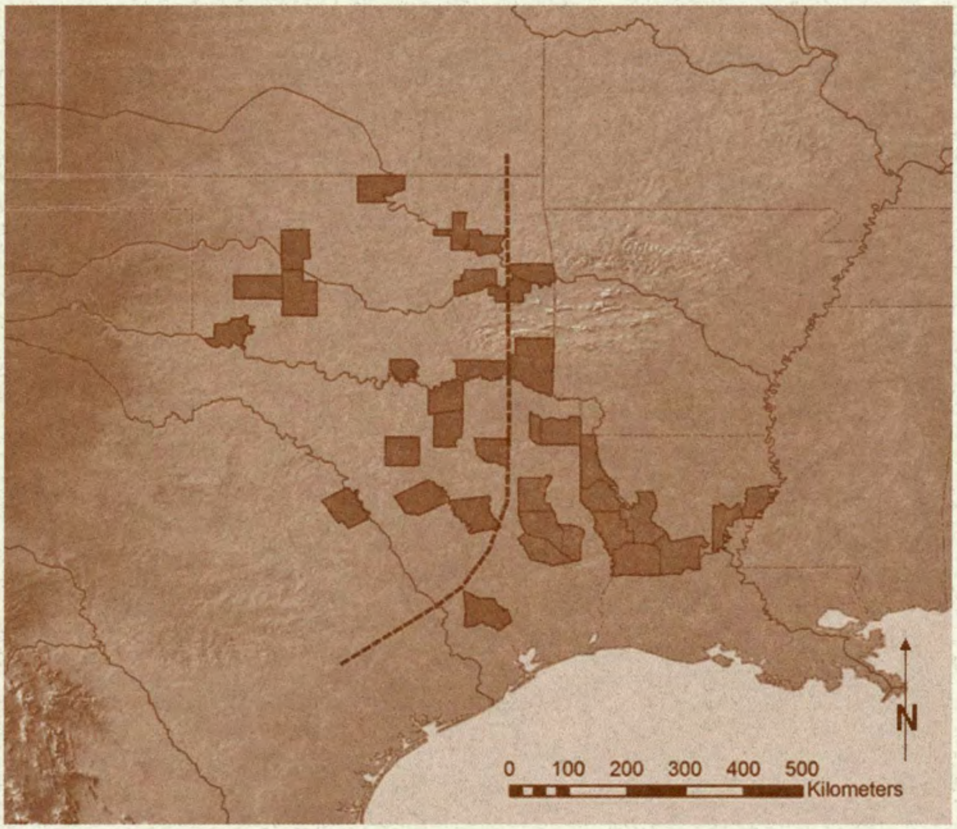
San Patrice Technology and Mobility across the Plains-Woodland Border

Thomas A. Jennings



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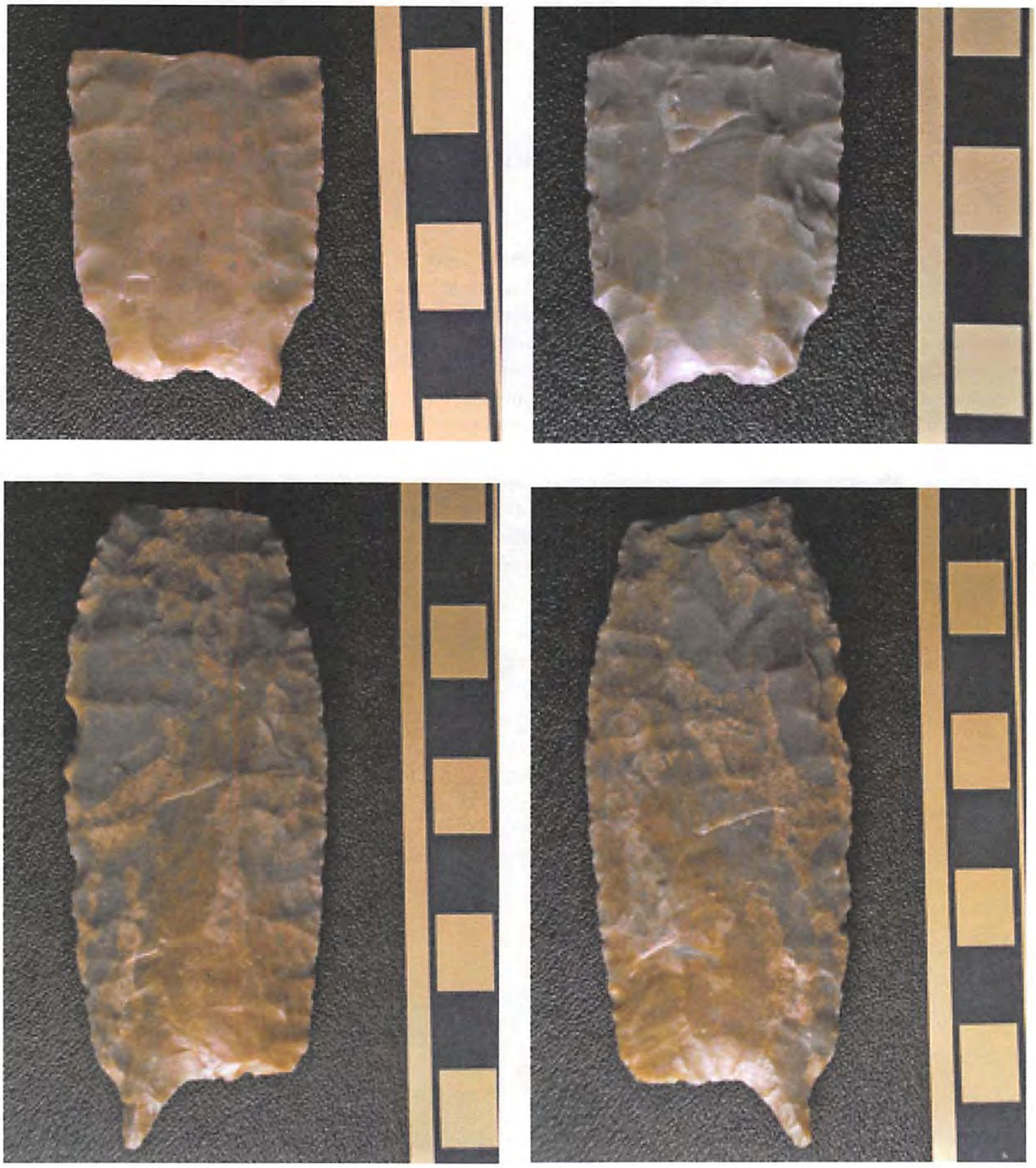
Abstract

The Pleistocene-Holocene transition was a period of severe climatic change throughout North America. Responding to increasing temperature, decreasing effective moisture, and increasing seasonality, floral and faunal communities dramatically reorganized as individual species settled into their modern niches. Grasslands expanded on the Plains and southern pines came to dominate Southeastern forests. Coincident with this environmental restructuring, numerous regionally specific projectile point styles emerged on the Plains and in the Southeast. This study examines one such projectile point style, the San Patrice point. The style includes both lanceolate and notched varieties. Because the "heartland" has long been thought to lie in Louisiana and eastern Texas, previous researchers have associated San Patrice points with woodland adapted hunter-gatherers. However, in recent years, more and more San Patrice points have been found on the Southern Plains. My study investigates San Patrice point distributions and how they occur along the plains-woodland border of some 10,000 years ago. Projectile point distributions and raw material sourcing support the conclusion that San Patrice groups did maintain a significant presence on the Plains. Moreover, they adopted Plains-oriented adaptive strategies, including increased mobility, which differ from the strategies employed by San Patrice groups living in the nearby woodlands.



Frontspiece

Although not available at the time of Tom Jennings' compilation reported herein, these two finds exemplify some of the intrigue with the stone working technology associated with San Patrice points. Both are of Edwards chert from central Texas, and both were found in eastern Washita County of southwestern Oklahoma. The top specimen is 4.1 cm long, 2.86 cm in maximum width, and 0.66 cm in maximum thickness; the flute length on the left face is 3.6 cm, whereas the flute length on the right face is 2.95 cm; the blade was broken in bending. The bottom specimen is 8.1 cm long, 3.1 cm in maximum width, and 0.73 cm in maximum thickness. The flute length on the left face is 3.7 cm, whereas that on the right face is 3.38 cm long. The tip was broken in bending. The scales are in centimeter increments. Mr. and Mrs. Ricky Shuermann are thanked for sharing these finds.

Preface

Number 12 in the Memoir Series of the Oklahoma Anthropological Society consists of Tom Jennings' Masters thesis which he completed at the University of Oklahoma in 2006. Publishing this thesis was based on several reasons, not the least of which was Tom's reliance on many OAS members who provided information on San Patrice points in their collections. This study does rely on surface finds from Oklahoma as well as Texas and Louisiana. Surface finds are an important source of information about the distribution of all kinds of artifacts, especially if the collector has reliably recorded where the artifact was found. Clearly, as this monograph attests, responsible collecting can yield notable results.

Tom came to Lee Bement and me in 2005 seeking advice about a topic for his thesis. For years, I have been appalled at the lack of interest in San Patrice points. First found in Louisiana and reported by avocationalist Dr. Clarence H. Webb (Webb et al. 1971), these distinctive points manifest attributes that implicated they were affiliated with Paleoindians, but at what time was uncertain. Since Dr. Webb's study of the John Pierce site's materials, spearpoints attributed to San Patrice have been reported sporadically in central Texas (Horn Shelter; Redder 1985) and the Texas panhandle (Rex Rodgers; Willey et al. 1978). Also, a significant number of such points, and associated artifacts, were recovered at Fort Polk, Louisiana (Anderson and Smith 2003). However, it was the Big Eddy site in Missouri that reinvigorated Oklahoma interest in these distinctive artifacts. Located in southwestern Missouri, Big Eddy comprises one of the most important sites studied in the last 20 yeaars for information on early Holocene environments and human adaptations (Lopinot et al. 2000). The lowest levels at Big Eddy yielded artifacts attributable to Dalton, which is not a big surprise given the several Ozark border sites where Dalton materials comprise the earliest occupations at those settings. But the significant find at Big Eddy was a series of San Patrice points, preforms, and bifaces for making them, all of which seem to be in the same deposit as the Dalton materials. A radiocarbon date on that deposit implicates an age of around 10,100 years ago, our first reasonabel chronology for San Patrice.

So, Tom's inquiry about a Paleoindian thesis topic came at a propitious moment. New insight on a wide distribution, and chronology, for San Patrice was emerging, and I remembered many Oklahoma Anthropological Society members who had San Patrice points needing documentation, compilation, and synthesizing. Tom took this potential project to heart, worked out some realistic questions that could be answered by surface and excavated finds, which mostly are projectile points, and began contacting collectors and museum collection managers in Louisiana, Texas, and Oklahoma. He has synthesized his findings in a way that furthers our understanding of hunter-gatherer groups during the early part of the Pleistocene-Holocene transition, but he has raised questions that can only be addressed as we gain more information on the climatic and ecological changes and the human adaptations during that transition.

Because many OAS members helped him, a special effort was made to illustrate San Patrice points from these individuals' collections. Given the diverse materials being utilized by San Patrice makers, and given the important maps prepared by Tom, it was deemed important to utilize color illustrations throughout this monograph. It raises the cost modestly, but conveys much about the making and use of these often underappreciated artifacts.

Finally, although unavailable to Tom at the time he was compiling the basic information contained herein, two broken points from Washita County, Oklahoma, raise the intriguing question about technological ties between San Patrice and the somewhat earlier Folsom culture manifest on the Southern Plains. The points from Cedar Creek (Frontspiece) are well fluted but have the distinctive constricted stems of one variety of San Patrice. Until such points are found in a good context with other parts of the material culture and are radiocarbon dated, we can only speculate on the meaning of these technological similarities. But that, after all, is part of the fun of doing archaeology.

Don G. Wyckoff
Editor: O.A.S. Memoir Series

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Acknowledgments

This study would not have been possible without the help of a number of people. Don Wyckoff introduced me to the topic, provided direction, and kept me company as I traveled across Oklahoma, Louisiana, and Texas. Lee Bement and Tom Pluckhahn guided me through this research. Bob Brooks, Marjy Duncan, Stance Hurst, and Alan Skinner also provided much needed advice. Pete Gregory and Jeff Girard (NSU) and Neal Lopinot and Jack Ray (Southwest Missouri State University) helped shape my understanding of San Patrice. Linda Jennings helped with the statistical analyses.

This research was supported by the University of Oklahoma Anthropology Department, the Sam Noble Oklahoma Museum of Natural History (SNOMNH), the Texas Archeological Research Laboratory (TARL), the Fort Polk CRM branch, the Fort Worth District of the Corps of Engineers, and Northwestern State University (NSU).

I extend sincere thanks to the many avocational archaeologists who opened up their homes and collections to me: Keith Bean, Jim Cox, Dean Gamel, Vera McKellips, Terrell Nowka, Billy Ross, Lewis Smith, Lindel Thomasen, Mike Waller, Bill Young, and Lawrence and Gene LeVick. Without your contributions, this study would have been virtually "pointless".

Finally, I thank my friends and family.

Chapter 1
Introduction

This thesis explores San Patrice adaptations across the plains-woodland border. Recognized as early as 1954 and 1958 (Fig. 1; Suhm et al. 1954; Bell 1958), San Patrice is a poorly understood and understudied Late Paleoindian projectile point style in use from approximately 10,400 to 9,000 B.P. (Lopinot et al. 2000). The present study contributes to our understanding of how these early hunter-gatherers adapted to the conditions of the Early Holocene.

The highest densities of San Patrice points and sites are found in what Story (1990) has termed the "heartland" of eastern Texas and Louisiana, but the San Patrice distribution spreads from Texas and Oklahoma in the west to Mississippi in the east and from Louisiana in the south to Missouri in the north (Gilberti 1995; Ray et al. 1998; Story 1990). The San Patrice style is one of many to emerge following the end of the last ice age, and it shares similarities with the closely related Dalton style, found north and east of the San Patrice region (Anderson and Smith 2003). These new point styles are thought to reflect regionally specific adaptations of hunter-gatherers settling in to Early Holocene environments (Meltzer 2002).

With a few exceptions (Johnson 1989; Story 1990), the majority of San Patrice research has focused on a site-specific scale. These early investigations laid the foundation for the present study which represents a significant departure from single site excavations by exploring San Patrice through a regional perspective. A sample of 198 San Patrice points, from numerous counties in Oklahoma, Texas, and Louisiana, is analyzed, and research focuses on the technological transition from lanceolate to notched projectile point hafting and adaptations across the plains-woodland border.

Before comparisons across the plains-woodland border can be made, we must know where this ecotone was located 10,000 years ago. Chapter 2 summarizes the current understanding of Early Holocene environments within the study area. Dramatic environmental changes, in the form of gradually increasing temperature, decreasing effective moisture, and increasing seasonality, occurred following the last ice age (Bryant and Holloway 1985; Toomey et al. 1993). Responding to the shifting climate, wide scale biological reorganizations proceeded time transgressively as individual species reacted according to individual tolerance limits (Graham and Lundelius 1984). Numerous species became extinct throughout North America, and many more moved north in search of cooler climates.

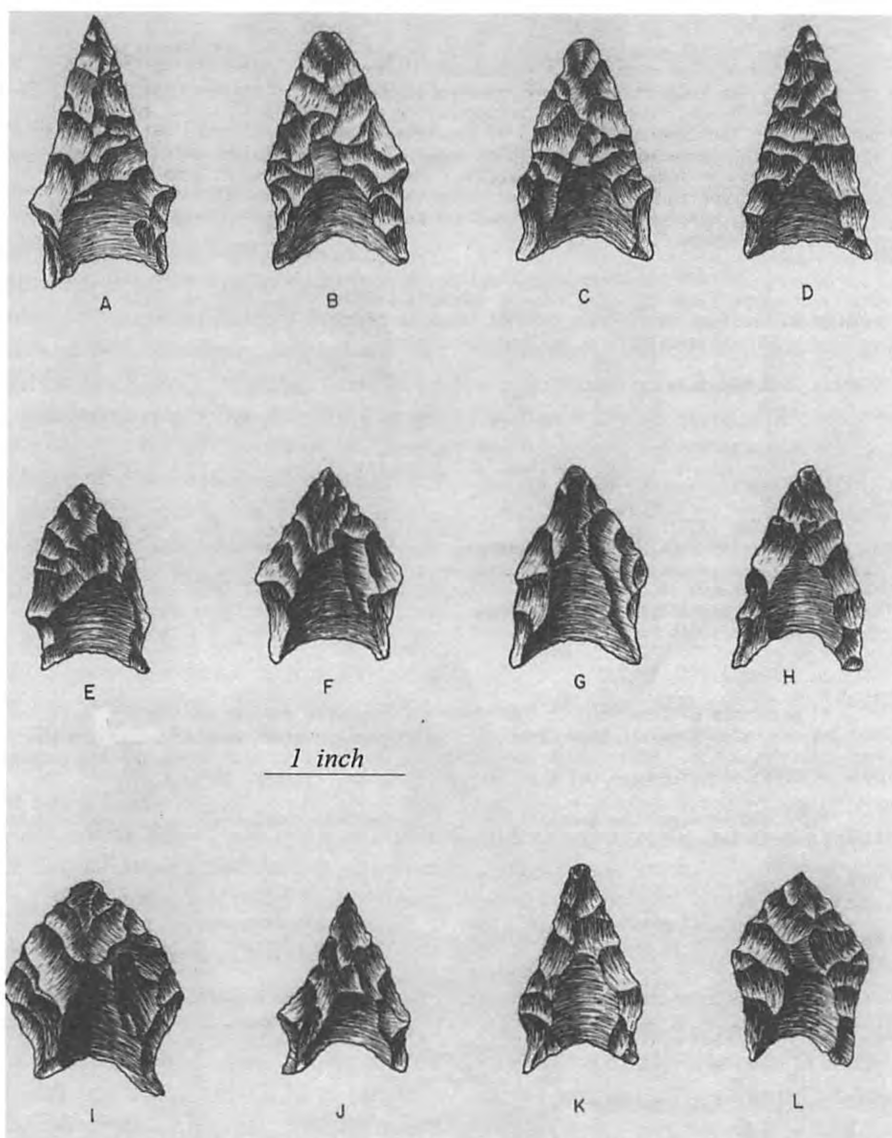
In the study area, grasslands came to dominate the Southern Plains, and they pushed east of their present location during the Early Holocene (Bryant and Holloway 1985). To the east, spruce and oak dominated forests of the Coastal Plain gave way to encroaching southern pines (Webb et al. 2004). Pleistocene megafauna, such as mammoths on the plains and mastodons in the woodlands, became extinct and were replaced by modern fauna (Graham and Lundelius 1984).

These environmental changes must have significantly impacted early hunter-gatherer adaptive strategies, and Chapter 3 discusses ethnographic research conducted among modern foraging societies and how the archaeological record offers insights into prehistoric adaptations. Unfortunately, archaeologists cannot directly observe the prehistoric peoples they study. However, the ethnographic record, through analogy, can provide a starting point for interpreting past behavior. Substantial diversity exists among modern hunter-gatherer culture and adaptations (Kelly 1995). Comparative analysis reveals a correlation between the environment and adaptive strategies (Binford 1980; Kelly 1995). Specifically, mobility varies with primary biomass (Kelly 1995). Modern foragers living in areas of high primary biomass move frequently, but travel short distances. Groups occupying regions with low primary biomass move less frequently, but travel greater distances. Applying this trend to the present study, if San Patrice populations occupied both the plains and woodland environments, plains groups should have adopted strategies involving long-distance mobility, particularly in the Plains where biomass was lower.

The stone tools and debris from their manufacture preserved in the archaeological record yield clues to prehistoric adaptations. Subsistence and mobility strategies are revealed in the organization of lithic technology, which includes projectile point style and hafting technique (Nelson 1991). Raw material sourcing and projectile point distributions provide a history of the places foraging bands visited on the landscape as well as the distances they traveled (Binford 1979; Goodyear 1989).

Chapter 4 describes previous research into the San Patrice projectile point style. Although the "heartland" has yet to provide any radiocarbon dates due to the poor preservation of organics, peripheral sites, namely Big Eddy (Lopinot et al. 2000), place San Patrice points in early hunter-gatherer hands from approximately 10,400 to 9,000

Figure 1. Location and San Patrice examples provided by C.H. Webb in a 1958 description of the type (Bell 1958:84-85).



years ago. Two Late Paleoindian point varieties have been defined, the lanceolate Hope and the notched St. Johns, and the two are at least partially contemporaneous (Lopinot et al. 2000). Some describe the San Patrice projectile technological trend as gradually decreasing haft area beginning with lanceolate forms and culminating with notched forms. Finally, technological organization indicates San Patrice groups were relatively mobile (Anderson and Smith 2003), but little is known regarding the distances they routinely traveled.

The current study, outlined in Chapter 5, addresses, among other factors, two primary aspects of San Patrice adaptations. First, cluster analysis examines the transition from lanceolate to notched hafting technologies. Second, projectile point distributions and raw material sourcing enable investigation of mobility strategies. Both lines of inquiry compare and contrast sub-samples of projectile points from the woodlands with those from the plains with the hope of identifying environmentally-specific adaptive strategies.

With the theoretical and methodological canvass tightened, Chapter 6 begins painting a refined picture of San Patrice adaptations along the plains-woodland border. Hope variety points differ distinctly from St. Johns points, indicating the transition from lanceolate to notched hafting was an abrupt technological shift, but no clear differences exist in projectile point distributions across the plains-woodland border. San Patrice foragers in both environments made extensive use of locally available stone tool sources, although raw material sourcing reveals San Patrice groups living on the plains employed strategies involving long distance mobility. However, a few projectile points from the woodlands are manufactured on raw materials from distant sources.

The final chapter places the results from the current study into perspective with previous San Patrice research. While others postulate projectile point notching developed due to changes in spearthrower technology (Morse et al. 1996), an alternative explanation involving the increasing use of San Patrice points as knives is offered. In addition, although some characterize San Patrice as a woodland-associated projectile point (Ensor 1986), San Patrice groups clearly made significant use of plains resources. Finally, plains and woodlands foragers developed markedly different mobility strategies, and a model of these strategies is offered.

Achieving a full understanding of San Patrice adaptive strategies requires much more research. The results presented in this thesis are limited to one artifact class, and therefore must be complemented by future studies examining the entire tool assemblage as well as debitage from tool manufacture and maintenance. Hopefully, however, this thesis provides a starting point and contributes to our understanding of San Patrice technological and mobility strategies across the plains-woodland border at the beginning of the Holocene.

Chapter 2
The Study Area: Present and Past Environments

Every environment presents unique adaptive challenges, and, as discussed in Chapter 3, humans throughout history and prehistory have developed numerous strategies. Hunter-gatherers must balance acquiring sufficient water and adequate shelter with hunting game, collecting plants, and procuring stone for tool manufacture. However, resource spacing and quantity varies greatly across different environmental regions. This chapter presents the natural and physical environments within the study area in two sections. The first section briefly describes modern plant and animal communities and the distribution of lithic resources, and the following section summarizes our current understanding of the environmental conditions affecting San Patrice populations.

Study Area

The study area can be divided into six primary physiographic regions: the Llano Estacado, the Edwards Plateau, the Osage Plains, the Ozark Plateau, the Ouachita Province, and the Coastal Plain (Fig. 2). Major rivers, including the Arkansas, Canadian, Brazos and Red, among others, flow east through the study area, passing through multiple physiographic regions before eventually emptying into the Gulf of Mexico. While a variety of floral and faunal communities are present, the study area is broadly characterized by the transition from prairies in the west to woodlands in the east.

It should be noted that the defined physiographic regions and their associated biotic districts do not represent distinct, isolated environments. Rather significant overlap exists; regions blend into one another, and the floral and faunal communities which dominate one region also occur in other regions (Blair and Hubbell 1938). Not surprisingly, the gradual shift from grasslands to woodlands mirrors the precipitation gradient (Fig. 3). It should be noted, however, that effective moisture, when precipitation falls, is as important as the amount of precipitation (Toomey et al. 1993). I do not go into great detail describing the modern environments of these regions because, as I discuss in

Figure 2. Map of the study area and its physiographic provinces.

the following section, early Holocene environments, with the exception of lithic raw material sources (Fig. 4), were markedly different than those in existence today.

Llano Estacado

The Llano Estacado is the southern-most extension of the High Plains Province, and the region is bounded by escarpments on the north, east, and west and grades into the Edwards Plateau in the south (Johnson and Holliday 2004). The uppermost geologic unit of High Plains is a remnant of the Tertiary Ogallala Formation which is overlain by eolian sediments resulting in a vast, virtually featureless plain (Banks 1990; Gustavson et al. 1991; Johnson and Holliday 2004; Thornbury 1965). Today, the climate is semi-arid, and short-grass plains dominate the region with scattered cottonwoods growing along floodplains (Blair and Hubbell 1938; Johnson and Holliday 2004).

The region contains one of the most easily identifiable lithic sources, Alibates Silicified Dolomite (Banks 1990; Wyckoff 2006). Because the Canadian River bisects the formation, knappable Alibates cobbles occur well downstream in central and eastern Oklahoma (Wyckoff 1993, 2006). Other lithic sources in the region include the Tecovas Formation and Ogallala gravels (Banks 1990; Wyckoff 2006).

