	Hardeman	688	Prairie/Plains				0
TX	Harris	1,734	Prairie/Plains	6	1	7	14
TX	Haskell	901	Prairie/Plains				0
TX	Hays	678	Prairie/Plains	5			5
TX	Hill	968	Prairie/Plains	6			6
TX	Hood	425	Prairie/Plains	1		2	3
TX	Howard	901	Prairie/Plains	4	3		7
TX	Hudspeth	4,567	Prairie/Plains				0
TX	Jackson	844	Prairie/Plains				0
TX	Jeff Davis	2,257	Prairie/Plains				0
TX	Jefferson	937	Prairie/Plains	70	1	13	84
TX	Johnson	730	Prairie/Plains	2			2
TX	Jones	931	Prairie/Plains	1	2		3
TX	Kent	878	Prairie/Plains				0
TX	King	914	Prairie/Plains				0
TX	Knox	845	Prairie/Plains				0
TX	Lavaca	971	Prairie/Plains				0
TX	Loving	670	Prairie/Plains				0
TX	Matagorda	1,127	Prairie/Plains				0
TX	McLennan	1,031	Prairie/Plains	3			3
TX	Mitchell	912	Prairie/Plains		1		1
TX	Motley	959	Prairie/Plains				0

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
TX	Nolan	915	Prairie/Plains	2			2
TX	Nueces	847	Prairie/Plains		3	1	4
TX	Pecos	4,777	Prairie/Plains	1			1
TX	Presidio	3,857	Prairie/Plains				0
TX	Reagan	1,173	Prairie/Plains				0
TX	Reeves	2,626	Prairie/Plains				0
TX	Refugio	771	Prairie/Plains				0
TX	Rockwall	128	Prairie/Plains				0
TX	Runnels	1,056	Prairie/Plains	3	4		7
TX	San Patricio	693	Prairie/Plains	2	1	1	4
TX	Scurry	900	Prairie/Plains				0
TX	Shackelford	915	Prairie/Plains	1			1
TX	Somervell	188	Prairie/Plains				0
TX	Sterling	923	Prairie/Plains				0
TX	Stonewall	925	Prairie/Plains				0
TX	Tarrant	868	Prairie/Plains				0
TX	Taylor	917	Prairie/Plains	6	16		22
TX	Terrell	2,357	Prairie/Plains				0
TX	Throckmorton	912	Prairie/Plains				0
TX	Travis	989	Prairie/Plains	4		1	5
TX	Upton	1,243	Prairie/Plains				0
TX	Val Verde	3,150	Prairie/Plains	1	2		3
TX	Victoria	887	Prairie/Plains	1		6	7
TX	Waller	514	Prairie/Plains				0
TX	Ward	836	Prairie/Plains	3	3		6
TX	Washington	610	Prairie/Plains				0
TX	Wharton	1,086	Prairie/Plains		1	1	2
TX	Wheeler	904	Prairie/Plains				0
TX	Wichita	606	Prairie/Plains				0
TX	Wilbarger	947	Prairie/Plains				0
TX	Williamson	1,137	Prairie/Plains	2	1	5	8
TX	Winkler	840	Prairie/Plains	2	31		33
TX	Young	919	Prairie/Plains				
TX	Anderson	1,077	Savannah	1	2	2	5
TX	Atascosa	1,218	Savannah	8	7		15
TX	Bandera	793	Savannah	1			1
TX	Bastrop	895	Savannah				0
TX	Bexar	1,248	Savannah	3	10	4	17
TX	Blanco	714	Savannah	1	2		3
TX	Brazos	589	Savannah	2			2
TX	Brooks	942	Savannah				0
TX	Brown	936	Savannah	5	2		7
TX	Burleson	669	Savannah				0
TX	Burnet	994	Savannah	1			1
TX	Caldwell	546	Savannah				0
TX	Cameron	906	Savannah	1			1
TX	Coleman	1,277	Savannah				0
TX	Comanche	930	Savannah	7	2		9
TX	Concho	992	Savannah	1			1
TX	Delta	278	Savannah		1		1
TX	Denton	911	Savannah	4		1	5
TX	Dimmit	1,307	Savannah	6	10		16
TX	Duval	1,795	Savannah	1			1
TX	Eastland	924	Savannah				0
TX	Edwards	2,121	Savannah				0
TX	Erath	1,080	Savannah	5			5
TX	Falls	770	Savannah	2			2