Edwards Plateau

The Edwards Plateau blends with the Llano Estacado to the west, but the Ogallala cap has been removed leaving only the limestone surface (Thornbury 1965). Oak and juniper savanna dominate upland plateau settings, and the Brazos and Colorado Rivers drain the region (Collins 2004).

The Edwards Plateau, which includes 13 chert-bearing formations, is the most extensive lithic source in the study area (Banks 1990; Wyckoff 2006). Cherts from these

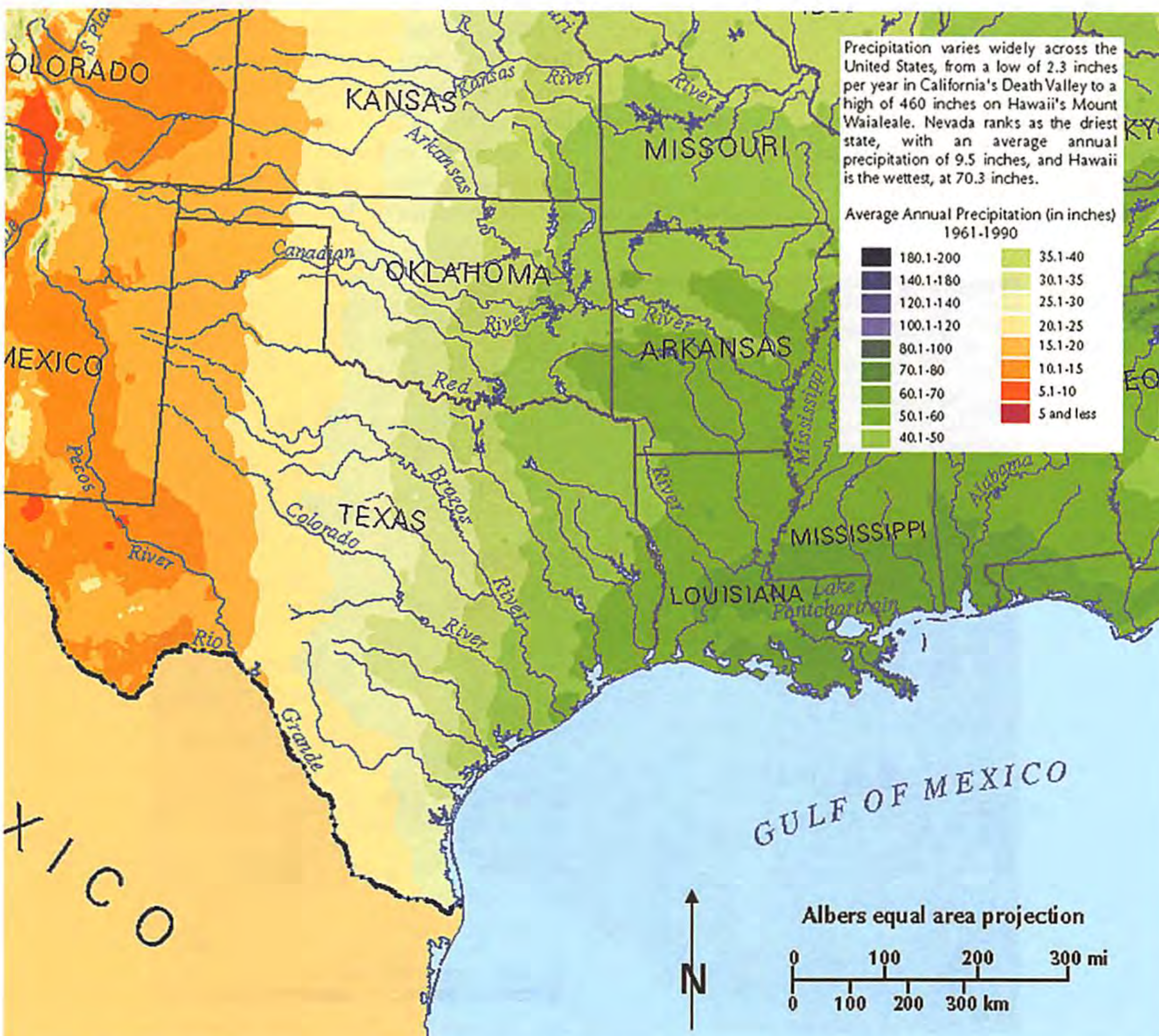


Figure 3. Map of study area showing the 1961 to 1990 annual precipitation averages. Adapted from: nationalatlas.gov.

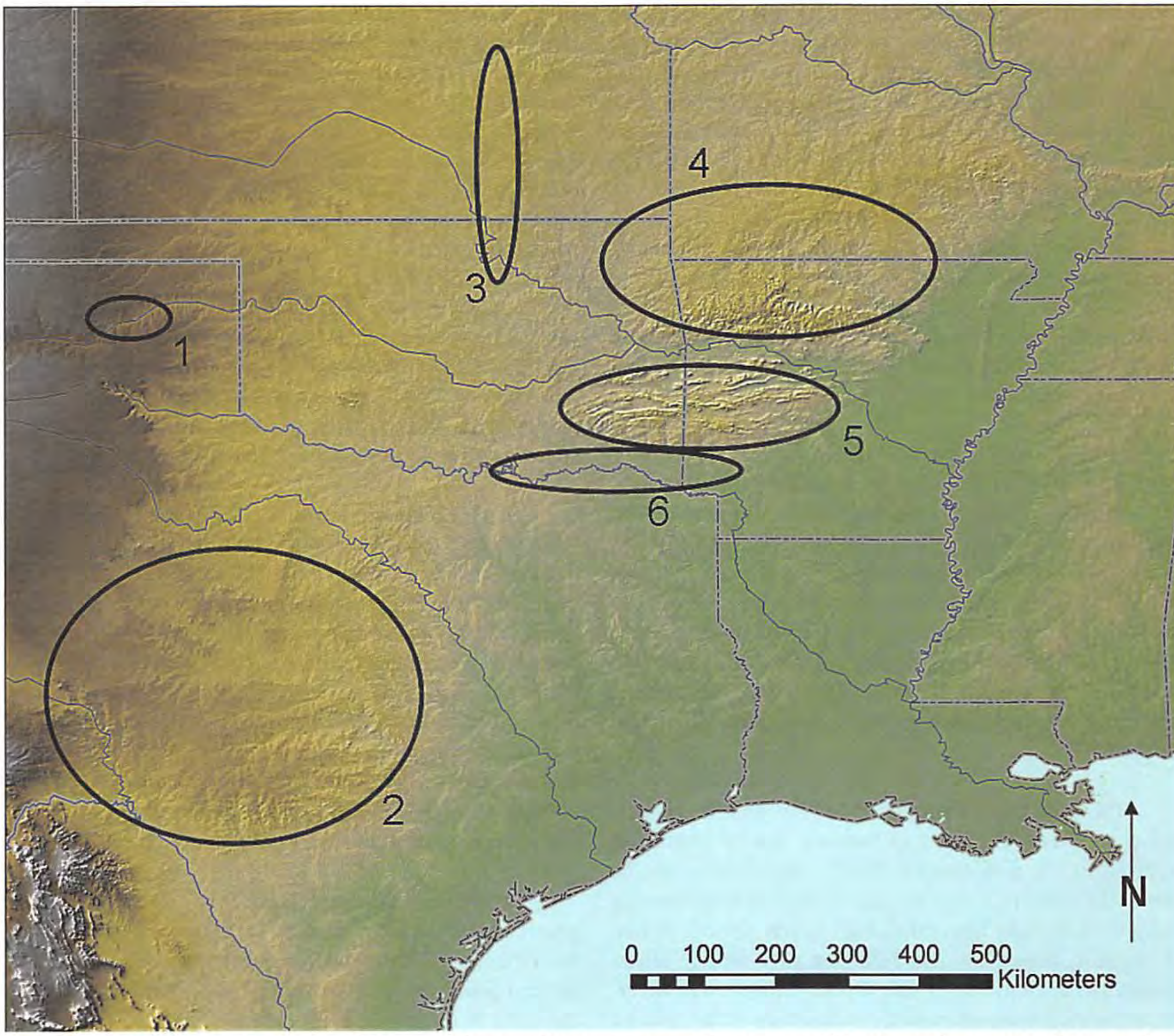


Figure 4. Approximate locations of important knappable stone material sources within the study area: 1, Alibates; 2, Edwards; 3, Flint Hills (Florence, Wreford, etc.); 4, Ozarks (Keokuk, Reed Springs, etc.); 5, Ouachitas (Novaculite, Johns Valley, etc.); and 6, Antlers (exotic cherts and indigeneous quartzite). Sources derived from Banks 1990.

formations are generally of extremely high quality and come in a variety of colors and textures.

Osage Plains (including the Rolling Plains)

The Osage Plains are generally rolling plains mixed with alluvial flats except where interrupted by the Wichita and Arbuckle Mountains and Flint Hills (Madole et al. 1991). The Osage Plains are comprised of the Osage Savanna Biotic District, analogous to the Cross-timbers, in the east and the Mixed Grass Plains in the west (Blair and Hubbell 1938). Vegetation in the Osage Savanna varies with the different soils present in the region (Madole et al. 1991); scrubby blackjack oak forest dominates sandstone hills while grassland communities grow in shale soils (Blair and Hubbell 1938). Mesic floodplain forest communities are similar to those found in the Ozark District (Blair and Hubbell 1938). The Mixed Grass Plains comprise a transition zone in which the tallgrass prairies of the east blend into the western shortgrass prairies (Blair and Hubbell 1938).

Frisco Chert occurs east of the Arbuckle Mountains of south-central Oklahoma. The Flint Hills, which begin in north-central Oklahoma, run north-south into Kansas (Banks 1990). Several distinct lithic sources outcrop in the Flint Hills including the Florence and Wreford cherts. As mentioned, the Canadian River carries Alibates cobbles into the region, and Ogallala gravels, consisting of petrified wood, cherts, and quartzites are also readily available on ancient ridges between today's major streams.

Ouachita Province

The Ouachita Province borders the Coastal Plain in the south and contains the mostly lowland Arkansas Valley and the Ouachita Mountains, whose great relief between ridges and valleys makes them the roughest formation in

Oklahoma (Blair and Hubbell 1938; Thornbury 1965). The Ouachita Mountains, a series of east-west ranges, average 80 km. wide and reach a height of 365 m. above sea level (Banks 1990; Thornbury 1965). Open yellow pine forests mixed with oaks and other trees dominate the region, and prairie openings occur less frequently than in the Ozark Plateau (Blair and Hubbell 1938).

Upland ridges are composed mostly of quartzitic sandstone while shales characterize drainage valleys (Banks 1990). Important toolstone located within the Ouachita Province includes Arkansas Novaculite, Bigfork Chert, Woodford Chert, and Johns Valley Shale and Silicified Sandstone (Banks 1990; Wyckoff 2006).

Ozark Plateau

Thornbury (1965) divides the Ozark Plateaus into the Springfield Plateau, consisting of flat interfluve prairies separated by deep valleys, and the Boston Mountains, an east-west string of rugged topography with even deeper drainage valleys. The primary rivers draining the plateau in Oklahoma are the largely spring fed Grand and Illinois (Blair and Hubbell 1938). Today, oak-hickory forest, with intermittent open prairie areas, caps the uplands while open hardwood forests populate the valley floodplains (Blair and Hubbell 1938).

The bedrock is primarily dolomites and limestones, and chert occurs regularly in bedrock and on almost all surfaces in the area (Banks 1990). The Ozarks are an extremely chert-rich region, and important chert-bearing formations include Boone/Keokuk, Reeds Spring, Pitkin, Moorefield, Tahlequah, and Jefferson City, among others (Banks 1990; Thornbury 1965; Wyckoff 2006). The diversity of cherts present attest to the complexity of the geology and stratigraphy in the region.

Coastal Plain

The Coastal Plain is a large and relatively featureless region which includes streams with large drainage basins and is characterized by the Mississippi Biotic District (Blair and Hubbell 1938; Thornbury 1965). The region is bounded sharply by the Ouachitas in the north, but blends gradually into the Osage Plains in the west (Blair and Hubbell 1938). Cypress swamps occur along drainages, and sweetgums, oaks, and pines grow in floodplains and on previously cleared land (Blair and Hubbell 1938).

The Coastal Plain is the most lithic-poor (Banks 1990), and poorly studied, region in the study area. Two primary geologic sources of lithic materials are the Catahoula and Manning Formations (Banks 1990; Brown 1976). The region does contain lithic materials in the form of gravels carried by major rivers with headwaters in chert-bearing formations (Banks 1990; Wyckoff 2006). The Antlers Formation, consisting of Cretaceous sands and gravels in southeastern Oklahoma, contains knappable cherts and silicified sandstones (Banks 1990; Wyckoff 2006). In addition, lag deposits of Ogalalla gravels occur in uplands and washing out of drainages. Although the gravels consist primarily of petrified woods, various cherts, and quartzites, Edwards chert cobbles have also been carried east of the Edwards Formation (Banks 1990; Byrd 1971; Menzer and Slaughter 1971). While some uncertainty remains regarding the eastern extent of these gravel deposits, it now appears they extend well into eastern Texas, and they may be related to similar gravels in Louisiana (Banks 1990; Trask 2005). Finally, Heinrich (1984) documents several additional lithic sources occurring in western Louisiana, including Eagle Hill Chert, "gravel chert," Fleming Gravel Chert, and Fleming Opal. Unfortunately, tracing these various gravel cherts and quartzites in the Costal Plain region to a specific source location proves incredibly difficult.

At this juncture, I would like to briefly discuss the "gravel chert" which corresponds to the local gravels utilized by San Patrice occupants of the John Pearce site (Webb et al. 1971) in northwestern Louisiana (Heinrich 1984) in greater detail. These cherts are opaque and range in color from brown to orange to dark yellow. Gravels outcrop in Pleistocene and Holocene stream sediments, but the precise origin of these cherts and the extent of the gravel bearing formation remains a mystery (Heinrich 1984). However, Larry Banks and Don Wyckoff (personal communication 2006) suspect they may be associated with the nearby Antlers Formation of southeastern Oklahoma.

One potentially important feature relating to these gravel cherts is the propensity for projectile points made from them to exhibit reddening of the tips or ears (Fig. 5). Several points from the Wolfshead site (Duffield 1963) and the John Pearce site (Webb et al. 1971) have red ears or tips, but neither report makes mention of this phenomenon. Michael Collins (personal communication 2005) has suggested heating associated with the insertion or removal from a mastic-laden haft might redden the tip and ears. Alternatively, reddening might occur during heat treatment of chert cobbles prior to flint knapping (Griffing 1994). A cobble from a protohistoric site in northwestern Louisiana displays similar reddening around its edges. However, more research is needed to determine whether this reddening is a natural feature of the gravel cortex or the result of heating. Experiments conducted to test if or how these gravel cherts react to heating could reveal significant information on the San Patrice point hafting process or the size of cobbles knappers selected for point manufacture.

Summary

Clearly, great physiographic and biotic diversity exists within the study area today. However, hunter-gatherers moving through the area 10,000 years ago encountered markedly different environments. The following section summarizes our current understanding of the climatic and biotic changes occurring within the study area as the last

Figure 5. Top: examples of San Patrice points with reddened tips and ears. Bottom: cobble from a protohistoric site in northwestern Louisiana with reddening near the cortex. Photos not to scale.

ice age came to a close.

The Pleistocene-Holocene Transition

Following the last ice age, the climate throughout North America changed in three fundamental ways. Temperatures increased, precipitation patterns shifted, and seasonality increased (Bryant and Holloway 1985; Fredlund and Tieszen 1997; Graham 1987; Toomey et al. 1993). These changes significantly impacted the floral and faunal communities on the Plains and in the Woodlands to the east. As grasslands expanded on the plains, southern pine came to dominate the eastern forests (Bryant and Holloway 1985; Webb et al. 2004). Reacting to these changes, a number of faunal species became extinct and others moved north to cooler environments resulting in the formation of biotic communities that had not existed during glacial times (Graham and Lundelius 1984). Understanding the nature of the environmental transformation which occurred with the onset of the Holocene is critical for understanding hunter-gatherer adaptations. The following summary presents our current knowledge of the climatic changes occurring during the Pleistocene-Holocene transition and their effect on plant and animal communities along the plains-woodland border.

Beginning on the Southern Plains, Bryant and Holloway (1985) summarize the pollen evidence for the Pleistocene-Holocene transition in the state of Texas. Generally, the Late Glacial Period (14,000-10,000 B.P.) is characterized by slow climatic deterioration and the gradual loss of woodland and parkland throughout much of the state. Speleothem growth in three Central Texas caves dramatically decreased during the Pleistocene-Holocene transition (15,000-10,000 B.P.), reflecting a pronounced warming and drying trend in the region (Musgrove et al. 2001). In northwestern Texas, lowland conifers were replaced by grasslands while upland conifers remained stable (Bryant and Holloway 1985). Further south, scrub grasslands replaced broad mosaic pinyon-juniper woods (Bryant and Holloway 1985). A disharmonious association of mammalian species during the latest Pleistocene (12,000-11,000 B.P.) on the southwestern Plains indicates the climate was cooler and moister and lacked extreme seasonality (Graham 1987). Evidence from Boriac Bog in East-Central Texas reveals a steady reduction in the number of arboreal taxa in which grassland and oak-savannah gradually supplanted deciduous woods (Bryant and Holloway 1985). Due to high oxidation of soils and high precipitation, few good pollen records exist for eastern Texas. However, Bryant and Holloway (1985) suggest the region likely remained forested but lost certain arboreal taxa.

For the Post Glacial period (10,500 B.P. to present), pollen, faunal, and geomorphological data indicate the environment continued warming and drying throughout Texas. Western and central Texas became increasingly xeric, characterized by a gradual decrease in effective moisture (Blum et al. 1994; Bryant and Holloway 1985; Humphrey and Ferring 1994; Toomey et al. 1993). The pollen sequence from Hershop Bog in Central Texas, "indicates a definite change in climate from mesic to less mesic at approximately 10,000 B.P." (Larson et al. 1972:366), and pollen data from Soefje bog shows that the modern oak-hickory dominated vegetation of central Texas has changed little in the past 8,000 years (Graham and Heimsch 1960). Again, little data exists for eastern Texas. Al-Rabab and Williams (2004) used modern population genetics to test the hypothesis that pine (P. taeda) populations in eastern Texas contracted significantly during the Pleistocene-Holocene transition. While they did find evidence of an ancient genetic bottleneck reflecting population constriction, the timing of this event(s) could only be narrowed to 30,000-3,000 yrs B.P. (Al-Rabab and Williams 2004).

Further north, Fredlund and Tieszen (1997) compared grass phytolith assemblages from seven sites in Kansas and Nebraska to modern assemblages. Percentages of cold adapted C3 grasses decrease through time reflecting the climatic shift from cold mesic conditions to a warmer arid climate during the Pleistocene-Holocene transition from 12,600-10,100 B.P. Plant macrofossil changes from groundwater-fed wetlands located within the north-central Nebraska Sandhills indicate a vegetation community similar to the present prairie grasses/herbs/forbs mix was established by 9,000-10,500 B.P. (Nicholson and Swinehart 2005). However, this transition might not have been as smooth as some pollen sequences indicate. Eolian sand deposits interbedded with peat revealed several periods of sand deposition. One such period began between 9,200-10,000 B.P. with high and continuous sand deposition continuing until 7,200 B.P. (Nicholson and Swinehart 2005). Optical dating of Bignell Loess deposits from western Nebraska and Kansas indicate that loess accumulation began between 10,000-9,000 B.P. and continued until shortly after 6,500 B.P. (Miao et al. 2005).

To the east, Webb et al. (2004) used fossil pollen data to construct time series pollen maps. They note that large biome changes took place between the Last Glacial Maximum and today with a major reorganization occurring 14,000-9,000 B.P. The Southeast was drier than today prior to 10,000 B.P. and then became wetter with southern pines replacing oaks after 8,000 B.P. Records at individual sites indicate, "rapid vegetation responses to abrupt climate changes... [occurred] nearly as fast as the climate changes that caused them" (Webb et al. 2004:469).

The pollen sequence from Ferndale Bog in southeastern Oklahoma reveals a gradual increase in aridity following the Pleistocene (Bryant and Holloway 1985; Holloway 1994). Palynological and faunal evidence from Missouri point to a gradual drying trend following the last ice age (McMillan and Klippel 1981), and the presence of prairie and edge species in faunal assemblages suggest forest openings in Illinois and Missouri were a regular occurrence by the Early Holocene period of 10,000-8,500 B.P. (Purdue and Styles 1987). Stable carbon isotopic evidence from the Big Eddy Site in southwestern Missouri indicates an Early Holocene warm/dry interval occurred from 11,200-10,100 B.P. (Hajic et al. 2000). The plant community became C4 dominant (70-80%) by 10,400 B.P., and rebounded to 50-60% C4 by 9,800 B.P. (Hajic et al. 2000). According to stable carbon isotopes of speleothems in the Ozark Highlands of southern Missouri and northern Arkansas, this rebound constituted a rapid early Holocene (9,500-8,200 B.P.) climatic return to cooler and moister conditions (Denniston et al. 2000).

In their work on inland dunes in southern Louisiana, Otvos and Price (2001) document three episodes of eolian activity and multiple phases of dune development and activation. Significantly, 10,500-7,900 B.P. was a major eolian interval in which again climate change was abrupt. Further, dune records indicate the modern regional climate did not begin to develop until the middle Holocene in this area.

Seasonality

Shifting seasonality may be the most significant factor differentiating the Pleistocene from the Holocene. For modern biotic communities, species diversity correlates positively with decreased climatic variability (MacArthur 1975). When compared with modern biotic communities, the degree of species diversity in disharmonious Pleistocene communities attests to less variable climate and decreased seasonal extremes (Graham and Lundelius 1984). Late Pleistocene disharmonious faunal assemblages attest to paleocommunities reflecting environments that no longer exist today (Graham and Lundelius 1984; Webb et al. 2004). Species that are allopatric today coexisted in Late Pleistocene environments, and there are no modern analogues for these communities (Graham and Lundelius 1984).

The onset of the Holocene continental climate with greater seasonal extremes resulted in a reorganization of species distributions (Graham 1987). These changes, however, were not at the community level, but were species-specific (Graham and Lundelius 1984). Reorganization proceeded time-transgressively with individual species responding according to individual tolerance limits (Graham and Lundelius 1984; McMillan and Klippel 1981). Critically, the, "individualistic response of each species reduced the predictability of the composition and structure of the new communities" (Graham and Lundelius 1984:243). Predictability varies inversely with the magnitude of environmental change.

Minimal seasonality characterized the late Pleistocene and was followed by maximum seasonality from the terminal Pleistocene through the middle Holocene (Toomey et al. 1993). These changes included not only the formation of distinct summers and winters, but also shifts in the seasonality of precipitation (Toomey et al. 1993). While many species eventually settled into their modern biotic niches, many others became extinct. The majority of these extinctions occurred between 10,000-12,000 B.P. (Graham and Lundelius 1984). Mammalian extinctions included species of all sizes, from rabbits to mammoths (Graham and Lundelius 1984). Species within a multitude of adaptive zones and trophic classes became extinct (Graham and Lundelius 1984). These changes were particularly significant on the Great Plains where the faunal resources shifted from an abundant and evenly dispersed distribution during the Pleistocene to a less abundant and more patchy distribution in the Holocene (Bamforth 1988).

The Prairie-Forest Border

An important question for this thesis is where the prairie-forest border lay during San Patrice times. While a number of San Patrice sites are located in areas that are today woodlands, this may not have been the case 10,000 years ago. Palynological and faunal evidence indicates that grasslands expanded east considerably at the end of the Pleistocene. Based on the presence of prairie and edge species in faunal assemblages, forest openings in Illinois and Missouri were a regular occurrence by the Early Holocene period of 10,000-8,500 B.P. (Purdue and Styles 1987), and the prairie border in Missouri moved east by 8,500 years ago (Baker and Waln 1985). Similarly, the spruce forest dominance in northeastern Kansas ended 11,500 years ago, and the region became prairie-dominated by 9,900 B.P. (Baker and Waln 1985). Evidence from Central Texas also points to an eastward grassland expansion which replaced extant woodland communities (Bousman 1998a; Graham and Heimsch 1960; Larson et al. 1972).

Ferndale Bog, located in southeastern Oklahoma, provides the best dated evidence to date of how far east grasslands expanded following the Pleistocene (Fig. 6).

Around 12,000 years ago the area consisted of open woodlands with an herbaceous and grassy understory (Holloway 1994). Between 12,000 and 10,000 years ago, arboreal pollen decreased dramatically as grasslands began to dominate.

Although the full extent of the eastern grasslands expansion in the study region remains a mystery due to the lack of refined environmental data from Louisiana and southern Arkansas, data from Texas and Oklahoma along with climatic reconstruction models (Prentice et al. 1991; Webb et al. 2004) provide clues how far grasslands extended 10,000 years ago. Figure 7 displays where this border likely lay in the Early Holocene. The prairie-forest border, however, is not a distinct edge on the landscape. The line thus merely approximates, for heuristic purposes, where a predominance of grasslands became a predominance of woodlands.

Summary

The study area contains a diverse selection of physical and natural environments. After the end of the last ice age, the Early Holocene climate became increasingly continental resulting in dramatic biotic reorganizations, including the eastward expansion of grasslands, and the formation of new floral and faunal communities. In addition lithic resources, while present in every physiographic region, occur at specific diverse locations on the landscape and vary significantly in quality and accessibility. Having reconstructed, in broad terms, the environmental conditions which San Patrice populations faced, I now turn to developing a theoretical perspective to help predict how San Patrice groups likely adapted to living in these settings and how different adaptations manifest themselves in the archaeological record.

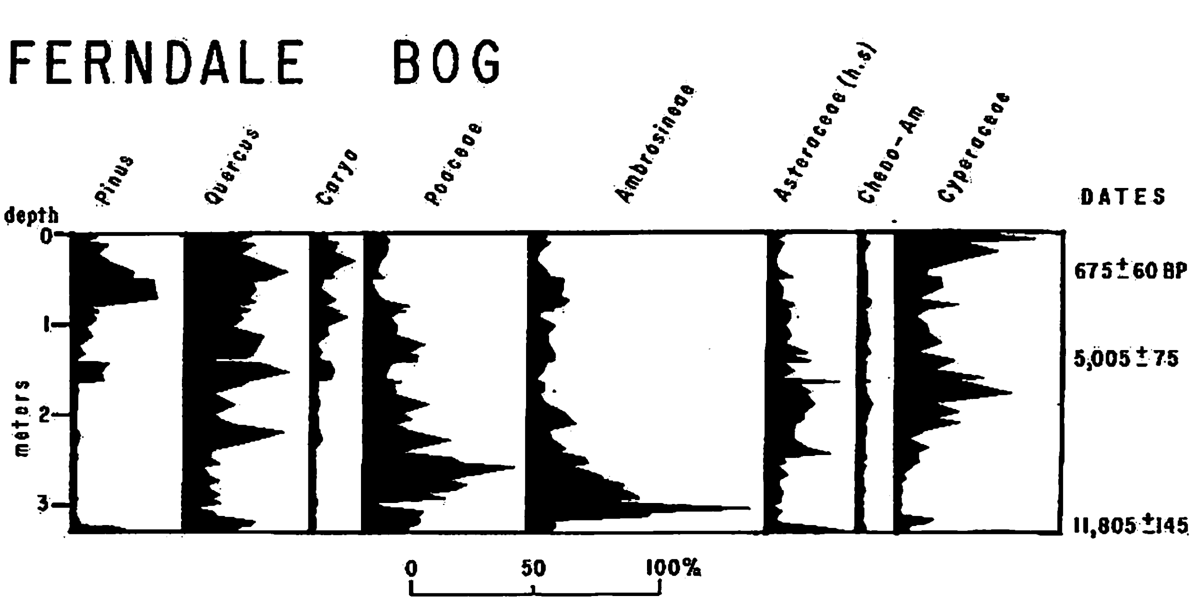


Figure 6. Summary pollen sequence from Ferndale Bog, Atoka County, Oklahoma. Adapted from Bryant and Holloway 1985:Fig. 6.

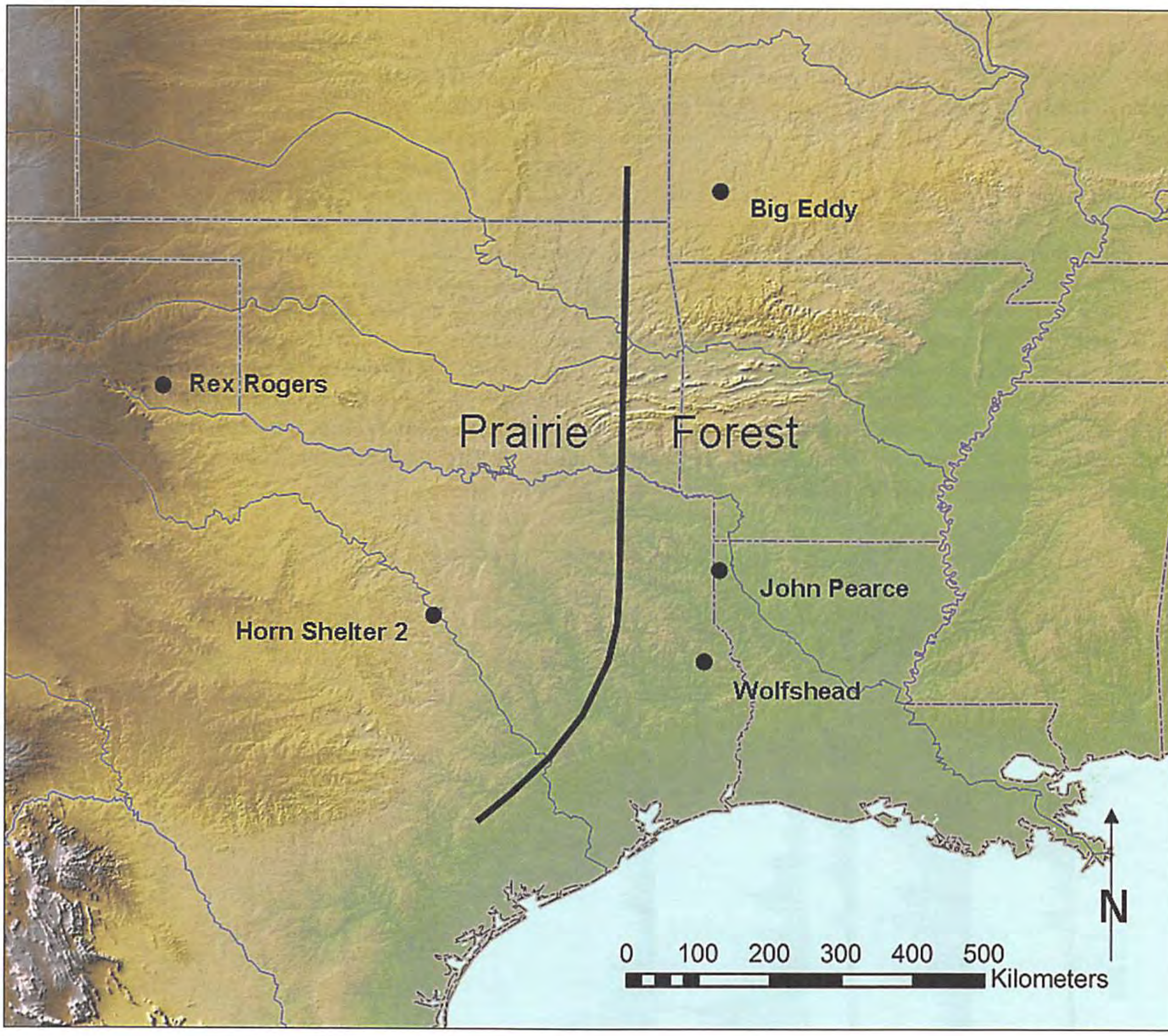


Figure 7. Map of the study area showing some key San Patrice sites and the approximate location of the prairie-woodlands border of some 10,000 years ago.

Chapter 3: Theoretical Perspective to This Study

This chapter outlines the theoretical perspective which will be relied upon for the analyses presented in Chapter 5. The focus is on hunter-gatherer adaptation, specifically mobility and subsistence strategies. The concepts of mobility, how people move across the landscape, and subsistence, what they eat, are intimately related and are critical for understanding hunter-gatherer societies.

I begin with general models for predicting hunter-gatherer behavior, followed by a summary of how adaptive strategies are reflected in the lithic technologies employed by foraging groups. I conclude by discussing the information we can learn from studying projectile points, the focus of this thesis. Projectile points alone cannot tell us everything we wish to know about hunter-gatherer lifeways; they are but one piece, a sensitive one, of the puzzle. Studying projectile points can inform us, however, about technological organization which in turn informs us about specific adaptive strategies.

Hunter-Gatherers

The importance of understanding hunter-gatherer mobility has long been recognized in archaeological research (Beardsley et al. 1956; Binford 1980; Boyd and Richerson 1985; Eder 1984; Harris 1978; Jochim 1981; Kelly 1983; Sahlins 1972). Mobility, the way people move across the landscape and how often, has significant social consequences (Binford 1980; Kelly 1992). While mobility has been conceptualized in different ways (as a continuum or as discrete analytical categories), most definitions acknowledge the importance of behavior (Kelly 1992). Degrees of mobility correspond to environmental adaptations, cultural conceptions of the landscape, and social organization and interactions (Binford 1980; Jochim 1981; Kelly 1992; Sahlins 1972; Shott 1989b). Thus, understanding mobility is critical to understanding cultures.

Unfortunately, current archaeological techniques do not allow us to travel back in time to observe Paleoindians first-hand. We must therefore turn to the ethnographic record for insights into how these first Americans lived. However, as Kelly (1995) discusses, it is important to recognize the limits of ethnographic analogy. No isolated, untouched hunter-gatherer societies exist today; all have in one way or another been impacted by contact with the industrial world. Moreover, the world is constantly changing. The environmental and cultural conditions affecting modern foragers are distinct from those which impacted prehistoric societies. Finally, we must exercise caution when interpreting patterns identified through ethnographic research. Modern hunter-gatherers are not necessarily optimally adapted to the environment in which they live, and assuming they are can lead to incorrect expectations regarding prehistoric adaptive strategies (Bettinger 1991). In spite of these and other drawbacks, ethnographic analogy provides a useful starting point for thinking about and understanding prehistoric hunting and gathering groups.

Ethnographic research reveals great diversity among hunting and gathering societies (Kelly 1995). A variety of cultural, technological, and historical factors influence hunter-gatherer behavior and produce much of this diversity (see articles in Crothers 2004). However, anthropologists have long recognized correlations between environment and adaptation and have spent considerable effort trying to determine when and how environmental conditions shape hunter-gatherer subsistence and mobility strategies (Binford 1980; Eder 1984; Harris 1978; Jochim 1971; Kelly 1983; Winterhalter and Smith 1981). Bettinger (1991) reviews the development of hunter-gatherer theory with an eye towards the processes through which hunter-gatherers adapt to various environments. Two of the more widely applied theories are evolutionary ecology, (e.g. Winterhalter and Smith 1981) which emphasizes the biological survival and reproduction of systems, and cultural inheritance, which stresses the non-genetic transmission of behavior through social interaction (e.g. Boyd and Richerson 1985). While investigating these and other theories remains important for understanding foraging societies, the present study is concerned with the end product, the behavioral adaptations, rather than the processes by which they develop.

Binford (1980) sparked renewed interest in the subject of hunter-gatherer adaptations when he used ethnographic data to link settlement strategies with differences in effective temperature. Essentially, effective temperature provides a measure of the average temperature and average duration of the growing season in a given region (Bettinger 1991). As effective temperature increases, so does the length of the growing season and the temperature during that period. Thus, effective temperature directly measures plant productivity and indirectly measures animal productivity.

Kelly (1995:121) included another variable, primary biomass, which he defines as, "the total amount of standing plant matter in an environment." Among modern hunter-gatherer groups, a correlation indeed exists between primary biomass, effective temperature, and mobility (Bettinger 1991; Binford 1980; Kelly 1995). In general, the frequency of residential moves increases with primary biomass. Additionally, as effective temperature decreases, a proxy measure for increasing resource patchiness, hunter-gatherers travel farther with each move. An inverse relationship exists between how often hunter-gatherers make residential moves and the distance traveled per move.

Modern ethnographic data also show a relationship between subsistence strategies and the environment. As Kelly (1995) notes, dependence on gathering varies directly with effective temperature and primary production (the yearly net plant production). Predicting reliance on hunting is less straightforward due to other factors such as trade or the availability of aquatic resources. However, in areas of low primary productivity and few aquatic resources, hunting becomes a major subsistence strategy (Kelly 1995). In particular, the scarcity of edible plants in grassland environments, such as the Great Plains, forces groups occupying those habitats to depend primarily on hunting (Bamforth 1988; Kelly 1995).

Applying these patterns to the current study area, we should expect that groups living in the deciduous woodlands, with greater primary biomass and primary production, frequently moved short distances, exploited a variety of plant resources supplemented by hunting. In contrast, groups occupying the more patchy plains environments moved less frequently, but covered more territory per move as they focused comparatively more on hunting.

Having developed predictions regarding subsistence and mobility strategies within the study area, I now turn to the archaeological record. The settlement strategy employed by a foraging group is reflected in the material culture left behind. The organization of lithic technology reflected in the stone tools and knapping debris recovered from archaeological sites yields clues regarding mobility patterns.

Lithic Technology

Stone tools and the debris from their manufacture are often the only materials preserved in sites dating to the Paleoindian period. While lithics cannot inform us about every aspect of hunter-gatherer culture, understanding technological organization provides important information regarding adaptive strategies. Nelson (1991:57) defines the study of technological organization as one concerned with, "the selection and integration of strategies for making, using, transporting, and discarding tools and the materials needed for their manufacture and maintenance."

As Nelson (1991) notes, technological strategies balance cultural concerns with environmental constraints, and thus, several lines of behavior can be investigated. Multiple adaptive problems affect technological strategy, including the time available for tool production, the costs of tool manufacture, the requirements of mobility, and resource availability.

Two technological strategies have commonly been identified as indicators of corresponding mobility strategies: curation and expediency. For Nelson (1991:62), curation is, "a strategy of caring for tools and toolkits that can include advanced manufacture, transport, reshaping, and caching or storage." Curated technologies are prepared in anticipation of insufficient resources at the time of tool use, and curation includes manufacturing tools in advance or preparing and transporting cores for later tool manufacture (Nelson 1991).

Mobile toolkits should minimize transport cost while ensuring maintainable and functional tools are readily available (Bleed 1986; Kuhn 1994). Additionally, transported tools should be multifunctional or/and resistant to breakage (Kuhn 1994; Shott 1989b). Multifunctional tools keep weight down by eliminating the need to carry multiple, single purpose tools; minimizing transport weight is important because, "every kilo of tools or raw material people carry with them means one kilo less of food, clothing, or shelter" (Kuhn 1994:428-9).

In contrast, expediency is a strategy that anticipates sufficient access to raw materials and tool manufacturing time (Nelson 1991). For Parry and Kelly (1987:301), "[a]n expedient technology is a wasteful one" utilized when raw material is in abundance. Expediency occurs when activities are anticipated to occur near raw material sources. Long occupation duration or regular use of a raw material outcrop also favors an expedient strategy (Nelson 1991), and expediency also allows flexibility to quickly adapt a toolkit to unforeseen opportunities (Bement, personal communication 2006).

The importance of transport cost increases directly with mobility (Kuhn 1994). Decreased mobility reduces concerns about tool weight and tool use-life (Bleed 1986; Kuhn 1994; Shott 1989a). Thus, optimizing tool function and manufacture time become primary foci of expedient technologies (Bleed 1986; Kuhn 1994; Parry and Kelly 1987). Designs that optimize manufacturing cost should include the use of easily accessible raw materials, less elaborate tool forms, and decreased manufacturing stages (Shott 1989a). Because expedient toolkits are not transported long distances, the number of single purpose tools and the weight of individual tools are of secondary concern.

Because curation and expediency strategies cope with scales of mobility, curated and expedient technologies vary as greatly as hunter-gatherer mobility strategies. Curation and expediency represent opposite ends of a continuum. Different foraging groups exercised different levels of curation and developed alternative strategies for conserving toolstone (Wyckoff 1999). Indeed, the use of curated or expedient technology could vary within the same group from season to season, year to year, or in different aspects of the same toolkit (Hofman 2003). As such, identifying curated and expedient technologies provides only a relative measure of mobility when two or more sites or foraging groups are compared. While the study of technological organization provides insight regarding how mobile hunter-gatherer groups were, it cannot tell us how far they moved. Raw material sourcing begins to answer this question.

Raw Material as an Indicator of Mobility

Lithic raw material outcrops are located in specific, non-moving places on the landscape (Goodyear 1989). Often, locations of tool use do not coincide with locations of raw material outcrops. Curation increases the use-life of a tool allowing for the conservation of raw materials (Shott 1989a). Thus, curation is a strategy to ensure sufficient raw materials are on hand for manufacturing tools as populations move across the landscape (Bamforth 1986; Kelly 1988; Nelson 1991), and curation should vary directly with mobility (Shott 1989b).

While transport costs surely influence curated technologies (Kuhn 1994), Bamforth (1986) argues curation relates more directly to raw material availability. As access to raw materials is restricted, either through resource depletion or through behavioral choices such as mobility, curation should increase. Thus, curation strategies may differ significantly within a single society as groups move further from raw material sources. Highly mobile populations may exhibit characteristics associated with expedient technology when these groups pass through areas of raw material abundance (Parry and Kelly 1987).

Curation strategies involving raw material conservation often maximize tool use-life. Transportable tools should show extensive evidence of use, wear, maintenance, recycling, and depletion (Goodyear 1989; Nelson 1991; Shott 1989a, b). Further, "a preponderance of small resharpening flakes, a high index of thickness to length for a tool class, and the occurrence of especially steep retouch within a tool class are indicative of extended toolkit use-life" (Nelson 1991:75).

Raw material sourcing provides a means of measuring how far mobile populations traveled utilizing a curated technology (Binford 1979; Goodyear 1989). As noted, stone sources occur in specific locations. Often, stone from an individual outcrop possesses unique physical and chemical signatures. As such, when archaeologists encounter a particular stone type, the distance from the outcrop location to the artifact recovery location can be calculated, providing a gross estimate of how far the foraging group traveled. It should be noted, however, that projectile point replacement and discard is largely a function of the number of hunting episodes and resharpening events a given point has undergone (Bement 2002; Buchanan 2006; Hofman 1991). Thus, the straight line distance calculated from raw material source to projectile point recovery location likely represents only a portion of the actual distance traveled since procurement.

Caution must also be exercised when interpreting the presence of an artifact of extralocal stone at an archaeological site. The occurrence of exotic raw materials may not be the result of direct procurement from the source location; indirect procurement, such as through exchange, is an equally likely explanation (Bamforth 2002; Meltzer 1989). Thus, the distances calculated through raw material sourcing may merely indicate range rather than actual distances traveled for direct procurement (Kelly 1992). Indeed, Meltzer (1989) identifies only two scenarios in which archaeologists can confidently identify the method of stone acquisition:

1) stylistically distinct artifacts, not typically present in similar regional assemblages, manufactured from exotic stone were likely acquired through exchange;
2) an assemblage containing tools manufactured solely of extralocal material reflects direct procurement by highly mobile groups.

Outside of these two conditions, raw material sourcing alone cannot distinguish between direct vs. indirect procurement. Determining the relative mobility of prehistoric hunter-gatherers requires combining raw material sourcing with other indicators of mobility such as technological organization. Having outlined the information which can be gleaned from studies of lithic technology, I now turn to the artifact class this thesis is concerned with: projectile points.

Projectile Points:
Clues to Hunter-Gatherer Adaptations

A projectile point's primary function is to take down game, and to achieve this goal, it must meet certain functional requirements. A projectile point can be broken down into two primary components, the blade and the base (Fig. 8). The blade is the business end; it performs the piercing, cutting, and tearing. The base is the portion hafted to the spear.

The blade's functions are to open a hole wide enough for the shaft to pass through and to inflict cutting damage on internal organs, and balancing these two functions necessitates a compromise in certain design features (Friis-Hansen 1990; Frison 1991; Howard 1995). A wider, thicker blade may tear a larger hole, but drag reduces penetration (Friis-

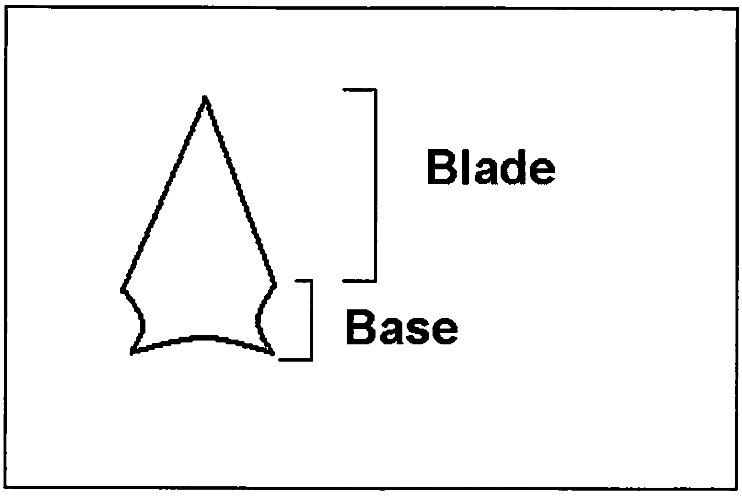


Figure 8. Illustration of a projectile point showing the blade and base elements.

Hansen 1990). A narrow tip angle increases penetration, but points which are too narrow and thin will break when they hit bone (Cheshier and Kelly 2006; Friis-Hansen 1990). While these functional requirements impose certain limitations, enough leeway exists to allow considerable stylistic variation (Ahler and Geib 2000; Friis-Hansen 1990).

As noted, the base connects the point to the spear or foreshaft. Hafting presents significant obstacles. The hafting assembly, consisting of the shaft, adhesive, and wrapping material, add mass and greatly increase friction which can impede penetration (Frison 1991; Howard 1995). This problem can be alleviated via a number of strategies, and two of the most prominent in North American prehistory are projectile point fluting and notching (Fig. 9).

Fluting of lanceolate points, achieved by removing a flake(s) from the base of the point in the direction of the tip, provided a slightly concave surface for effective bonding and reduced bonding mass (Ahler and Geib 2000; Howard 1995). Notching allowed hafting to move inside the lateral edges of the blade, reducing friction and bonding mass; however, this design decreases the cutting efficiency of the blade somewhat and may reduce durability (Cheshier and Kelly 2006; Howard 1995).

Because a certain degree of leeway exists for producing functional blade and haft designs, and because certain elements can be manipulated with minimal effect on function (Wiessner 1983), hunter-gatherers throughout prehistory and history developed unique, culturally specific, projectile point forms. Although these differences are sometimes subtle, their presence allows archaeologists to distinguish between projectile points made by distinct foraging groups. Once these groups have been identified, we can begin to ask how they differ adaptively and culturally.

Returning to the questions of mobility and subsistence strategies, the presence of a projectile point in an assemblage cannot alone prove how mobile a given society was; both mobile and sedentary groups used projectile points for hunting. As noted, determining relative mobility requires a complete understanding of lithic technological organization, among other lines of evidence. Projectile points can, however, reveal some information regarding overall mobility strategies.

The distribution of a projectile point type across the landscape provides a gross potential estimate for the territorial range of a foraging society (Hurst 2006; Meltzer 2002). While individuals surely did not mark their territories by dropping points along the border, point style distributions approximate the limits within which everyday subsistence activities occurred. The size of a territory thus corresponds to the maximum distance a foraging group could have traveled on a regular basis.

Projectile points also provide data on how far groups traveled. As noted, raw material sourcing of lithic artifacts, including points, generates information regarding the distances hunter-gatherers traveled to procure toolstone. Moreover, because projectile points are curated, they can be very helpful in reconstructing movement patterns among multiple raw material outcrops across the landscape (i.e. Bement 2002; Buchanan 2002; Hofman 2003).

Projectile point reuse can reveal information on adaptive strategies. Highly resharpened points or numerous points recycled into other tools after breakage reflect a need for curation (Wyckoff 1999). In some cases, it may even be possible to calculate the expended and residual utility of resharpened points which, when combined with raw material data, facilitates the reconstruction of population move-

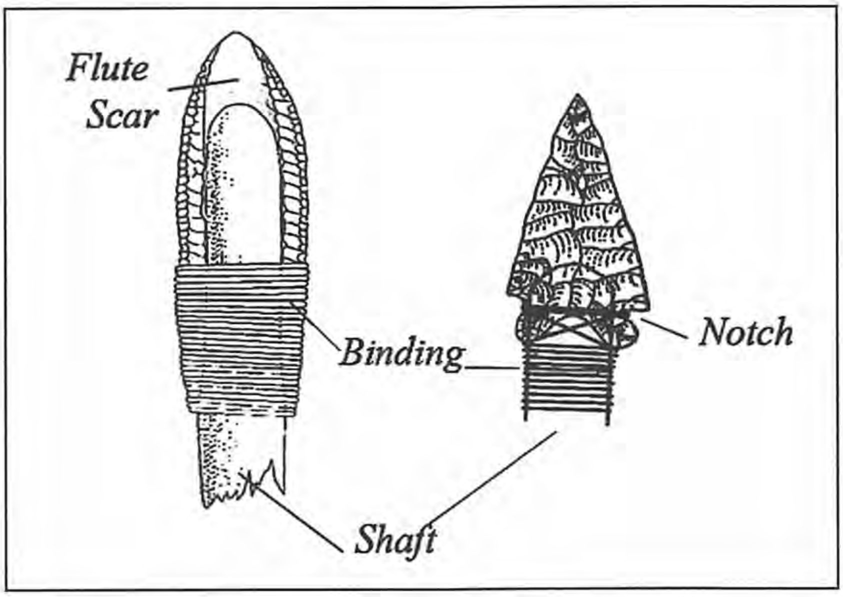


Figure 9. Hypothetical hafting of a fluted lanceolate point (left, adapted from Ahler and Geib 2000) and a notched projectile point (right, adapted from Hughes 1998).

ments and band ranges (Ballenger 2001; Bement 1999; Hofman 1991).