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
TX	Fayette	950	Savannah	3			3
TX	Freestone	888	Savannah				0
TX	Frio	1,133	Savannah		2		2
TX	Gillespie	1,061	Savannah				0
TX	Gonzales	1,068	Savannah	1	3		4
TX	Guadalupe	713	Savannah				0
TX	Hamilton	836	Savannah	3			3
TX	Henderson	888	Savannah	4	3	2	9
TX	Hidalgo	1,569	Savannah		1		1
TX	Hopkins	789	Savannah				0
TX	Hunt	840	Savannah	1	1	4	6
TX	Irion	1,052	Savannah				0
TX	Jack	920	Savannah				0
TX	Jim Hogg	1,136	Savannah				0
TX	Jim Wells	867	Savannah				0
TX	Karnes	753	Savannah		1		1
TX	Kaufman	788	Savannah	1	1	1	3
TX	Kendall	663	Savannah	3			3
TX	Kennedy	1,389	Savannah				0
TX	Kerr	1,107	Savannah	2			2
TX	Kimble	1,250	Savannah	1			1
TX	Kinney	1,359	Savannah				0
TX	Kleberg	853	Savannah				0
TX	La Salle	1,517	Savannah				0
TX	Lampasas	714	Savannah	1	1	2	4
TX	Lamar	919	Savannah	4	1	2	7
TX	Lee	631	Savannah				0
TX	Leon	1,079	Savannah				0
TX	Limestone	930	Savannah		2		2
TX	Live Oak	1,057	Savannah	1	3	1	5
TX	Llano	939	Savannah				0
TX	Madison	472	Savannah				0
TX	Mason	1,127	Savannah				0
TX	Maverick	1,287	Savannah		2		2
TX	McCulloch	1,071	Savannah				0
TX	McMullen	1,163	Savannah	3	4		7
TX	Medina	1,331	Savannah	3			3
TX	Menard	902	Savannah				0
TX	Milam	1,019	Savannah	1			1
TX	Mills	748	Savannah	1			1
TX	Montaque	928	Savannah	1	4		5
TX	Navarro	1,068	Savannah	3	1	1	5
TX	Palo Pinto	949	Savannah			3	3
TX	Parker	902	Savannah	1			1
TX	Rains	243	Savannah				0
TX	Real	697	Savannah				0
TX	Robertson	864	Savannah	1		1	2
TX	San Saba	1,136	Savannah	1			1
TX	Schleicher	1,309	Savannah	2			2
TX	Starr	1,226	Savannah	1	6	1	8
TX	Stephens	894	Savannah				0
TX	Sutton	1,455	Savannah				0
TX	Tom Green	1,515	Savannah	1			1
TX	Uvalde	1,564	Savannah	7	6		13
TX	Van Zandt	855	Savannah	2			2
TX	Webb	3,362	Savannah	1	1		2
TX	Willacy	589	Savannah				0

STATE	COUNTY	AREA (mi^2)	REGION	CLOVIS	FOLSOM	CODY	TOTAL
TX	Wilson	807	Savannah	1	1		2
TX	Wise	902	Savannah	1			1
TX	Zapata	999	Savannah		4		4
TX	Zavala	1,298	Savannah	2	1	1	4
TX	Angelina	807	Eastern Woodlands	7		3	10
TX	Bowie	891	Eastern Woodlands	1			1
TX	Camp	203	Eastern Woodlands	1	1		2
TX	Cass	937	Eastern Woodlands	1		18	19
TX	Cherokee	1,052	Eastern Woodlands	1	1	1	3
TX	Franklin	294	Eastern Woodlands				0
TX	Gregg	273	Eastern Woodlands		1	4	5
TX	Hardin	898	Eastern Woodlands				0
TX	Harrison	908	Eastern Woodlands	6		4	10
TX	Houston	1,234	Eastern Woodlands				0
TX	Jasper	921	Eastern Woodlands	2		2	4
TX	Liberty	1,174	Eastern Woodlands				0
TX	Marion	385	Eastern Woodlands	4		11	15
TX	Montgomery	1,047	Eastern Woodlands	4			4
TX	Morris	256	Eastern Woodlands				0
TX	Nacogdoches	939	Eastern Woodlands				0
TX	Newton	935	Eastern Woodlands				0
TX	Orange	362	Eastern Woodlands				0
TX	Panola	812	Eastern Woodlands	1			1
TX	Polk	1,061	Eastern Woodlands	1			1
TX	Red River	1,054	Eastern Woodlands	1		1	2
TX	Rusk	932	Eastern Woodlands		1		1
TX	Sabine	486	Eastern Woodlands				0
TX	San Augustine	524	Eastern Woodlands	2		2	4
TX	San Jacinto	572	Eastern Woodlands			1	1
TX	Shelby	791	Eastern Woodlands				0
TX	Smith	932	Eastern Woodlands				0
TX	Titus	412	Eastern Woodlands	2	1	6	9
TX	Trinity	692	Eastern Woodlands				0
TX	Tyler	922	Eastern Woodlands	1			1
TX	Upshur	587	Eastern Woodlands			1	1
TX	Walker	786	Eastern Woodlands				0
TX	Wood	689	Eastern Woodlands	2		5	7
				570	720	325	1615

Appendix B.

Map of the Counties in the Study Area.

(From: Rand McNally. County Outline Map of United States.)