Summary

As ethnographic studies have shown, great diversity exists in hunter-gatherer subsistence and mobility strategies as they adapted to a variety of environmental conditions. These strategies are reflected in the lithic technology foragers use to acquire resources, and studying technological organization is an essential tool for discovering the adaptive strategies of prehistoric societies. Although the projectile point constitutes only a single artifact class, data on the designs, distributions, and raw material sources of recovered points provide an important piece of the overall adaptive puzzle.

From this theoretical base, the following hypotheses will guide the analysis and conclusions. These are:

1. Significant differences should exist between lanceolate and notched hafting techniques.
2. If San Patrice populations intensively exploited plains resources, the technological strategies employed by these groups should differ from woodland strategies.
3. San Patrice bands inhabiting plains environments should exhibit greater mobility, in terms of the distances traveled, than woodland groups.

Chapter 4
The San Patrice Complex

The disappearance "of Clovis projectile point forms appears to correspond closely with the extinction of Pleistocene megafauna, suggesting that the two events are closely related" (Morse et. al. 1996:328). The emergence of subregional technological traditions has been argued to result from decreasing mobility and a shift from hunting megafauna to modern game, an abandonment of the high-tech foraging subsistence system (Anderson 1996; Anderson and Smith 2003; Kelly and Todd 1988; Meltzer 2002; Morse et al. 1996). Within these traditions, subregional environmental variations should produce corresponding locally specific adaptations (Morse et al. 1996). The San Patrice projectile point style is thought to represent one such technological tradition developed by hunter-gatherers adapted to Early Holocene life in the Gulf Coastal Plain (Story 1990). Notable sites where San Patrice artifacts have been recovered are shown in Figure 10.

This chapter summarizes previous research into the San Patrice projectile point style. Knowledge of the chronology and distribution, when combined with environmental reconstruction data, provides clues regarding the environments encountered by hunter-gatherers making San Patrice points. Information on reduction strategies, mobility, and

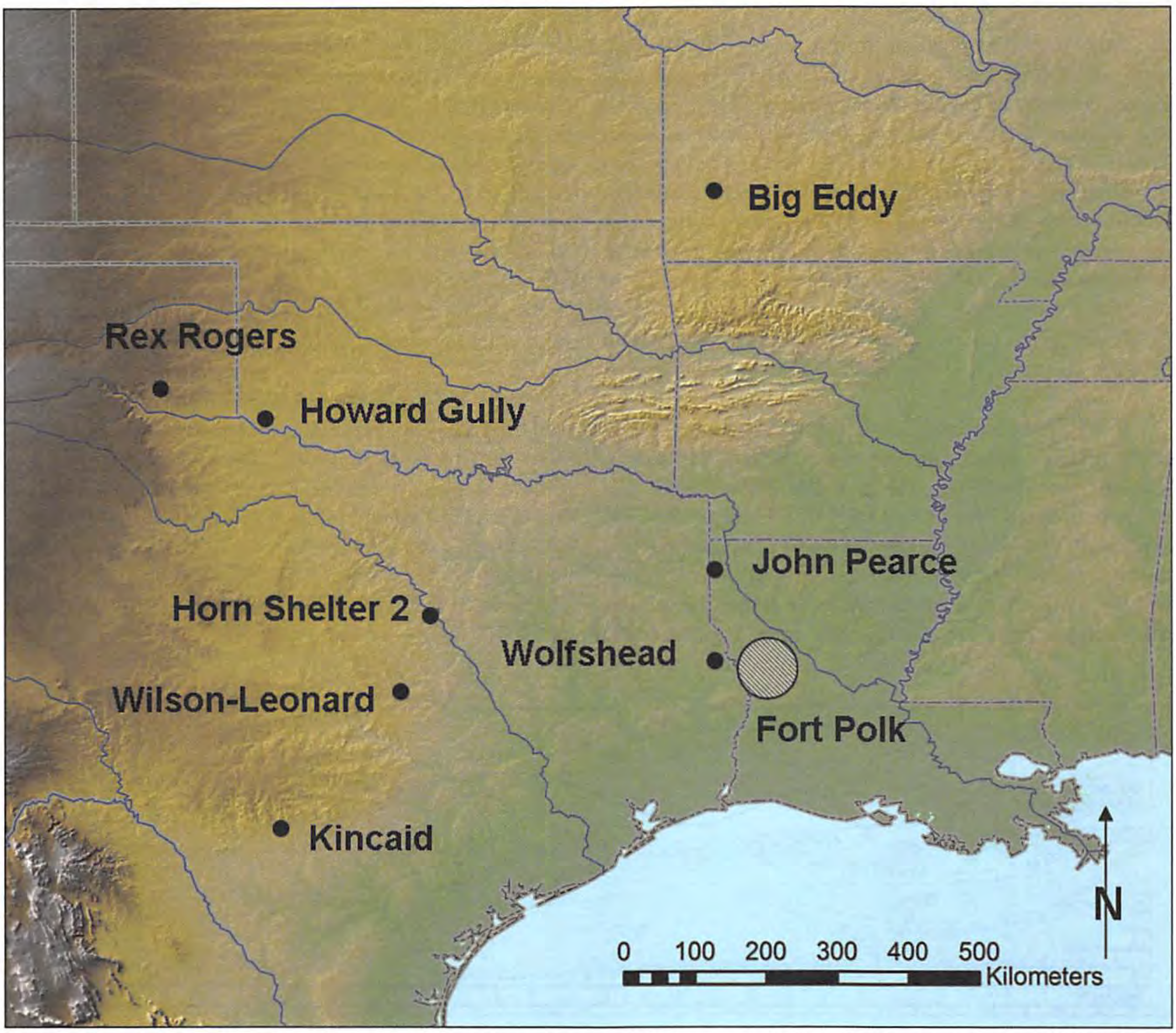


Figure 10. Map of some of the sites where notable contexts and artifacts of the San Patrice complex have been recovered.

subsistence reveals how San Patrice populations dealt with the challenges these environments presented.

Distribution and Chronology

The San Patrice "heartland" appears to be Louisiana and eastern Texas (Jeter et al. 1989; Story 1990). The distribution spreads east into Mississippi and north into Oklahoma, Arkansas, and Missouri (Jeter et al. 1989; Gilberti 1995; Ray et al. 1998; Story 1990). A few San Patrice sites have also been found on the plains to the west in Texas and Oklahoma (Hester and Newcomb 1990; Hughes and Willey 1978; Hurst 2006; Redder 1985). However, San Patrice points occur mainly in the heavily wooded Gulf Coastal Plain. Story (1990) identifies two primary concentrations, one in northeastern Texas below the Sulphur River and the other in central east Texas from the Angelina to the Sabine Rivers. Projectile points from sites to the west are thought to represent forms from San Patrice populations who moved beyond their woodland homeland and onto the plains (Story 1990).

Stratigraphic associations from key sites (Fig. 10) such as Wolfshead in eastern Texas (Duffield 1963) and John Pearce in northwestern Louisiana (Webb et al. 1971) as well as a number of sites in the Fort Polk area of west-central Louisiana (Anderson and Smith 2003) place San Patrice in a relative chronological position between early Paleoindian cultures such as Clovis and later, Archaic, cultures. Unfortunately, no San Patrice sites have been securely dated within the "heartland" because of the poor preservation of organic materials. All radiocarbon dates, therefore, come from sites in the periphery, and the temporal relationship between these sites and the "heartland" remains uncertain.

Rex Rogers, a bison kill site located in Briscoe County in the Texas panhandle, represents the westernmost San Patrice site recorded to date (Hughes and Willey 1978). Bison bone apatite yielded a date of 9118 ± 83 BP (SMU-274) (Speer 1978). However, the site was highly eroded, and the presence of Plainview points raises questions regarding with which cultural complex the bison bones are associated. A bison petrous bone from the nearby Howard Gully site, also a bison kill, in southwestern Oklahoma yielded a date of 10,214 ± 55 BP (NZ-21229) (Hurst 2006). In contrast to Rex Rogers, excavations at Howard Gully have produced San Patrice points in clear association with the bison remains. Thus, the 10,200 BP radiocarbon date more confidently documents the period of San Patrice occupation on the western plains.

Evidence from two central Texas sites, Kincaid rockshelter in the Sabinal Valley of Uvalde County (Collins et al. 1988) and Wilson-Leonard in Williamson County (Collins 1998), also supports a Late Paleoindian chronological placement. The Wilson-Leonard specimens were recovered from sediments accumulating between 8,400 and 10,000 BP (Bousman 1998b). However, retrieval of a number of other Late Paleoindian points from the same stratigraphic unit (Unit II in Fig. 11) prohibits more precise dating of the San Patrice component.

Horn Shelter No. 2 is another central Texas rockshelter site and is located along the Brazos River in Bosque County (Redder 1985). Excavators recovered San Patrice points from Strata 5F and 5G (Fig. 12). Stratum 5G yielded four radiocarbon dates (Watt 1978): 9,500 ± 200 (Tx-1830), 10,030 ± 130 (Tx-1998), 9,980 ± 370 (Tx-1722), and 10,310 ± 150 (Tx-1997). In addition to the large error associated with each of these dates, Horn Shelter No. 2, like Wilson Leonard, is not a single component site. Both strata yielding San Patrice points also possessed material from other Paleoindian cultural complexes.

The Big Eddy site in southwestern Missouri is the most well-stratified San Patrice site yet uncovered (Lopinot et al. 1998, 2000; Ray et al. 1998). The stratigraphic integrity of the site has been established through geomorphological (Hajic et al. 1998) and refitting (Stackelbeck 2000) analyses. A series of radiocarbon dates in and around the 3Ab horizon (Fig. 13) place the San Patrice occupation of the site between 9,800-10,500 BP (Hajic et al. 1998; Hajic et al. 2000).

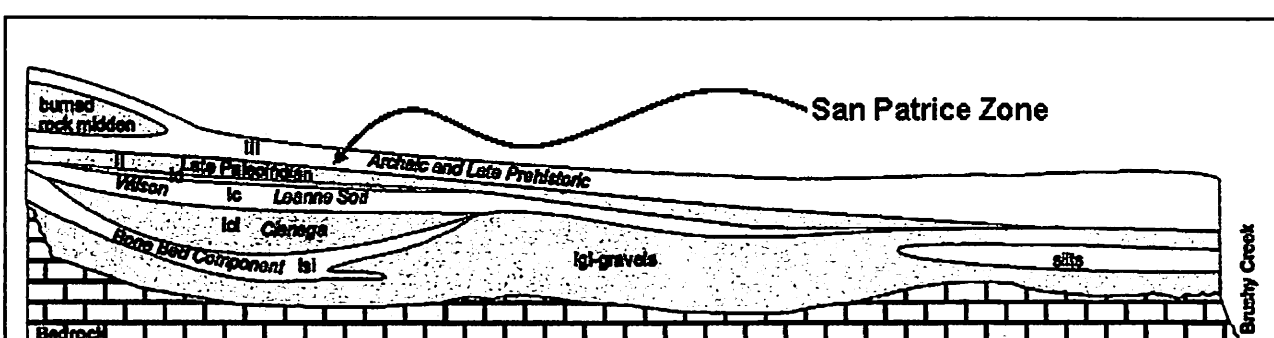


Figure 11. Illustration of the stratigraphy at the Wilson-Leonard Site, Texas. Adapted from Bousman 2004:Figure 2.26.

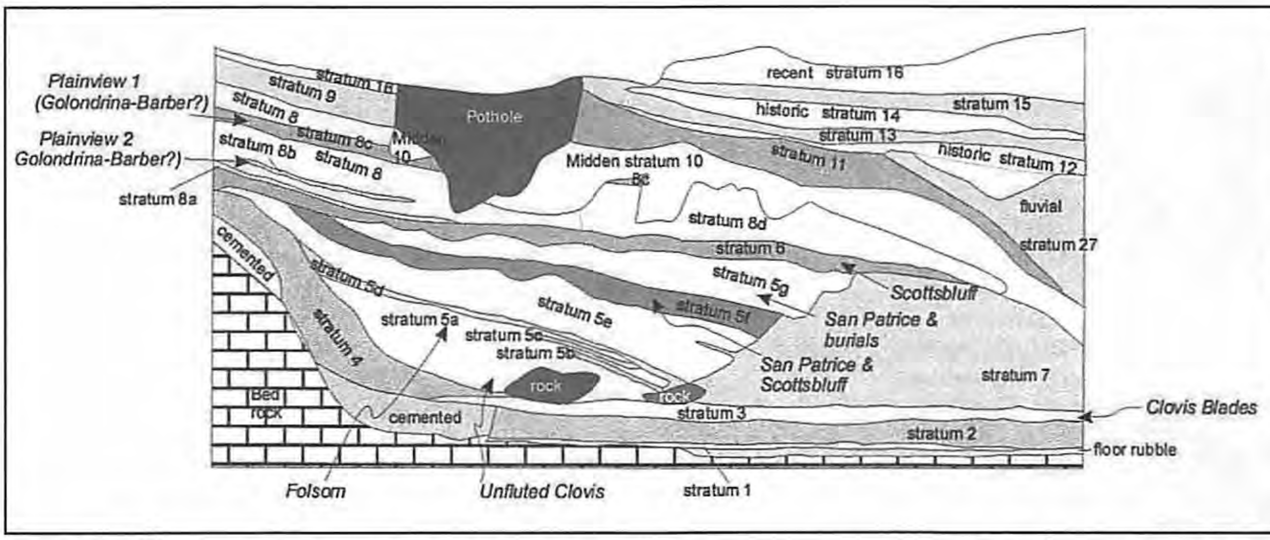


Figure 12. Illustration of the stratigraphy at Horn Shelter No. 2 in central Texas. Adapted from Bousman 2004:Figure 2.30.

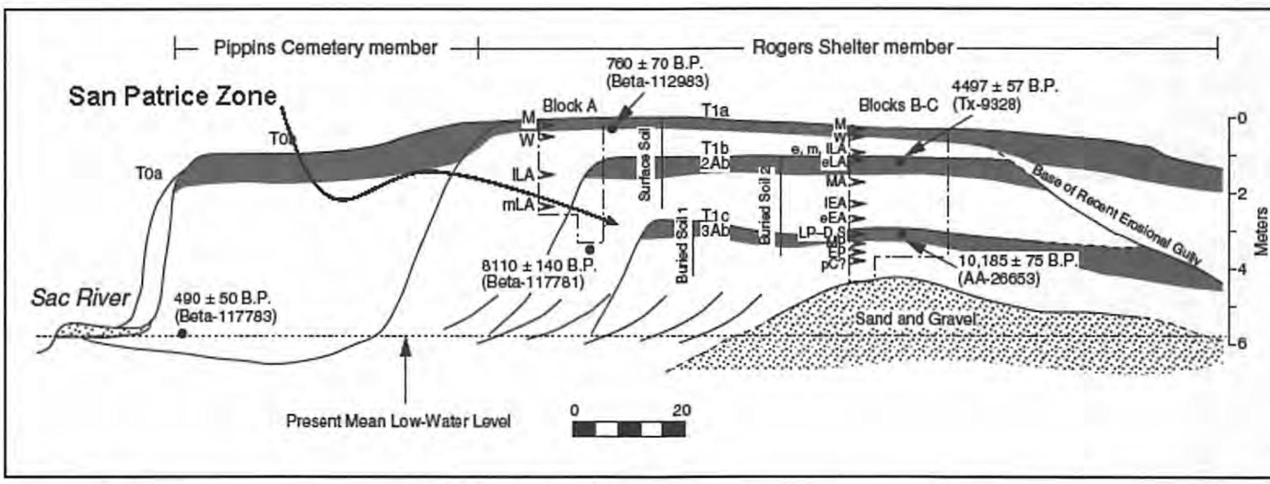


Figure 13. Illustration of the stratigraphy at the Big Eddy Site in Missouri. Adapted from Lopinot et al. 2000: Figure 1.3.

Summary of San Patrice Chronology

Our present knowledge places San Patrice firmly in the Late Paleoindian period. While the sample of sites yielding reliable dates is small, the three most securely dated sites (Horn Shelter No. 2, Howard Gully, and Big Eddy) suggest the primary period of San Patrice occupation occurred between 10,000-10,400 BP. Dates from other sites such as Rex Rogers and Wilson-Leonard provide hints that San Patrice culture may have persisted as late as 9,000 BP. It remains to be seen how these peripheral sites relate temporally to sites in the "heartland". Clearly, more findings, in the form of single component sites with datable material, are necessary to sharpen our understanding of San Patrice chronology.

Technological Organization

In addition to projectile points, discussed in greater detail later, the San Patrice toolkit (Figs. 14-16) includes the distinctive Albany scraper, although the Albany scraper (Fig. 16) now appears to be a localized phenomenon (Anderson and Smith 2003), and a variety of bifacial and unifacial tools (Anderson and Smith 2003; Duffield 1963; Griffing 1994; Johnson 1989; Lopinot et al. 1998, 2000; Redder 1985; Story 1990; Webb et al. 1971). Raw material quality greatly influenced San Patrice lithic manufacturing strategies. San Patrice is the first culture in the study area to extensively utilize local gravels (Anderson and Smith 2003; Hillman 1985; Story 1990). As such, the size of San Patrice tools is often limited by the size of the cobble (i.e., Fig. 16) from which they were crafted (Duffield 1963; Ensor 1986; Jeter et al. 1989).

The use of local gravels to manufacture projectile points required the development of alternative reduction

Figure 14. Both faces of San Patrice points, end scrapers and a graver. All scrapers and gravers made on flakes. All are from the John Pearce site, Caddo Parish, Louisiana. Scales are in centimeters. Photos courtesy of Northwestern Louisiana State University.

Figure 15. Both faces of implements, usually bifacially flaked, made from Red River jasper pebbles. The specimen in the middle row might be a preform for an adz. All scales are in centimeters. All speciments are from the John Pearce site, Caddo Parish, Louisiana. Photos courtesy of Northwestern Louisiana State University.

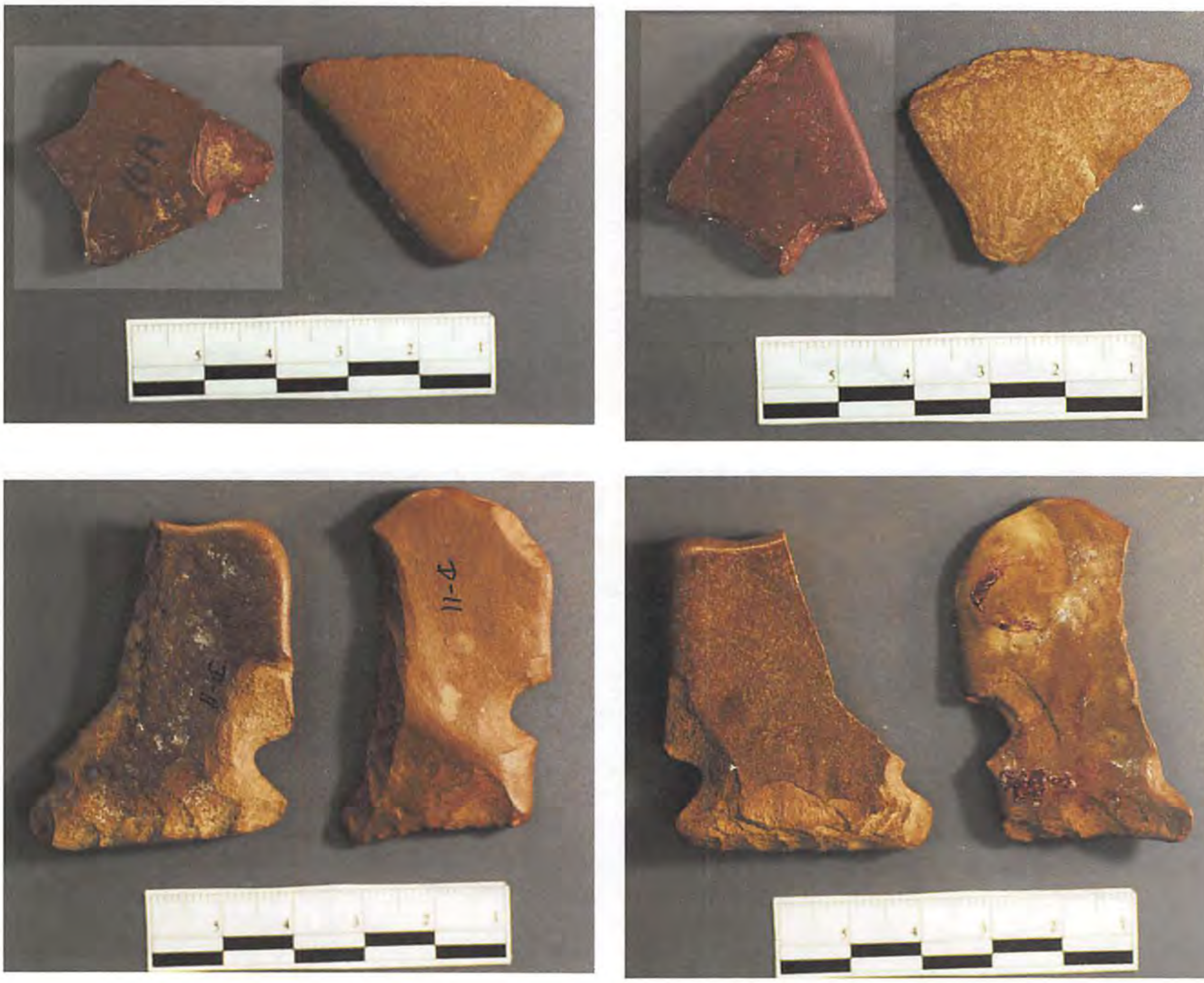


Figure 16. Top: both faces of intact and split pebbles of Red River jasper minimally flaked into pointed or side scrapers. Bottom: both faces of Albany scrapers minimally flaked from tabular pebbles and small cobbles of Red River jasper. The top row is from the John Pearce site in Caddo Parish, Louisiana, whereas the Albany scrapers are from DeSoto Parish, Louisiana. The scales are in centimeters. Photos courtesy of Northwestern Louisiana State University.

strategies (Anderson and Smith 2003). Research at the Big Eddy site provides the most detailed account to date of these strategies. There, San Patrice groups employed what Ray (1998a) has termed, "cobble-blank" reduction. Under this strategy, individual stone cobbles are transformed directly into specific tools with exterior flakes thrown out as debitage. The focus of cobble reduction appears to be the production of bifaces, however, suitable flakes produced expediently during this process at Big Eddy and Horn Shelter No. 2 served as blanks for scrapers and unifacial flake tools (Johnson 1989; Ray 1998a; Story 1990). In contrast, bifacial thinning flakes are uncommon at many sites in the Fort Polk area indicating a greater reliance on unifacial flake tools (Anderson and Smith 2003). This discrepancy may simply reflect San Patrice groups engaging in different activities at different sites.

The San Patrice projectile point type includes varieties that represent the evolution from lanceolate to side to corner notching in a temporal and cultural continuum spanning the Late Paleoindian period (Anderson and Smith 2003). The type has been subdivided into two primary varieties (Fig. 17). Both varieties have roots in the fluted point tradition, and fluting appears to have been achieved via the direct percussion technique (Ray 1998a). The Hope variety (Fig. 17) is lanceolate in shape, deeply concave based with weak shoulders, fluted, and basally ground. The St. Johns variety (Fig. 17) is more varied basally with pronounced notches (Anderson and Smith 2003; Bousman 2004; Duffield 1963; Ensor 1986; Story 1990; Webb et al. 1971). Resharpening can change them from corner-notched to side-notched. Some researchers have named other varieties such as Rogers Side-Hollowed and Brazos based primarily on subtle differences in ear shape (Hughes and Willey 1978; Redder 1985), but most researchers agree these notched points are closely associated with the San Patrice complex (Anderson and Smith 2003; Bousman 2004; Johnson 1989; Story 1990; but also see Ensor 1986).

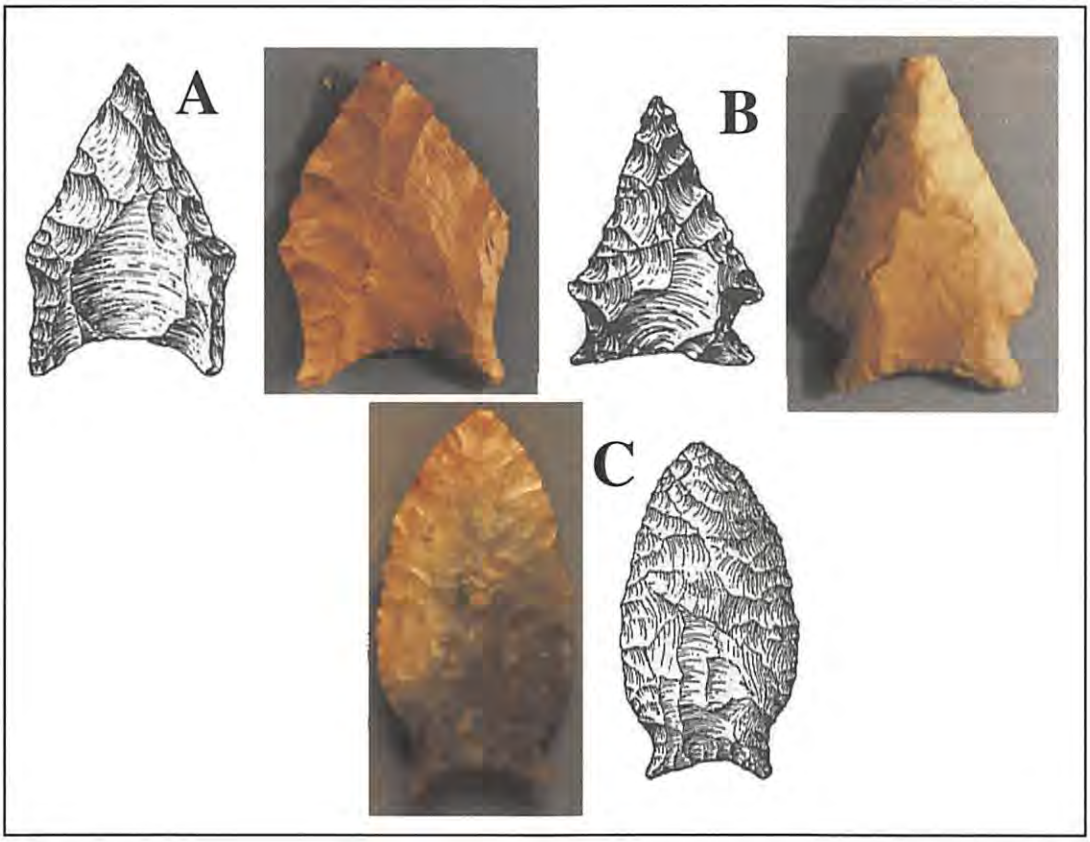


Figure 17. Drawings and photos of varieties of San Patrice points. A is the Hope *variety, whereas B is the* St. Johns *variety and C is the* Brazos *variety. Drawings A and B are adapted from Turner and Hester 1999; drawing C is adapted from Johnson 1989. All shown larger than actual size.*

Fundamentally, the St. Johns variety differs from the Hope variety by having a shortened base. The decrease in hafting area mirrors trends seen elsewhere in the Southeast during the Early Holocene (Morse et al. 1996). Although notched point styles appear to have replaced lanceolate forms throughout much of the region, exceptions occur in peripheral areas (Ellis et al. 1998). It is possible the base of Hope points gradually shortened until notched hafting eventually replaced lanceolate techniques. Morse and colleagues (1996) argue this technological shift relates to either the appearance of the atlatl or significant technological advancement of the spearthrower immediately following the Pleistocene, but no convincing arguments have yet been developed to explain this relationship (Ellis et al. 1998). Although determining the precise chronological relationship between the lanceolate and notched varieties requires more refined stratigraphic data (Ensor 1986), associations of Hope and St. Johns points at Big Eddy and numerous Fort Polk area sites demonstrate the contemporeneity of the two varieties (Anderson and Smith 2003; Lopinot et al. 2000).

Extensive blade resharpening has been noted on later stages of San Patrice points. In prior Paleoindian technologies, point reworking was concerned with reforming the tip, but, San Patrice retooling reflects, "intensive resharpening of the Paleoindian lanceolate for hafted knife usage (Morse et al. 1996:330)." Indeed Kay (2000) demonstrates through use-wear analysis (currently the only study of its kind conducted on San Patrice points) that both Hope and St. Johns varieties were used as projectiles and as knives. The nature of resharpening varies. Some points exhibit beveling or serration associated with unifacial edge retouch (Duffield 1963; Gilberti 1995; Webb et al. 1971). However, most San Patrice points are bifacially reworked (Anderson and Smith 2003; Brown 1995; Griffing 1994; Johnson 1989; Story 1990). Rigorous projectile point resharpening reflects a technological strategy designed to conserve lithic material while providing maximum tool utility (Ballenger 2001; Johnson 1989; Story 1990; Wyckoff 1999).

Relationship to Dalton

Many researchers believe San Patrice is closely related to Dalton and consider it a sub-regional expression (Anderson and Smith 2003; Ensor 1986; Morse and Morse 1983). Dalton is another Late Paleoindian projectile point form that occurs throughout the Southeast (Fig. 18), including portions of the current study area (Anderson and Sassaman 1996; Ballenger 2001; Johnson 1989; Story 1990). Morphologically, San Patrice projectile points resemble contemporaneous Dalton varieties (Daniel 1998; Ensor 1986). For Morse and colleagues (1996), San Patrice points possess a mixture of lanceolate Dalton and side-notching traits reflecting an evolutionary relationship between the two forms. San Patrice shares a number of technological similarities with Dalton. As noted, some San Patrice points exhibit beveling, and some consider this the single technological common denominator linking projectile point forms within the Dalton horizon (Morse et al. 1996). Finally, Dalton groups employed a variety of knapping strategies depending on the size, shape, and quality of lithic material available (Wyckoff 1999), and San Patrice groups appear to have utilized the same strategies when faced with similar circumstances (Ensor 1986; Ray 1998a).

Significant differences do exist, however, between San Patrice and Dalton technologies. While their territories do overlap somewhat the San Patrice range lies largely south of Dalton, and much of that region is devoid of Dalton points (Lopinot et al. 1998, 2000; Story 1990). San Patrice blades are more leaf-shaped, and initial stage blade edges extend well beyond the width of the base. As noted, some San Patrice blade edges were unifacially resharpened, however, most exhibit no evidence of the beveling so common to Dalton technology. Moreover, Dalton point

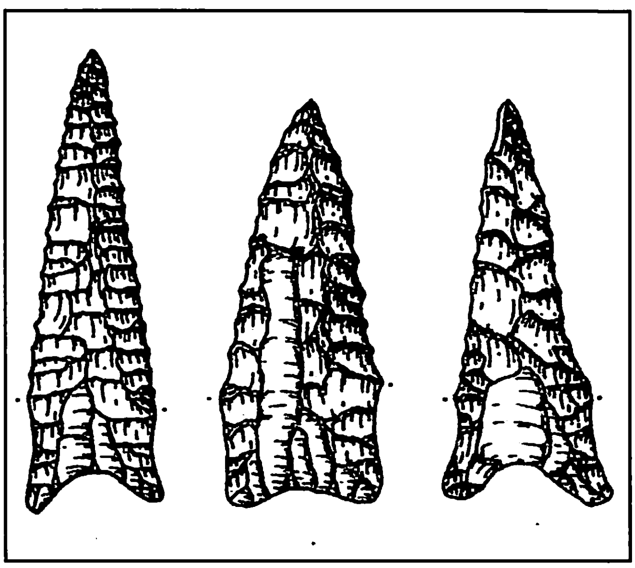


Figure 18. Examples of Dalton points and varying degrees of blade resharpening. All are from Haskell County, Oklahoma. Adapted from Ballenger 2001.

resharpening was angled perpendicular to the long axis resulting in a final stage drill-like blade (Ballenger 2001; Goodyear 1974; Wyckoff 1999). In contrast, San Patrice reworking occurred perpendicular to the blade, producing a short, stubby final stage point (Ensor 1986; Story 1990). The San Patrice toolkit lacks the diagnostic Dalton adze; likewise, Dalton populations never manufactured Albany scrapers (Ensor 1986; Story 1990). Finally, although both complexes are derived from fluted point traditions, San Patrice points were fluted more consistently, and fluting was achieved via direct percussion rather than pressure flaking (Lopinot et al. 2000). Taken together, these differences reveal San Patrice to be a unique complex, culturally distinct from contemporaneous Southeastern traditions.

Subsistence and Mobility

Given the location of the "heartland" in the Gulf Coastal Plain, most researchers assume San Patrice groups primarily adapted to living in woodland environments (Ensor 1986; Johnson 1989; Story 1990). Ensor (1986) argues that adaptation to forest environments distinguishes San Patrice culture from nearby plains big-game hunters. Projectile point distributions suggest San Patrice bands regularly exploited resources in more upland settings (Story 1990), and increasing cultural diversity during this time period may reflect regional adaptations to microenvironments (Ensor 1986).

Some argue the technological changes which occur with the emergence of San Patrice and other sub-regional technological traditions are tied to the shift from hunting megafauna, which became extinct at the end of the Pleistocene, to smaller game (Anderson and Smith 2003; Morse et al. 1996). As with radiocarbon dating, poor preservation of organic materials in the "heartland" greatly hinders research regarding the plants and animals San Patrice groups regularly consumed, and by analogy with Dalton, exploitation of deer is hypothesized (Jeter et al. 1989). Once again, however, sites in the periphery provide insight. San Patrice levels at Horn Shelter No. 2 yielded faunal remains which included deer, fish, turtle, snake, rodents, rabbits, and bird (Redder 1985), revealing a broad spectrum diet and exploitation of both terrestrial and riverine environments. Whether or not one accepts the association of San Patrice points with the Rex Rogers bison kill site (Hughes and Willey 1978), Howard Gully provides clear evidence of San Patrice groups exploiting plains resources (Hurst 2006).

Precious few studies have investigated the role mobility plays in San Patrice adaptations to these environments. Although San Patrice populations relied heavily on local stone tool sources, the presence of a few points of extralocal high quality cherts in the Fort Polk area implies a conservation strategy by mobile groups (Anderson and Smith 2003:359) and "extensive reuse and curation of materials was indicated during the San Patrice period" (Anderson and Smith 2003:152). Once more, analogies with Dalton may provide a starting point for estimating how far groups traveled. For Dalton populations, "[m]ovements of peoples over a distance of 150-200 km or more have been postulated" based on raw material sourcing studies (Morse et. al. 1996:329). The Big Eddy site appears to be a rendezvous location where non-resident San Patrice groups periodically visited Dalton groups in the Ozarks (Lopinot et al. 1998, 2000). As such, San Patrice bands clearly moved significant distances beyond their home territory. Lopinot and colleagues (2000) cannot, however, rule out the likelihood that lithic materials were exchanged at these gatherings. Thus, raw material sourcing from Big Eddy, in their view, cannot provide definitive information regarding the distances San Patrice populations traveled.

Summary

The San Patrice projectile point first emerged around 10,400 BP and may have remained in use as late as 9,000 BP. Points occur in greatest densities in the woodlands of eastern Texas and western Louisiana, but they also occur on the plains to the west. Two primary varieties of San Patrice points have been defined, a lanceolate form and a notched form, and these appear to represent opposite ends of a continuum reflecting decreasing hafting area. While less mobile than earlier Paleoindians, technological organization and raw material sources implicate San Patrice groups maintained a high degree of mobility as they exploited woodland resources in the Gulf Coastal Plain region.

Chapter 5
Methods

As discussed in the previous chapters, the Early Holocene environment differed markedly from that of the Pleistocene. For the current study, the most important aspect of the changing environment is the eastward expansion of grassland habitats. Current evidence indicates the plains-woodland boundary was considerably east of its present day location. While the majority of known San Patrice sites are situated well within the woodlands, a few sites occur firmly in the plains. Thus, groups of San Patrice hunter-gatherers apparently exploited, at least minimally, two distinctly different environments. Based on ethnographic analogy, populations living on the plains should employ adaptive strategies distinct from those in the woodlands. The methods employed in this thesis are designed to address several questions regarding San Patrice adaptations and projectile technology along the plains-woodland border:

1. In terms of projectile point hafting technology, are significant differences evident between lanceolate and notched San Patrice points?
2. How intensively did San Patrice groups exploit plains environments? Further, do technological strategies, specifically blade resharpening as evidenced by projectile point distributions or blade beveling and serration, differ across the plains-woodland border?
3. Do mobility strategies, as evidenced by raw material procurement, differ across the plains-woodland border?

To help answer these questions, a sample of 198 San Patrice projectile points, which includes artifacts from Wolfshead (Duffield 1963), John Pearce (Webb et al. 1971), Horn Shelter No. 2 (Redder 1985), and several Fort Polk area sites (Anderson and Smith 2003) as well as a number of specimens recovered by avocational archaeologists, is analyzed. The data recorded for each point consists of a series of metric measurements selected to document variation in blade and base size and shape. These variables, all measured in mm, are maximum Thickness, total Length, Blade Length, maximum Blade Width, Base Length, maximum Base Width, and basal Concavity (Fig. 19). In addition, two ratios, Blade Length / Blade Width and Base Length / Base Width, approximate the blade and base shape, respectively. Any evidence of beveling or serration of the blade is also noted.

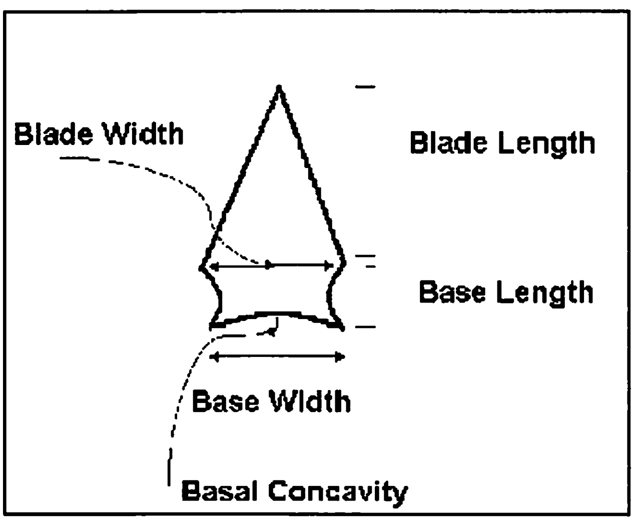


Figure 19. Measurements recorded in this study of San Patrice points.

The comparative lithic collection at the Oklahoma Archaeological Survey aided in the identification of lithic material source for each point. Don Wyckoff (Sam Noble Oklahoma Museum of Natural History), Michael Collins (Texas Archeological Research Laboratory), and Pete Gregory (Northwestern State University) also assisted with raw material classification. Sources are grouped into seven broad categories defined by Banks (1990) and described briefly in Chapter 2: the Ozarks, the Ouachitas, the Flint Hills, Antlers gravels, Edwards, Alibates, and other gravel cherts, quartzites, and petrified woods.

Provenience information is also presented for each specimen. Location data for points recovered from excavated sites are obviously quite precise. However, for some of the surface collected points, only the county of origin is known. For consistency, therefore, the provenience information for all specimens is restricted to the county level. The projectile points in the present sample come from a number of counties in Oklahoma, Texas, and Louisiana (Fig. 20). I should stress that the composition of the sample reflects a desire to have roughly equal numbers of points from the western and eastern portions of the study area. As such, the number of points from each individual county in no way reflects the intensity of San Patrice occupation within that county.

Hafting Technology

The San Patrice projectile point type has been broken down into two main varieties: Hope and St. Johns (including Brazos), and current evidence shows these varieties were at least partially contemporaneous (Anderson and Smith 2003; Lopinot et al. 1998, 2000). They were manu-

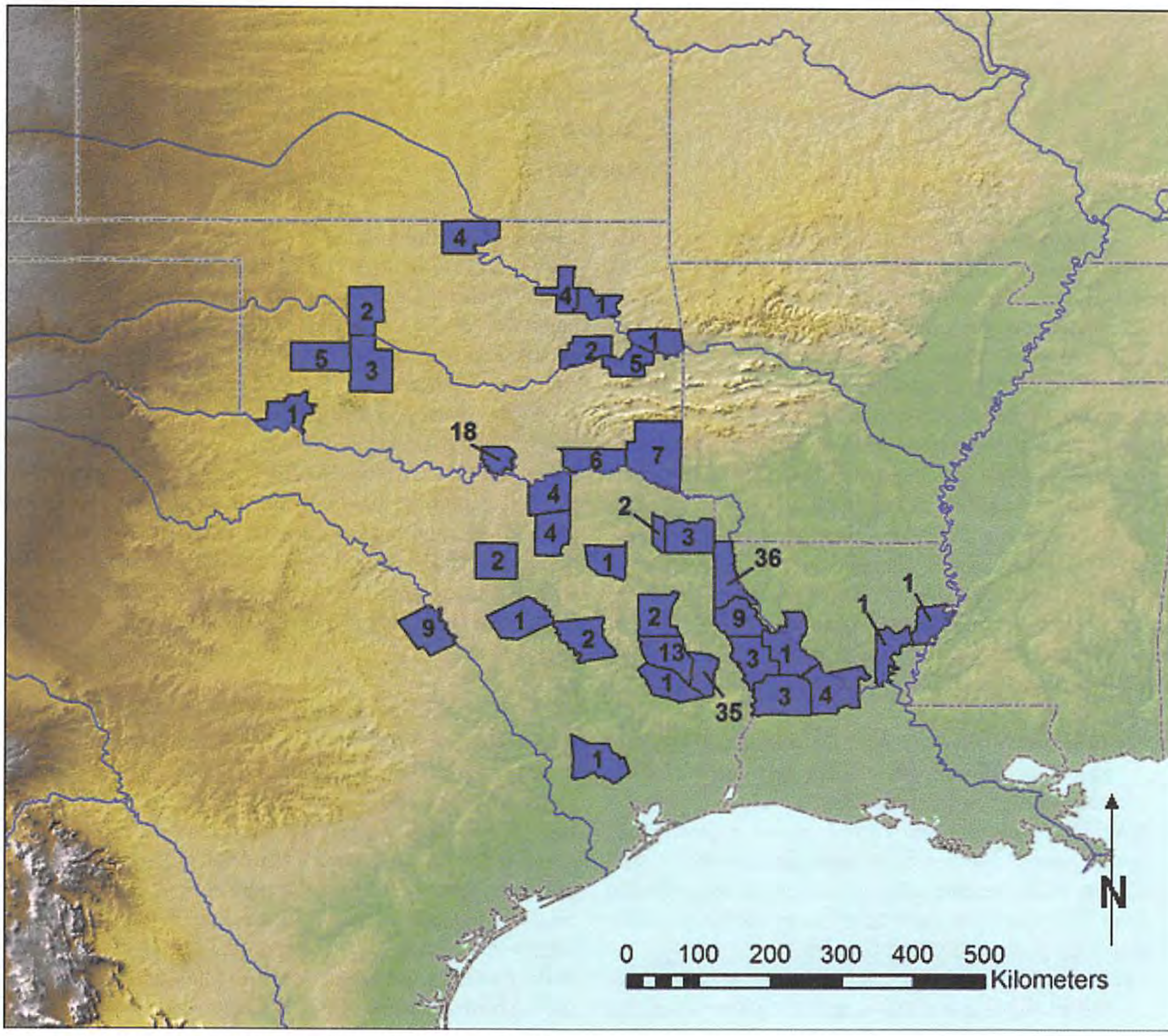


Figure 20. County distribution of San Patrrice projectile points in the sample of this study.

factured and utilized at the same time and were part of the same toolkit. Some researchers contend the San Patrice varieties reflect a Late Paleoindian trend of gradually decreasing haft area culminating in notched projectile points (Morse et al. 1996). However, few studies have empirically investigated the nature of this change.

Do Hope and St. Johns points simply represent opposite ends of the same continuum from lanceolate to notched hafting? If so, Hope and St. Johns points should grade into one another in a gradual transition of decreasing base length. If, on the other hand, the shift in hafting technology was more abrupt, comparisons should reveal significant differences between the haft areas of the two varieties. Cluster analysis, a generic term referring to a variety of methods for revealing and defining homogeneous groups within a given data set, is employed to test this possibility.

Cluster analysis has long proven useful in projectile point typology studies, and the goal is to classify subsets of individuals which are similar to each other yet different from individuals in other groups (Baxter 1994; Bradbury and Carr 2003; Kerr 2000). The two most commonly employed methods are hierarchical and k-means clustering (Mirkin 2005). Hierarchical agglomerative clustering builds clusters in bottom up fashion starting with each data point as a single cluster. Clusters are then gradually and sequentially merged until all data points fall within a single cluster. This structure can be visualized as a dendrogram in which longer stems reflect greater distances between clusters. In contrast, in k-means clustering, the number of clusters, k, is user defined. Computation iterations consist of two steps. First, data points within a minimum distance from a cluster centroid are assigned to that cluster. Second, cluster centroids are updated to account for new members. Iterations proceed until all data points have been assigned to a cluster, producing k mutually exclusive clusters.

As Baxter (1994) notes, cluster analysis is a heuristic tool that should be used with some degree of caution. Although the goal is to identify distinct clusters, clear differences do not necessarily exist in the data. This can pose a problem for k-means clustering in which the number of clusters is not always obvious. In such circumstances, cluster analyses can impose inappropriate structure on archaeological data. Thus, care must be taken to ensure clusters reveal real patterns. Finally, it should also be noted that cluster analysis cannot detect all patterns present in a given data set. Computer algorithms have limits, and the results of any analysis should be combined with other research methods.

If carefully employed, however, cluster analysis can be an extremely powerful tool whose primary advantage for the current study is the removal or at least minimization of the subjectivity so integral to many typological analyses. Applying multiple cluster methods provides one means for alleviating some of the problems associated with cluster analyses (Baxter 1994). The present study first employs hierarchical clustering in order to determine the number of clusters present in the data. Once determined, all subsequent analyses utilize the k-means method. The kappa statistic was used as a measure of agreement to evaluate the similarity of the two clustering techniques. A small sub-sample of the San Patrice points analyzed in the present study have been previously assigned to one of three Late Paleoindian varieties, Hope, St. Johns, and Brazos. Comparing this sub-sample to the generated clusters tests the accuracy of the clustering method. Because San Patrice point blades frequently exhibit evidence of resharpening (Anderson and Smith 2003; Brown 1995; Duffield 1963; Gilberti 1995; Griffing 1994; Johnson 1989; Story 1990; Webb et al. 1971) clusters are defined using only point Thickness and the haft variables Base Length, Base Length/Width ratio, and Concavity. If distinct metric differences exist between the hafting regions of Hope and St. Johns points, cluster analysis will help reveal them. Follow up comparisons consider blade variables.

Comparison to Dalton

Many researchers have noted the similarities between San Patrice and Dalton projectile points (Anderson and Smith 2003; Ensor 1986; Morse and Morse 1983). To determine whether significant differences exist in hafting techniques, cluster analysis is again utilized. Ballenger (2001) presents data on a number of Dalton points from eastern Oklahoma. The first 50 complete Dalton points presented from the Billy Ross locality are compared to the San Patrice points from the current study. No points from the Billy Ross sample show evidence of notching. The primary focus, therefore resides in the differences between Dalton and Hope variety points. Unfortunately, Ballenger (2001) did not record basal concavity, so cluster analyses consider only Thickness, Base Length, and Base Length/Width ratio. Although not explicitly recorded, Dalton point Base Length is calculated by subtracting blade length from the total length.

Technological Comparisons of San Patrice Points from the Plains and Woodlands

Given the presence of many San Patrice sites within the Coastal Plain region, researchers traditionally assume San Patrice points are associated with woodland adapted hunter-gatherers (Ensor 1986; Johnson 1989; Story 1990). Although sites occur on the Plains (Hester and Newcomb 1990; Hughes and Willey 1978; Hurst 2006; Redder 1985), little is known about San Patrice interactions beyond forest environments. The current study examines projectile point distributions and raw material sources to shed light on adaptations across the Early Holocene plains-woodland border as reconstructed using palynological evidence from Oklahoma and eastern Texas (Bousman 1998a; Graham and Heimsch 1960; Holloway 1994; Larson et al. 1972) and climatic reconstruction models (Prentice et al. 1991; Webb et al. 2004). To this end, projectile points are grouped by county into Woodland and Plains categories (Fig. 21). Counties in the Woodland group lie well east of the plains-woodland border in a fully forested Late Pleistocene environment. These include counties located within the "heartland" as defined by Story (1990). Plains counties are those which lie west of and adjacent to the plains-woodland border in grassland or grassland-woodland ecotone Late Pleistocene environments.

If San Patrice groups routinely exploited plains environments, projectile point distributions should include numerous counties and extend well into the plains. Moreover, familiarity with plains resources should be reflected in lithic material choice. If San Patrice hunter-gatherers regularly lived on the plains, alternative adaptations associated with living in open grasslands, namely increased mobility, should be evident. These adaptations should differ significantly from the strategies of woodland groups (Kelly 1995). Comparing raw material use and the distribution of lanceolate vs. notched points and the percentage of beveled points across the plains-woodlands border should reveal such strategies.

Plains and Woodland Mobility Strategies

As noted, raw material sourcing can provide clues to the distances hunter-gatherer groups traveled (Binford 1979; Goodyear 1989). Ray (1998a:226) defines three categories of lithic resources: local, nonlocal, and exotic. Local resources, occurring within 10 km of a given site, are those which hunter-gatherers had access to daily. Nonlocal resources require more than 1 day and less than 10 days to procure and occur between 10 and 100 km from a site. Exotic resources require significant effort to obtain and occur greater than 100 km from a site. The present study adopts these definitions with one caveat. Ray's (1998a) local and nonlocal categories are grouped together, and hereafter the term "local" applies to this grouping. For analytical pur-

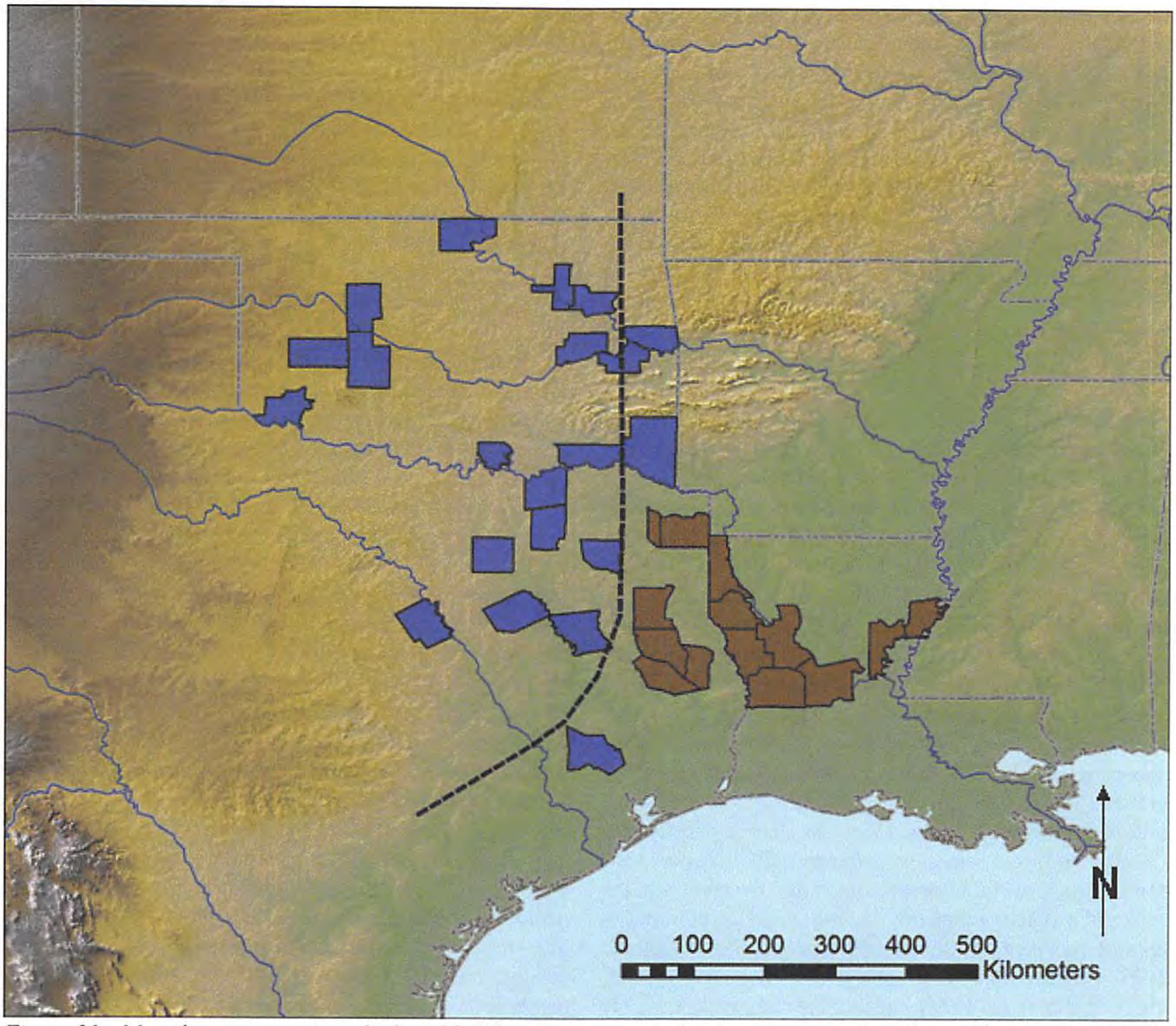


Figure 21. Map showing counties which yielded San Patrice points for the current study. Plains (blue) and Woodland (brown) counties are depicted in relation to the Plains-Woodland border (dashed line) of 10,000 years ago.

poses, raw materials are considered locally procured if any portion of the lithic source outcrops within 100 km of the center of a county from which a given projectile point was recovered. Likewise, gravel cherts, quartzites, and petrified woods, including Alibates cobbles in the Canadian River (Wyckoff 1993), are considered locally procured if any portion of the gravel bearing formation lies within the same distance. For projectile points manufactured on exotic raw materials, the straight-line distance from a county center to the edge of a raw material source location is calculated. Raw material use in the plains and woodlands is then compared.

Statistical Evaluations

All statistical operations, including cluster analyses are performed in SPSS 12.0.1. Categorical data is analyzed using the Fisher's Exact test for 2x2 tables and the likelihood chi square test for lager tables. Comparisons between continuous variables are performed with the t-test. A p-value less than 0.05 is considered statistically significant.

Forty-eight specimens resulted in missing data in at least one category. Cluster analysis is performed on the remaining 150 San Patrice points. Selected examples of these studied specimens are shown in Figures 22 through 34.

Figure 22. Examples of San Patrice points from Caddo Parish, Louisiana. The top row examples are from the John Pearce site. Photos courtesy of Northwestern Louisiana State University. Scales are in centimeter increments.

Figure 23. San Patrice point examples from various counties in Texas. Top left: Montgomery County; top right: Cass County; bottom left: Fanin County; and bottom right: Bosque County. Scales are in millimeter or centimeter (lower right) increments.

Figure 24. Two examples of San Patrice points from the Horn Shelter, Bosque County, Texas. Scales are in centimeter increments. Photos courtesy of Baylor University.

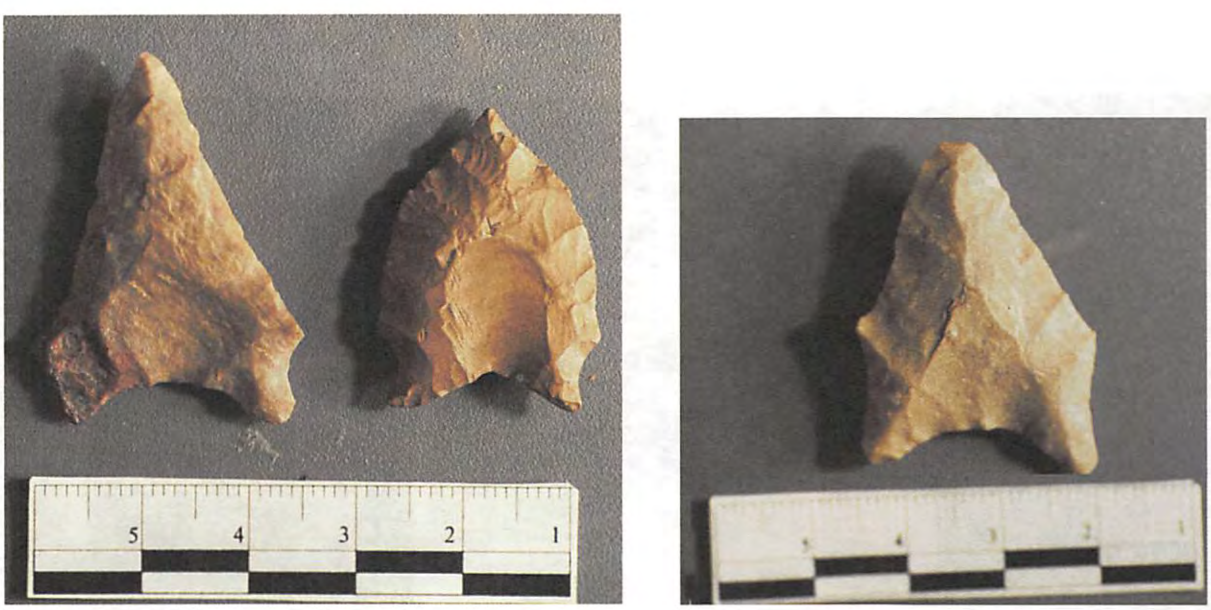


Figure 25. Three examples of San Patrice points from the Wolfshead site, San Augustine County, Texas. Photo courtesy of the Texas Archeological Research Laboratory, University of Texas. Scales aare in centimeter increments.

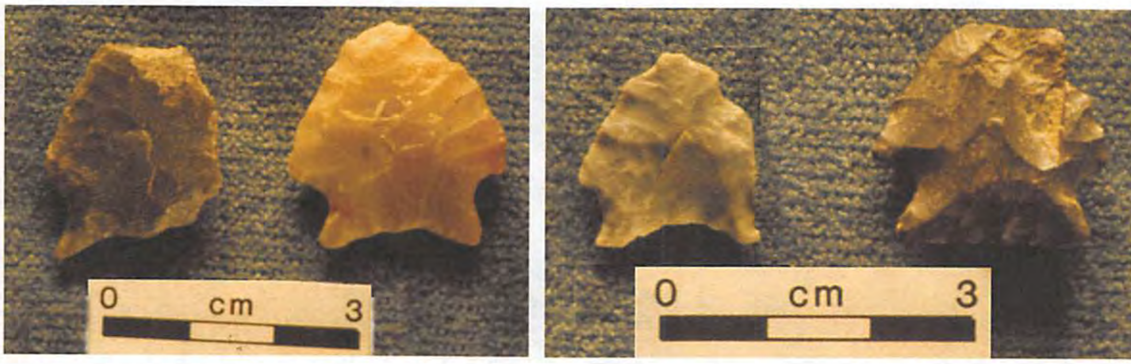


Figure 26. San Patrice points recovered from excavated sites in souhteastern Oklahoma. The two on the left come from 34Mc21, whereas the two on the right are from 34Mc105, both sites being in the Broken Bow Reservoir area of McCurtain County. The scales are in centimeters.

Figure 27. Southeastern Oklahoma surface find examples of San Patrice points. The left and center specimens are from McCurtain County, whereas the right example is from Choctaw County. Photos courtesy of Keith Bean. The scales are in centimeter increments.

Figure 28. Examples of San Patrice points from eastern Oklahoma. The specimen on the left is from Haskell County, whereas the center and right specimens are from site 34Mi136, McIntosh County. Artifact photos courtesy of Billy Ross and Vera McKellips. The scales are in millimeter (left and right) or centimeter (middle) increments.

Figure 29. San Patrice examples from northeastern Oklahoma. All were found in the Arkansas River. The specimen on the left is from Wagoner County, and the center and right specimens are from Tulsa County. All specimens were loaned for study by Dr. Jim Cox. The scales are in centimeter increments.

Figure 30. San Patrice specimens from north-central Oklahoma. All were found in the Arkansas River in Kay County. Specimens loaned for study by Barry Splawn and Dr. Jim Cox. The scales are in centimeter increments.

Figure 31. San Patrice projectiles from along the Red River in Marshall County, south-central Oklahoma. Specimens loaned for study by Mike Waller and Dr. Jim Cox. The scales are in centimeter increments.

Figure 32. San Patrice points from west-central Oklahoma. The one on the left is from Blaine County, and the one (a cast) on the right is from Caddo County. Artifacts loaned for study by Terrell Nowka and Dr. Jim Cox. The scales are in centimeter increments.

Figure 33. San Patrice examples from southwestern Oklahoma. All three of these specimens were found in Washita County and were loaned for study by Dean Gamel. The left one is Alibates, whereas the center is a glossy jasper and the one on the right is a heated quartzite (most probably Ogallala). The scales are in centimeter increments.

Figure 34. An Edwards chert example found in Jackson County, southwestern Oklahoma. It was loaned for study by Lawrence and Gene LeVick. The numbered scale is in centimeter increments.

Chapter 6
The Results

This chapter presents analyses of 198 San Patrice projectile points recovered from a variety of locations through out the Southern Plains and Eastern Woodlands with the goal of improving our understanding of Early Holocene adaptations. Emphasis is placed on exploring the transition from lanceolate to notched hafting technology as viewed from changing projectile point base forms. Subsequent analyses test potential differences in San Patrice adaptive, technological, and mobility strategies across the plains-woodland border.

Hafting Technology

Analyses of San Patrice hafting technology begins with hierarchical clustering. Although data was collected on 198 points, broken bases on 48 specimens resulted in missing data in at least one category. Cluster analysis is performed on the remaining 150 San Patrice points.

Exploratory hierarchical clustering (using Base Length, Thickness, Concavity, and Base Length / Width ratio) reveals two primary clusters and one single outlier, easily visible in the cluster dendrogram (Fig. 35). Of the previously typed San Patrice projectile points, Hope variety points dominate the smaller of the two clusters which consists of 30 specimens. The larger cluster, numbering 116 points, contains St. Johns and Brazos variety points as well as a few Hope points.

Based on these results, the subsequent k-means cluster analysis is limited to two clusters. All 150 points are grouped into one of two clusters, including the outlier which hierarchical clustering identified. The hierarchical method and the k-means method grouped a few specimens differently. However, a high level of agreement exists between the two clusters (Table 1).

Given the similarity between the two clustering methods, all subsequent analyses utilize only the clusters generated via the k-means method. Clusters 1 and 2 consist of 34 (including the outlier identified by the hierarchical clustering method) and 116 projectile points, respectively for a total of 150 points. Comparing the generated clusters to the sub-sample of 47 projectile points previously assigned to the Hope, St. Johns, and Brazos varieties facilitates renaming of the clusters. All St. Johns and Brazos variety points group into Cluster 2 (Table 2). The majority of Hope variety points fall into Cluster 1. Although these results are not statistically significant due to the small sample size of previously typed projectile points, the clusters can be confidently renamed. For the remainder of this thesis, Cluster 1 has been renamed the Hope Cluster. Cluster 2 has been renamed the St. Johns Cluster.

As mentioned in Chapter 5, k-means clusters are defined using four variables, Thickness, Base Length, Base

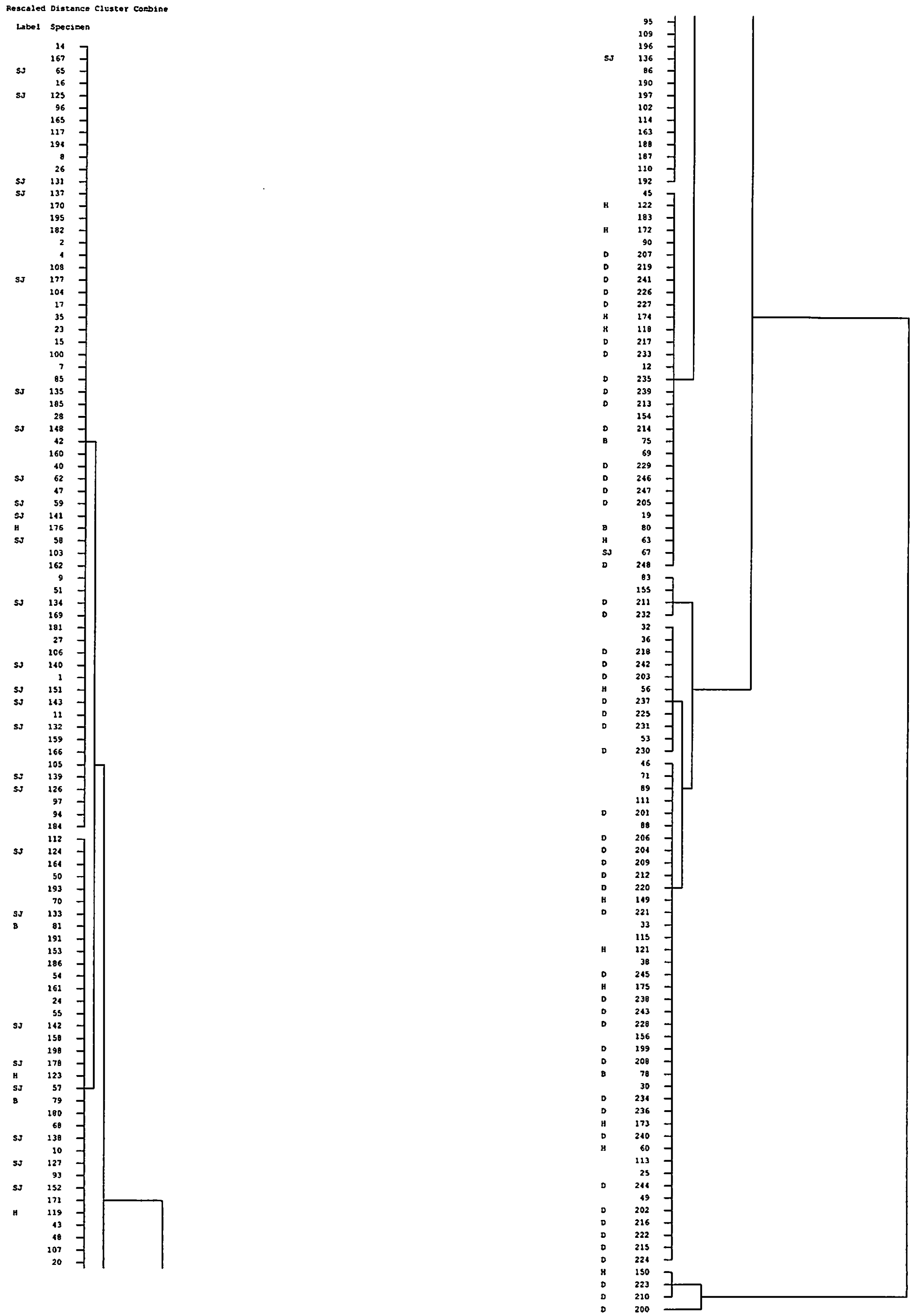
Table 1. Comparison of Hierarchical and K-means clusters of San Patrice Points.

		K-Means Cluster		Total
		1	**2**	
Hierarchical Cluster	**1**	30	0	30
	2	3	116	119
Total		33	116	149
Kappa (Measure of Agreement)				.940

Table 2. Comparison of Previously Typed San Patrice Varieties to the Generated K- means Clusters.

		K-Means Cluster		**Total**
		1	2	
Variety	*Hope*	11	4	15
	St. Johns	0	28	28
	Brazos	0	4	4
	Unspecified	23	80	103
Total		34	116	150

Figure 35. Hierarchical clustering dendrogram of San Patrice and Dalton points. Previously typed point labels: sj, St. Johns; h, Hope; and B, Brazos. Specimen numbers correspond to Appendix A.



Length / Base Width ratio, and Concavity. Once each of the 150 points is assigned to a cluster, follow up comparisons consider all eight blade and haft variables. Table 3 presents comparisons of the means for each cluster by variable. T-tests for equality of the means reveal significant differences for 6 of the 8 variables. No differences exist between the two clusters for the average shape of the blades (Blade Length / Blade Width) or average blade lengths. However, the Hope and St. Johns clusters represent two distinct populations for all other variables. On

Table 3. Cluster Means by Variable and P-values of T-tests for Equality of Means.

	K-Means Cluster	Number of specimens	Mean	Std. Deviation	p-value
Blade Length	Hope	26	24.8288	10.80374	.766
	St. Johns	94	24.2085	8.99072	
Blade Width	Hope	34	25.1859	3.89045	<.001
	St. Johns	115	22.7892	3.25221	
BladeLength / BladeWidth	Hope	26	.9652	.32929	.247
	St. Johns	93	1.0542	.34939	
TCK	Hope	34	6.8315	1.20613	<.001
	St. Johns	116	5.1036	.96363	
Base Length	Hope	34	15.5353	2.34860	<.001
	St. Johns	116	8.4438	1.61532	
Base Width	Hope	34	23.6494	4.03819	<.001
	St. Johns	116	19.3434	2.64432	
BaseLength / BaseWidth	Hope	34	.6694	.11720	<.001
	St. Johns	116	.4374	.06706	
Concavity	Hope	34	4.3682	1.44498	<.001
	St. Johns	116	2.9303	1.09881	

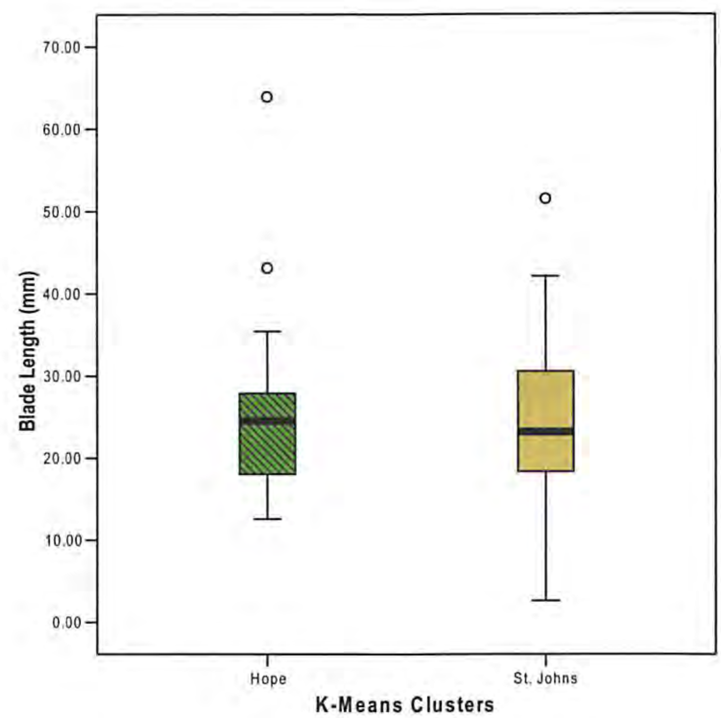


Figure 36. Box plot comparing Hope and St. Johns clusters for blade length. Black line represents the populationn median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

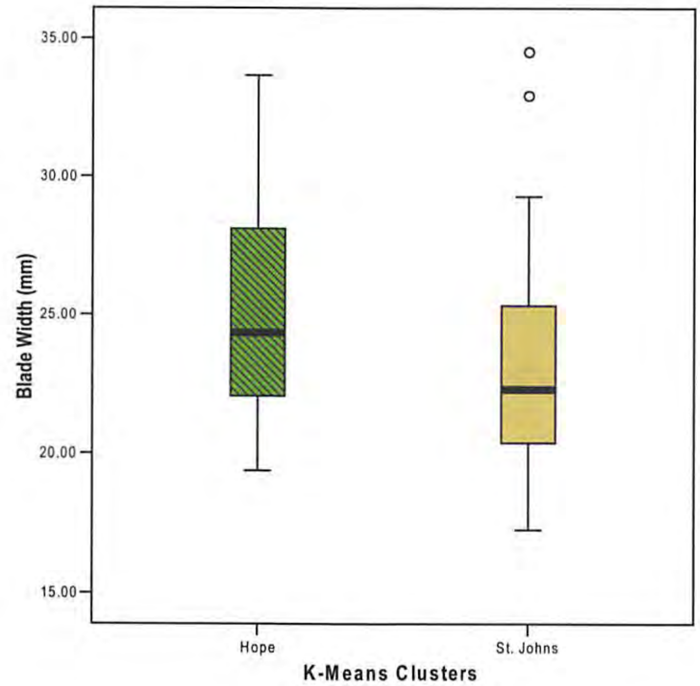


Figure 37. Box plot comparing Hope and St. Johns clusters for blade width. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

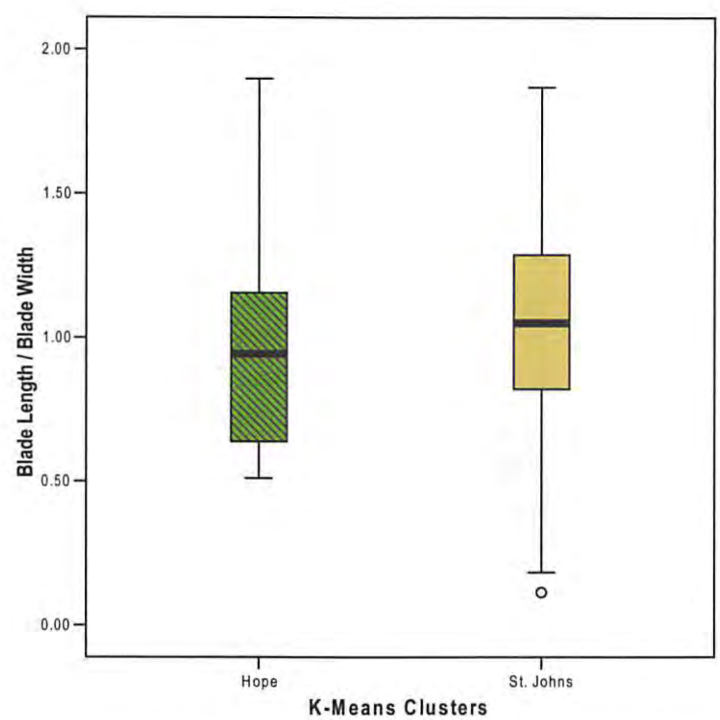


Figure 38. Box plot comparing Hope and St. Johns clusters for blade length/blade width. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

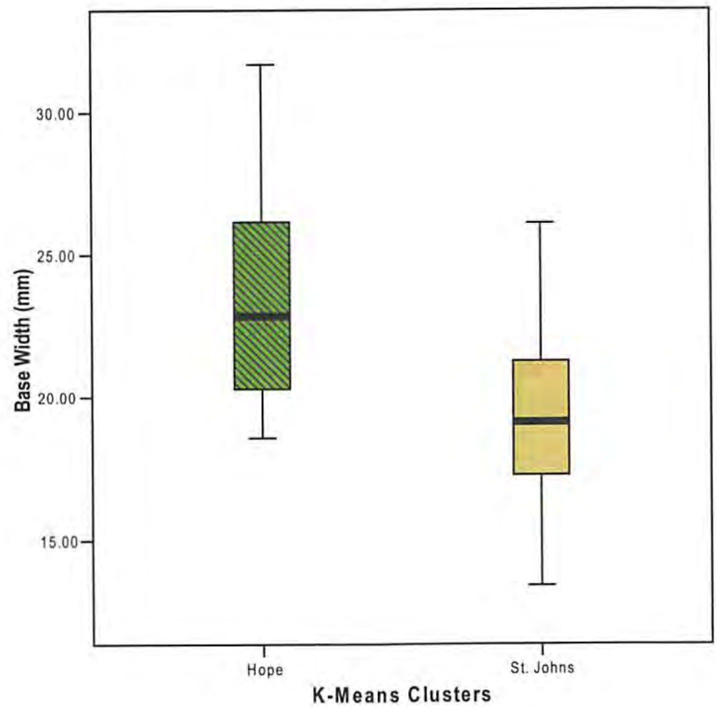


Figure 39. Box plot comparing Hope and St. Johns clusters for base width. Black line represent the population median. Boxes are bounded by 1st and 3rd quartiles.

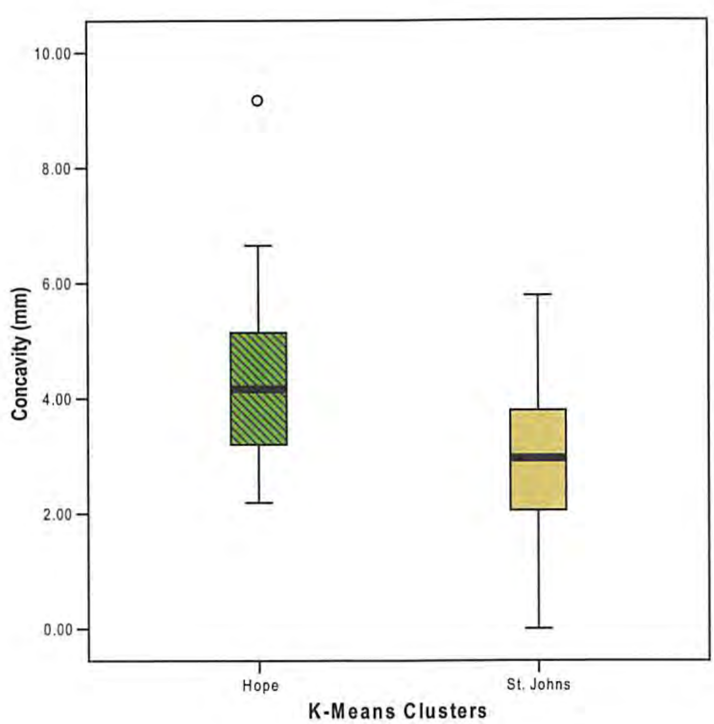


Figure 40. Box plot comparing Hope and St. Johns clusters for basal concavity. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

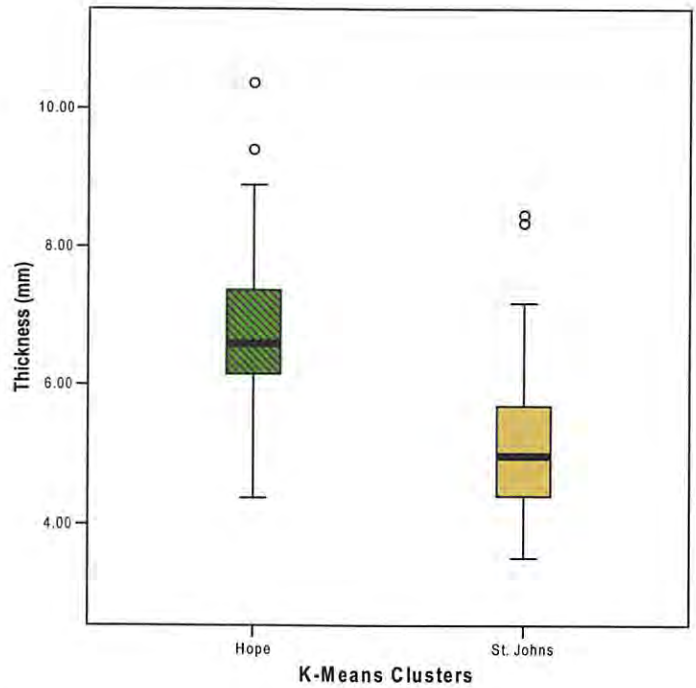


Figure 41. Box plot comparing Hope and St. Johns clusters for thickness. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

average, Hope Cluster points possess wider blades, longer and wider bases, a greater base length to width ratio, greater overall thickness, and deeper basal concavity than St. Johns Cluster projectile points. In other words, the Hope cluster points are larger in every dimension recorded than the St. Johns cluster points.

Despite the distinctness of the average sizes and shapes of projectile points, the Hope and St. Johns clusters overlap considerably for several variable categories. Box plots of Blade Length, Blade Width, Blade Length / Width ratio, Base Width, and basal Concavity illustrate the population intersections (Figs.36-41). None of these variables, taken individually, accurately predicts cluster membership. Taking basal Concavity as an example (Fig. 40), the median lines for each cluster indeed differ greatly. However, the boxes and whiskers, representing the variability within the two clusters, overlap considerably. Although the Hope Cluster points have, on average, more deeply concave bases than St. Johns Cluster specimens, some Hope points possess shallow bases. Likewise, the bases of some St. Johns points exhibit more concavity. Critically, the boxes and whiskers of both clusters overlap; measuring Base Width alone cannot predict whether an individual projectile point belongs in the Hope or St. Johns Cluster.

Examining the population variation between the Hope and St. Johns Clusters for the variables Thickness, Base Length, and Base Length / Base Width reveals the distinctness of the two clusters. Box plots again aid in illustrating these differences. No population overlap occurs between the middle 50% of projectile points within the Hope and St. Johns Clusters for any of the three variables (Figs 41-43). Although point thicknesses display more distinctness than any of the blade variables, the whiskers of each cluster do overlap the interquartile range of the alternate cluster.

For an individual projectile point, Base Length and Base Length / Base Width ratio are the only variables which may singly predict cluster membership. Combining either of these variables with Thickness helps demonstrate the discreteness of the Hope and St. Johns clusters (Figs. 44-45). Of these three variables, Base Length appears to most effectively differentiate between projectile points within the two clusters. A clear gap in Base Lengths exists between the two clusters; the majority of Hope Cluster bases measure greater than approximately 13 mm whereas St. Johns Cluster bases measure approximately 12 mm or less.

Comparison to Dalton

The comparisons between San Patrice points and Dalton points are again achieved through cluster analysis. Exploratory hierarchical clustering grouped 154 San Patrice points and 50 Dalton points using the variables Thick-

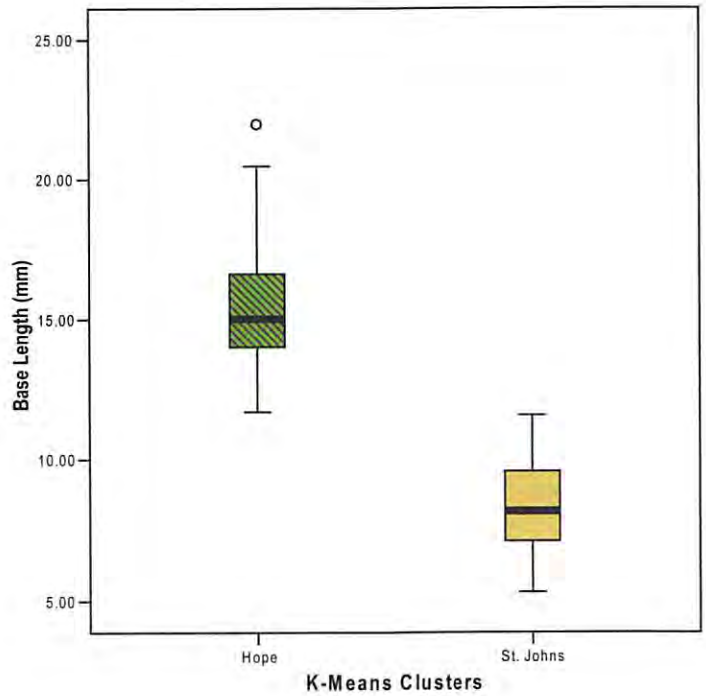


Figure 42. Box plot comparing Hope and St. Johns clusters for base length. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

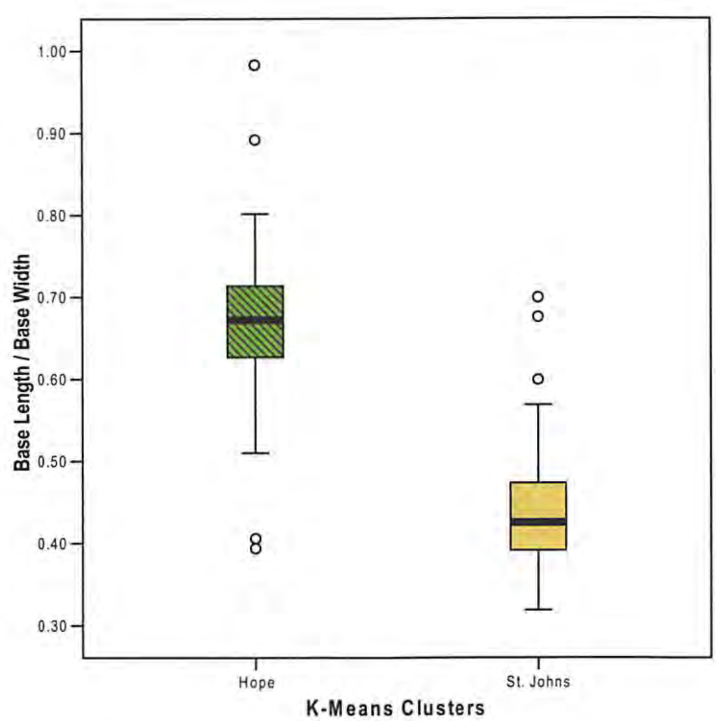


Figure 43. Box plat comparing Hope and St. Johns clusters for base length/base width. Black line represents the population median. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers.

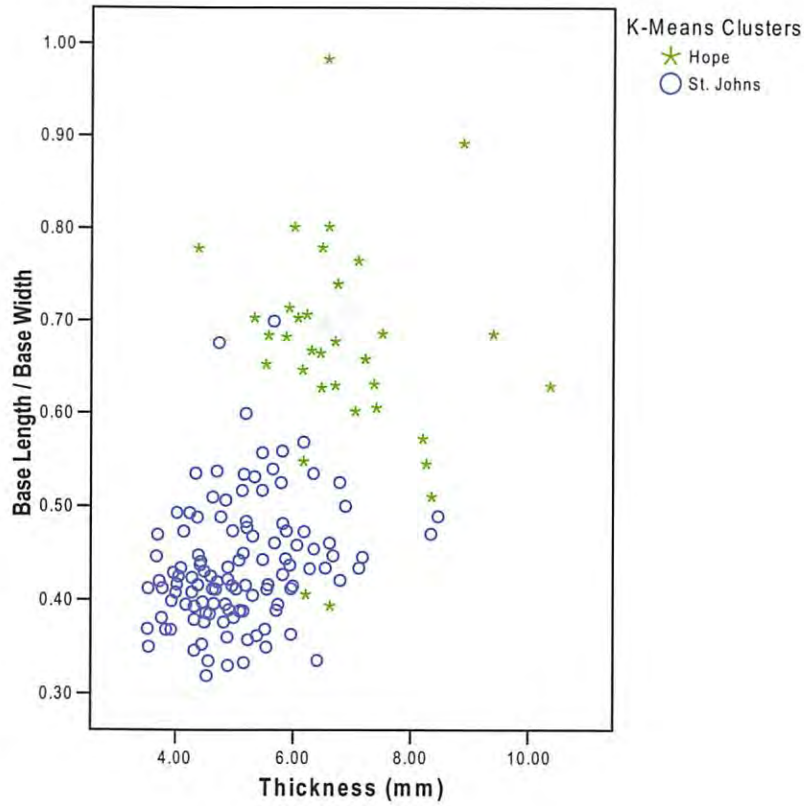


Figure 44. Scatter plot comparing the Hope and St. Johns clusters for base length/base width vs. thickness.

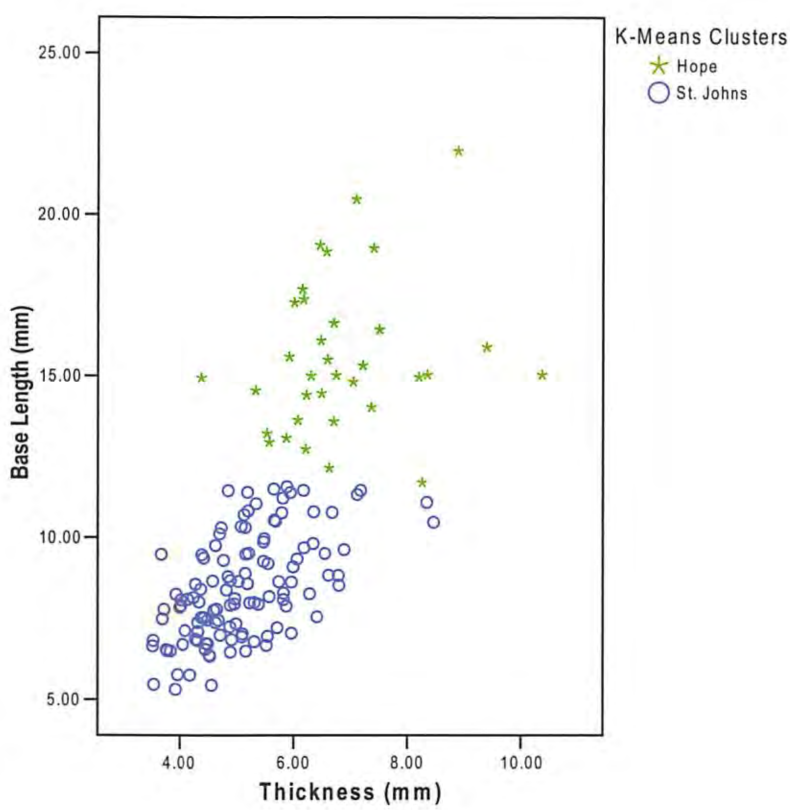


Figure 45. Scatter plot comparing the Hope and St. Johns clusters for base length vs. thickness.

ness, Base Length, and Base Length / Base Width ratio. Three primary clusters emerge from the dendrogram (Fig. 47). The two largest clusters consist of 144 and 56 projectile points, and the third cluster contains only 4 points.

Comparing these generated clusters to the 48 San Patrice points and the 50 Dalton points previously typed by archaeologists decisively displays the inability of cluster analysis to distinguish between these two projectile point styles (Table 4). Although Cluster 1 contains all St. Johns points, 53% of Hope points and 32% of Dalton points are grouped in Cluster 1.

Summary of San Patrice Variation

Cluster analyses reveal distinctions between lanceolate and notched San Patrice points facilitating the classification of all suitable points into two clusters, Hope and St. Johns. The average size and shape of the blade and base attest to the discreteness of the two clusters. While some exists overlap between the Hope and St. Johns clusters for certain variables, base length and base shape distinguish between them. The distinctiveness of Hope and St Johns projectile point bases reflects a shift from lanceolate to notched hafting technology. The transition did not progress simply as the result of gradually decreasing haft area; rather, the shift in projectile point hafting strategy was abrupt.

Interestingly, the Hope Cluster consists of only 34 projectile points, 23% of the 150 points suitable for comparison. Such a small percentage suggests Hope variety San Patrice points were either in production for a much shorter temporal duration than St. Johns points or, if produced over the same time period, San Patrice groups manufactured them in much lower numbers. Notched hafting replaced lanceolate hafting as the dominant projectile point technology employed within the study region.

Finally, cluster analysis failed to differentiate between San Patrice and Dalton projectile points. The main problem stems from the Dalton recharpening process, which differs from the San Patrice trajectory (Fig. 46). As Dalton points undergo multiple resharpening events, the base length frequently gradually decreases (Ballenger 2001). Consequently, cluster analyses grouped final stage Dalton drills with notched San Patrice points. It is possible that including other measures not considered in the present analysis, such as those associated with the lateral

Table 4. Frequencies of Typed and Untyped Projectile Points in Each Hierarchical Cluster.

		Projectile Point Variety / Type					Total
		Untyped	Dalton	*Brazos*	*Hope*	*St. Johns*	
Hierarchical Cluster	1	88	16	4	8	28	144
	2	18	31	1	6	0	56
	3	0	3	0	1	0	4
Total		106	50	5	15	28	204

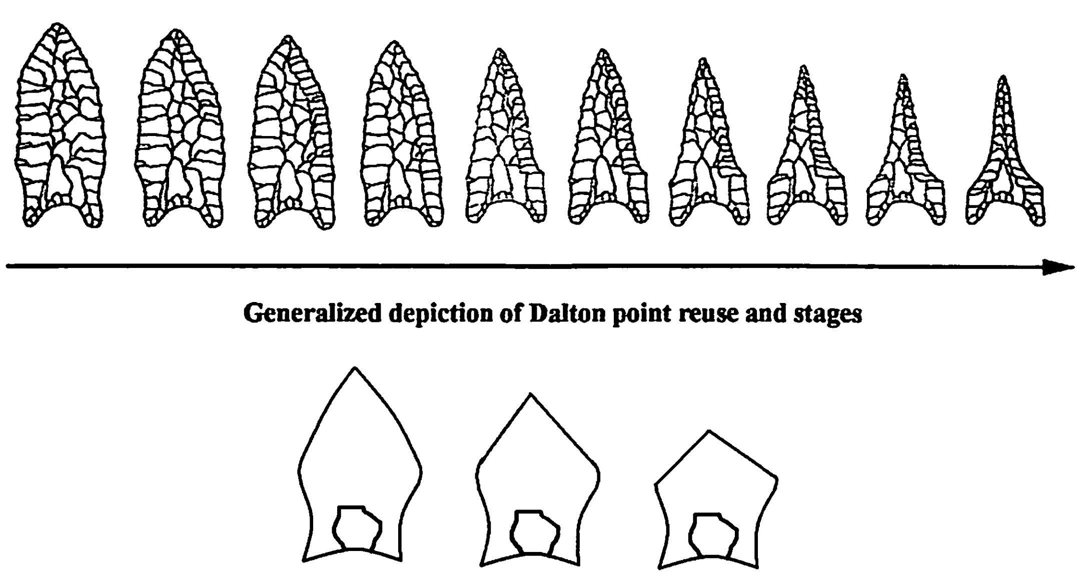
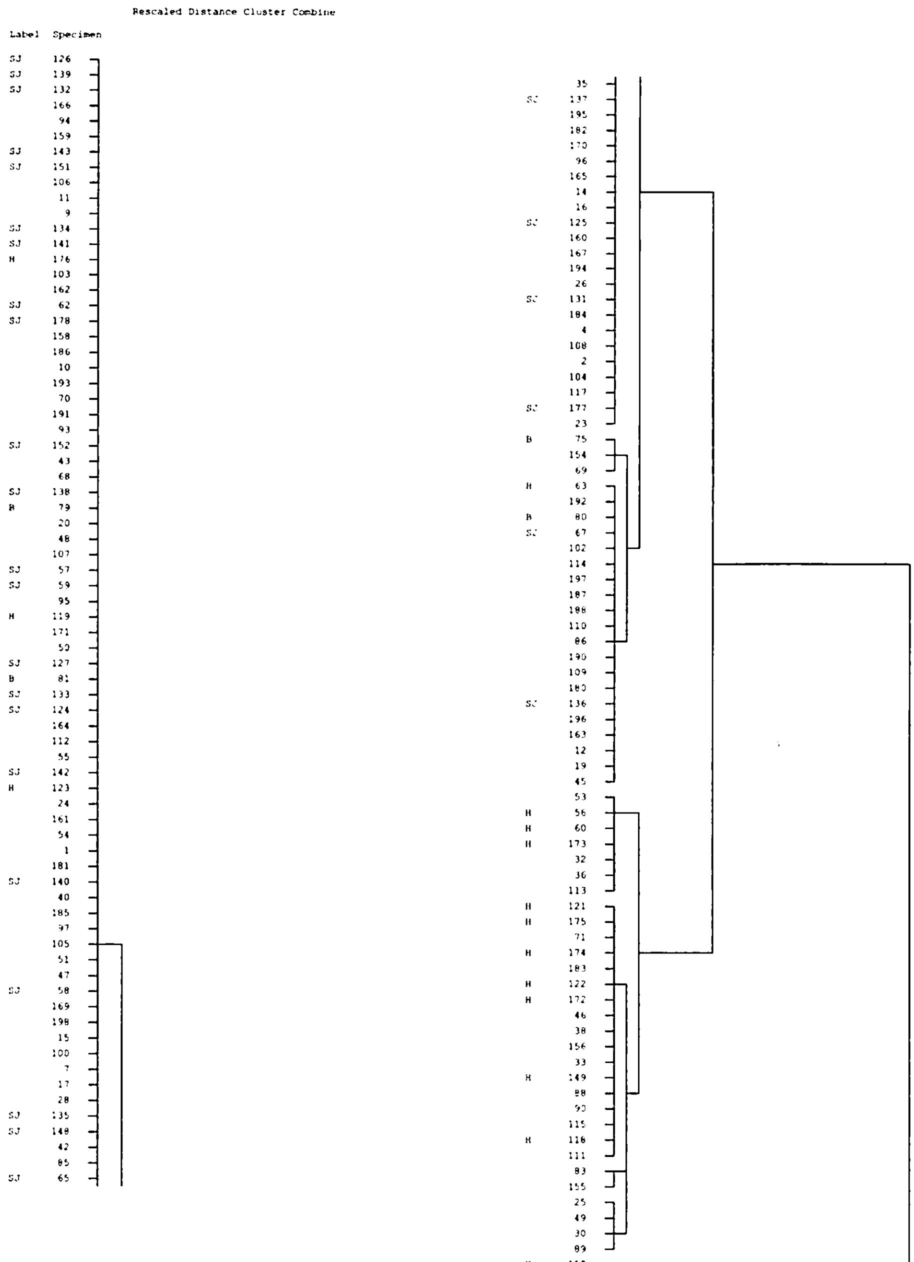


Figure 46. Top: generalized Dalton resharpening trajectory (adapted from Ballenger 2001:Figure 7). Bottom: even more generalized San Patrice resharpening trajectory.

Figure 47. Hierarchical clustering dendrogram of San Patrice and Dalton points. Previously typed point labels: sj, St. Johns; h, Hope; B, Brazos; and D, Dalton. Specimen numbers correspond to Appendices A and B.



base edges, may help resolve the issue. In the end, however, distinguishing between the two closely related projectile point forms requires taking the full range of unique morphological and technological traits into account (Ensor 1986; Johnson 1989; Story 1990).

Investigations across the Plains-Woodland Border

Having described the uniqueness associated with lanceolate and notched San Patrice projectile points, the remaining investigations shift focus to adaptations along the plains-woodland border. Projectile point distribution and raw material sourcing shed light on the intensity of San Patrice occupation. Differential use of Hope and St. Johns points or differential unifacial projectile point resharpening across the plains-woodland border may reflect environmentally specific adaptations. Finally, raw material sourcing contributes to an understanding of San Patrice mobility strategies.

Distribution

The overall distribution of projectile points analyzed for the current study indicates a substantial presence in plains settings by San Patrice hunter-gatherers (Fig. 48). Based on the current information regarding Early Holocene environments in the study area (as discussed in Chapter 2), San Patrice groups frequented six counties directly adjacent to the plains-woodland border. Moreover, the distribution of projectile points is not confined to the grassland-forest ecotone; specimens have been recovered from numerous counties well to the west in areas clearly dominated by grassland communities 10,000 years ago. The distribution of projectile points thus shows San Patrice groups maintained a considerable presence on the plains.

As discussed in Chapter 5, for analytical purposes, counties in the study area are divided into two groups: counties lying east of the plains-woodland border in the Coastal Plain woodlands, and counties adjacent to and west of the border. Comparing the frequencies of Hope and St. Johns Cluster points between the woodlands and plains reveals no significant correlation (Table 5). Lanceolate and notched points occur with similar frequency in either environment with notched projectile points making up 75.8% of the points in the woodlands and 80.4% in the plains.

Of the 198 projectile points analyzed in this study, 16.7% exhibit clear evidence of beveled or serrated blade edges associated with unifacial resharpening (Table 6, Fig. 49). Unifacially resharpened points occur with slightly greater frequency in the woodlands (18.6% compared to 13.0%). However, the difference is not statistically significant. As with hafting technology, projectile point resharpening technique does not correlate with environmental region.

Raw Material Sourcing

One problem encountered when comparing lithic use across the plains-woodland border in the study area lies with raw material sourcing. The vast majority of stone tool sources in the Coastal Plain are gravel outcrops (Banks 1990; Heinrich 1984) and, as noted in Chapter 5, the present study assumes all gravel materials are locally procured if any portion of the gravel bearing formation lies within 100 km of the county from which a given projectile point was recovered. This assumption could significantly impact any conclusions involving raw material procurement strategies. A San Patrice flint knapper could have collected a chert cobble from within that county or from a gravel outcrop located potentially 100s of kilometers away. The

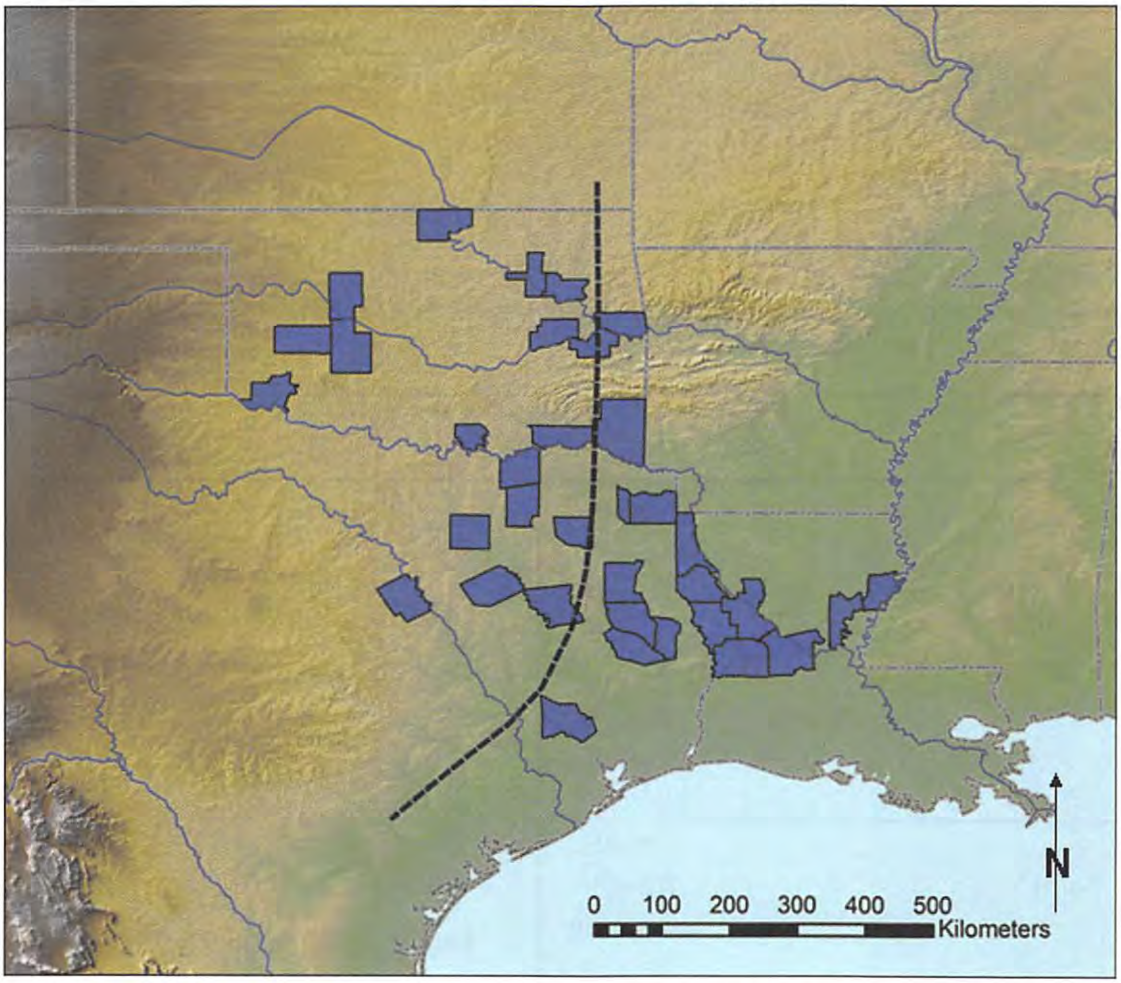


Figure 48. Map of counties from which projectile points in the current study have been recovered in relation to the Plains-Woodland border (dashed line) proposed for 10,000 years ago.

Table 5. Frequencies of Hope and St. Johns varieties of San Patrice Points from Plains and Woodlands Settings.

			Region		Total
			Plains	Woodlands	
K-Means Cluster	Hope	Count	10	24	34
		Row %	29.4%	70.6%	100.0%
		Column %	19.6%	24.2%	22.7%
	St. Johns	Count	41	75	116
		Row %	35.3%	64.7%	100.0%
		Column %	80.4%	75.8%	77.3%
Total		Count	51	99	150
		Row %	34.0%	66.0%	100.0%
		Column %	100.0%	100.0%	100.0%
		Likelihood Ratio Chi-Square			.517

Table 6. Frequencies of Unifacially and Bifacially reworked San Patrice Points Recovered from Plains and Woodland Settings.

			Region		Total
			Plains	Woodlands	
Type of Retouch	Bifacial	Count	60	105	165
		Row %	36.4%	63.6%	100.0%
		Column %	87.0%	81.4%	83.3%
	Unifacial	Count	9	24	33
		Row %	27.3%	72.7%	100.0%
		Column %	13.0%	18.6%	16.7%
Total		Count	69	129	198
		Row %	34.8%	65.2%	100.0%
		Column %	100.0%	100.0%	100.0%
		Likelihood Ratio Chi-Square			.309

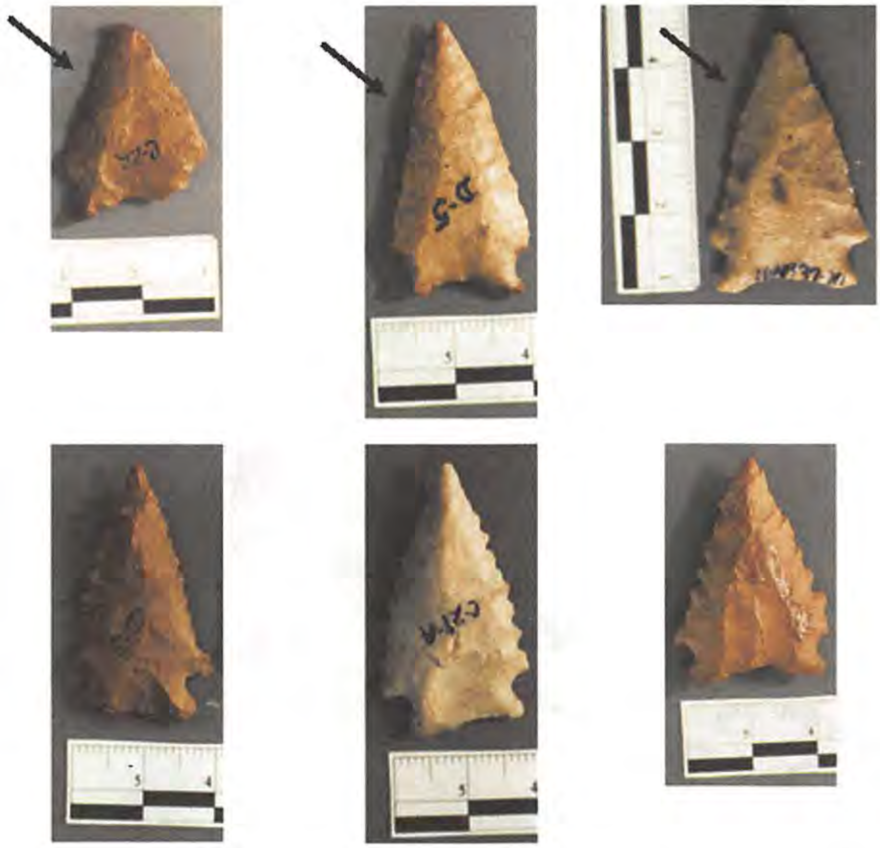


Figure 49. Examples of beveled (top row) and serrated (bottom row) San Patrice points. Arrows point to the beveled edges.

same problem holds for projectile points manufactured from plains gravel sources. Clearly, much more research is needed to investigate the variability within and between gravel outcrops exploited by prehistoric stone tool manufacturers. In spite of this raw material sourcing limitation, the results of the current study reveal real and significant differences in mobility strategies across the plains-woodlands ecotone.

Of the 198 projectile points analyzed, 174 (82%) are manufactured from local raw materials (Table 7), indicating limited reliance on high quality extralocal lithic sources by all San Patrice populations regardless of which environmental region they inhabited. Throughout the study area, projectile points are manufactured from lower quality cherts, quartzites, and petrified woods readily procured from nearby gravel sources.

The frequency of projectile points manufactured from exotic raw materials is significantly greater in the plains (20.7%) than in the woodlands (6%), reflecting differential raw material procurement strategies in the two regions. The higher incidence of exotic raw material use suggests San Patrice groups living on or near the plains adopted strategies involving greater mobility, in terms of how often bands traveled large distances, or engaged more often in long distance exchange than populations occupying woodland environments.

San Patrice groups transported materials to a variety of locations throughout the study area (Fig. 50). Ozark stones moved south to various counties in Oklahoma and Louisiana, and Ouachita materials also traveled south into Louisiana. Texas materials moved north and east throughout Oklahoma. Interestingly, the projectile point sample from woodlands counties contains no examples of points made of high quality Alibates or Edwards cherts. The paucity of woodland projectile points manufactured from Texas flints suggests San Patrice populations inhabiting the plains made little effort to return to the woodlands and vice versa.

In some cases discarded projectile points landed great distances from their source outcrop (Table 8). No significant difference exists in the average distance from an exotic raw material source location between the two regions (Table 9). In both cases, exotic raw materials were transported well over 200 km from the source outcrop. When woodland bands acquired exotic raw materials, the stone came from distances as far or farther than that acquired by plains groups.

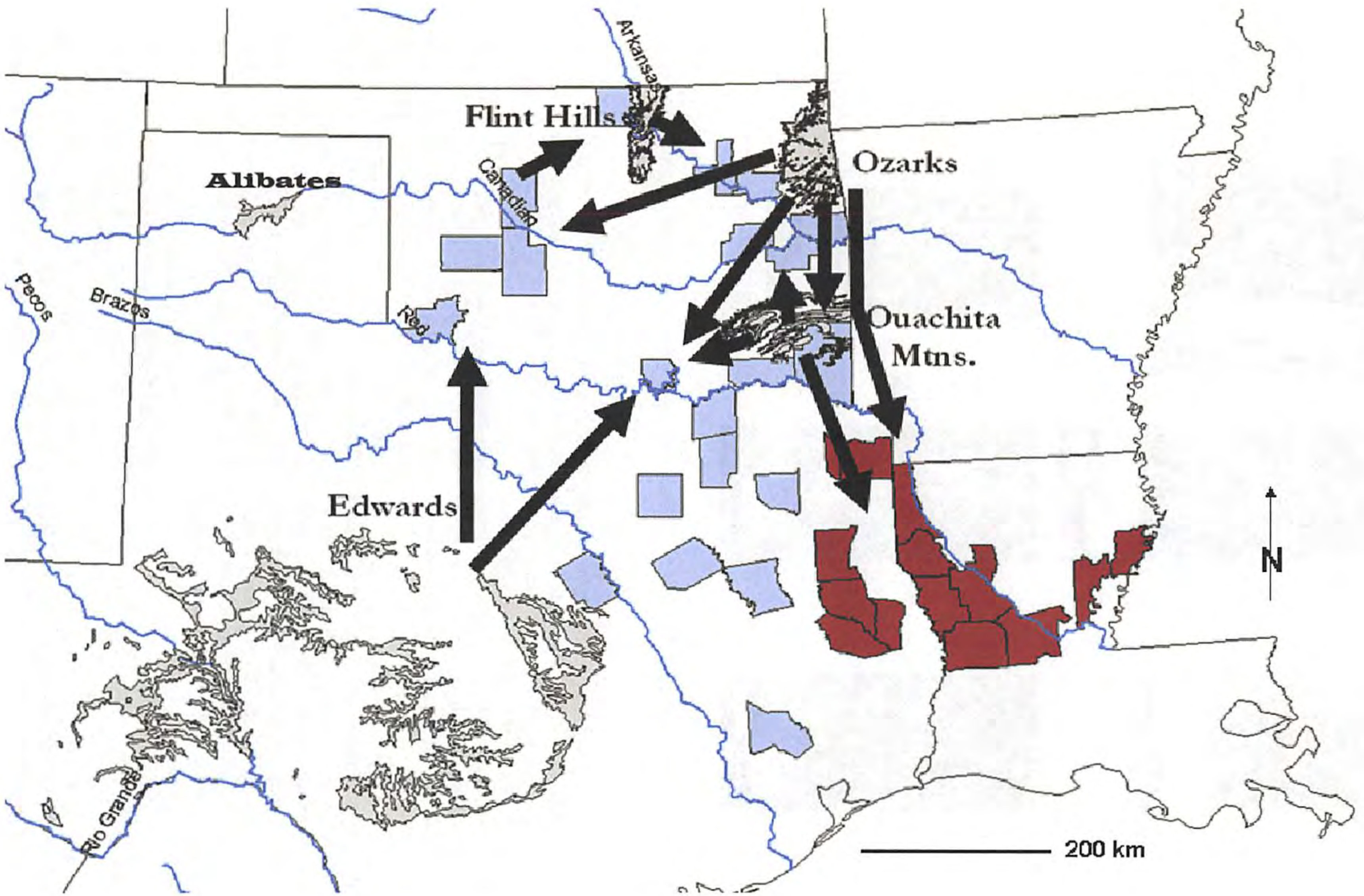


Figure 50. Map showing the direction (arrows) of raw material flow. Woodland counties around 10,000 years ago are depicted in brown. Map adapted from Hurst 2006.

Table 7. Frequencies of San Patrice Points Made from Local and Non-Local Raw Materials in the Plains and Woodlands.

			Region		Total
			Plains	Woodlands	
Raw Material Source	Local	Count Row % Column %	65 37.4% 79.3%	109 62.6% 94.0%	174 100.0% 81.8%
	Exotic	Count Row % Column %	17 80.6% 20.7%	7 19.4% 6.0%	36 100.0% 18.2%
Total		Count Row % Column %	82 41.4% 100.0%	116 58.6% 100.0%	198 100.0% 100.0%
				Fisher's Exact	.003

Table 8. Destinations and Distances of Exotic Raw Material Transport. Woodland Counties are Bold-Faced.

Source	Destination County (# of specimens)	Distance from Outcrop (km)
Ozark Mtns.	**Caddo, LA (2)**	**350**
	Blaine, OK (2)	285
	Choctaw, OK (1)	175
	Marshall, OK (2)	240
	McCurtain, OK (3)	160
Ouachita Mtns.	**Caddo, LA (3)**	**175**
	Tensas, LA (1)	**370**
	Hunt, TX (1)	130
	Rusk, TX (1)	**215**
Alibates	Kay, OK (1)	165
Edwards	Caddo, OK (2)	280
	Jackson, OK (1)	240
	Marshall, OK (3)	285
	Washita, OK (1)	330

Table 9. Average Distance from Exotic Raw Material Source Outcrops for the Plains and Woodlands and P-value of T-test for Equality of Means.

Region	N	Mean	Std. Deviation	p-value
Plains	17	234.4	62.2	.463
Woodland	7	258.5	93.08	

Summary

Analyses of a sample of nearly 200 projectile points contribute new knowledge on San Patrice technological, adaptive, and lithic procurement strategies. Clustering identified distinct differences in the base size and shape of Hope and St. Johns points, indicating the transition from lanceolate to notched hafting was an abrupt technological shift. As the distribution of lanceolate and notched points in the woodlands equals that of the plains, the conditions sparking the technological shift are apparently unrelated to the exploitation of plant and animal resources in these regions. Likewise, unifacial blade resharpening, in the form of beveling or serration, does not correlate with environmental region.

The overall distribution of projectile points indicates San Patrice populations regularly inhabited plains environments, and the use of lithic sources such as Alibates and Edwards demonstrates familiarity with plains resources. The paucity of Texas flints moving to the woodlands suggests these groups stayed on the plains. Finally, in terms of raw material procurement, San Patrice groups living on the plains acquired exotic raw materials more often than groups in the woodlands. However, bands living in both environments focused primarily on local raw material procurement.

Chapter 7
Conclusions

The Pleistocene-Holocene transition from 14,000 to 9,000 B.P. was a period of dramatic climatic change. As the last ice age came to a close, temperatures gradually warmed, effective moisture declined and, perhaps the most important change, seasonality increased (Bryant and Holloway 1985; Fredlund and Tieszen 1997; Graham 1987; Toomey et al. 1993; Webb et al. 2004). The shifting climate resulted in dramatic biotic reorganizations which proceeded time-transgressively as individual species responded to unique tolerance limits, with notable species becoming extinct (Graham and Lundelius 1984). Grasslands gradually came to dominate the Southern Plains while spruce and oak forests of the Southeast yielded to southern pines (Bryant and Holloway 1985; Webb et al. 2004).

On the heels of this wide scale environmental reorganization, numerous regional projectile point styles emerged throughout North America (Anderson 1996; Anderson and Smith 2003; Ellis et al. 1998; Meltzer 2002; Morse et al. 1996). The replacement of Early Paleoindian projectile point styles has been linked to the extinction of Pleistocene megafauna and the settling of populations into smaller, defined territories. The present study takes a closer look at one sub-regional projectile point style, the San Patrice point, which first emerged around 10,400 years ago and perhaps persisted until 9,000 B.P. Returning to the hypotheses outlined in Chapter 3, the results offer new insights into the adaptive strategies of San Patrice populations living along the plains-woodland border.

Hafting Technology

Some researchers argue that emergent Early Holocene projectile point styles, including San Patrice, in the Southeast are characterized primarily by a trend of gradually decreasing haft area (Morse et al. 1996). Cluster analyses of San Patrice projectile points refine our understanding this process by identifying distinct differences between the lanceolate Hope variety, points and the notched St. Johns variety points. These results are significant not for simply distinguishing between lanceolate and notched points, a task few archaeologists would find difficult. Rather, the discreteness of the Hope and St. Johns projectile point clusters reveal marked differences between lanceolate and notched hafting techniques. The technological shift was abrupt.

Unfortunately, data on the precise chronological relationship between Hope and St. Johns points remains sparse due to the poor preservation of datable material in the San Patrice region. However, both varieties were recovered at similar depths at the Big Eddy site (Lopinot et al. 1998, 2000), and they consistently occur in the same stratigraphic levels at Fort Polk area sites (Anderson and Smith 2003). The stratigraphic associations of Hope and St. Johns points indicate San Patrice groups simultaneously employed both lanceolate and notched hafting technologies. San Patrice thus represents another example, in addition to the Packard site which dates to around 9,800 B.P. (Wyckoff 1985, 1989), of Early Holocene groups manufacturing and using more than one projectile point form on the Southern Plains and their eastern border. The nearly 4:1 dominance of St. Johns points over Hope points in the current study sample suggests lanceolate hafting was a comparatively short-lived phenomenon. Once San Patrice groups adopted notched hafting, the shift was final and long-lasting.

One question yet to be answered is what drove San Patrice groups to cease making lanceolate points and begin employing notched hafting technology. Social forces may have triggered this transformation. The discovery in northwestern Oklahoma of a 10,500 year old bison skull with a zigzag painted in red ochre provides a rare glimpse into the ritual of one early foraging society (Bement 1999). It also highlights how painfully little we know about Paleoindian culture. Bradley (1993) argues that art and ritual occupied integral roles in the Paleoindian projectile point manufacturing process.

As Wiessner (1983) shows, style also plays an important role in the structure of social relationships between modern hunter-gather groups. Hurst (2006) builds on the concept of style and social identity and argues the emergence of numerous Early Holocene projectile point forms reflects the development of territories associated with ethnically defined social boundaries. Viewed in this light, the shift from using Hope to St. Johns points among San Patrice hunter-gatherers could result from either intentional or passive cultural identification mechanisms. However, the use of notched hafting by numerous historically unrelated hunter-gatherers throughout the Holocene suggests the technology is more than just a social phenomenon.

As noted, the emergence of Early Holocene projectile point styles has been linked to increasing population throughout North America and the settling of populations into regional habitats (Anderson 1996; Anderson and Smith 2003; Meltzer 2002). Changes in projectile point technology are therefore viewed as responses to regionally specific adaptations by hunter-gatherers shifting subsistence focus from Pleistocene megafauna to smaller game (Anderson and Smith 2003; Ensor 1986; Morse et al.

1996). Specifically, Morse and colleagues (1996) suggest the development of notched projectile points corresponds to the appearance of the atlatl or a significant advancement in spearthrower technology.

I now add a second possible explanation, one which focuses on the projectile point itself rather than spear-throwing technology. The argument rests on two important factors. First, Early Holocene hunter-gatherers throughout the Southeast began using projectile points as more than just projectiles. Intensive blade resharpening reflects the widespread use of points as hafted knives (Ellis et al. 1998; Morse et al. 1996). Use-wear analysis supports the conclusion that San Patrice points were used both as projectiles and as knives (Kay 2000).

The second key factor is raw material procurement strategy. San Patrice hunter-gatherers are the first in the study area to extensively utilize local gravel sources to manufacture projectile points (Anderson and Smith 2003; Hillman 1985; Story 1990). The use of cobbles required developing new lithic reduction strategies (Anderson and Smith 2003; Ray 1998a). I contend cobble use may also have altered hafting technology. Cobble size limits projectile point size (Duffield 1963; Ensor 1986; Jeter et al. 1989). As San Patrice groups increasingly used points as knives rather than projectiles, manufacturing strategies likely began to emphasize the conservation of blade length. As such, a cobble-based lithic technology favors notched points over lanceolate points to maximize knife blade length (Fig. 51). In addition, notching may provide a haft advantage over lanceolate forms when the implements are used as knives (Bement 2006, personal communication). However, determining whether notched hafting arose due to cultural processes, alterations in spearthrowing technology, or efforts to maximize blade length on hafted knives requires a much greater understanding of the chronology and organization of San Patrice hafting technology.

Technological Strategies along the Plains-Woodland Border

The distribution of projectile points reveals a significant San Patrice presence on the plains. San Patrice groups exploited resources along the plains-woodland border and also moved well into the open grasslands. The use of plains lithic sources such as Alibates and Edwards cherts and the execution of bison kills (Hughes and Willey 1978; Hurst 2006) demonstrate considerable familiarity with plains resources. We must, therefore, continue to examine what effects the presence of San Patrice and other groups on the Plains may have had on each other (Johnson 1989; Wyckoff and Bartlet 1995).

No significant differences exist between the distribution of lanceolate vs. notched points or the distribution of

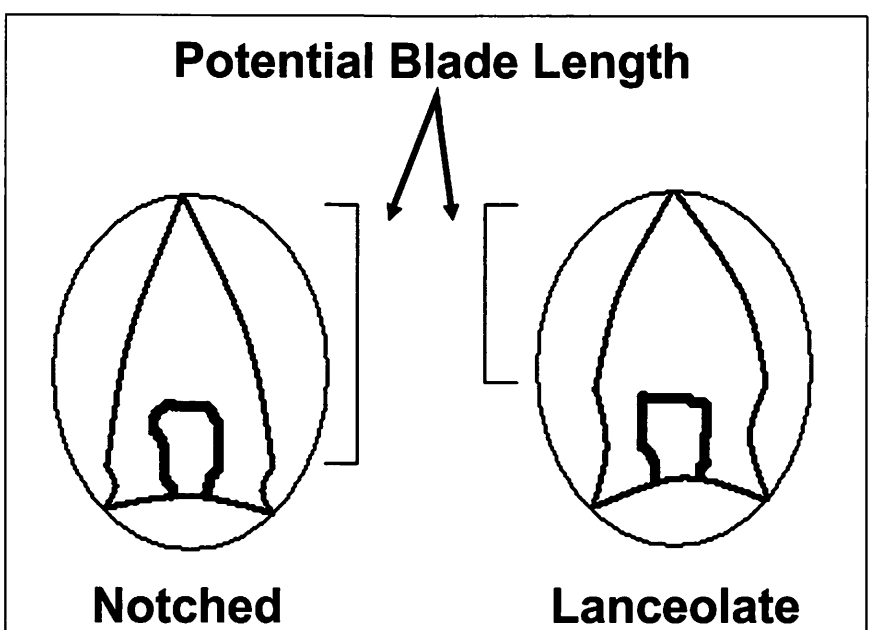


Figure 51. Illustration comparing potential blade lengths between notched and loanceolate varieties of San Patrice points when limited by cobble size.

points with beveled blades across the plains-woodland border. Two explanations may account for these similarities. First, San Patrice groups living on the Plains may have primarily exploited resources in riparian settings similar to those encountered in the woodlands and thus employed similar technological strategies. Second, if San Patrice groups indeed made full use of plains resources, alternative technological strategies may be reflected in tool classes other than the projectile point. Investigating these possibilities requires studying the entire San Patrice toolkit.

Mobility Strategies along the Plains-Woodland Border

Raw material sourcing yields important clues to San Patrice adaptive strategies. Results from the current study agree with others in showing San Patrice groups readily utilizing local raw material sources regardless of quality (Anderson and Smith 2003; Duffield 1963; Griffing 1994; Johnson 1989; Lopinot et al. 1998, 2000; Redder 1985; Story 1990; Webb et al. 1971), and local raw material usage dominates the "heartland." Such a lithic procurement strategy has significant adaptive consequences for mobility and exchange. The option of using local sources, when necessary, greatly increases freedom of movement. Groups no longer need to incorporate forays to high quality outcrops. As a result, while San Patrice bands took advantage of high quality lithic sources when in the neighborhood, such as at Big Eddy (Lopinot et al. 1998, 2000; contra Goodyear 1989), toolstone acquisition likely only minimally impacted mobility patterns.

San Patrice groups living in the woodlands apparently made little effort to consistently acquire higher quality raw materials from the nearby Ouachitas to the north or the plains to the west. While population growth throughout southern North America likely increasingly forced groups to reduce their territory sizes, thereby restricting access to high quality raw material sources, the paucity of projectile points manufactured on exotic toolstones reflects minimal emphasis on the acquisition of high quality flints either directly or through exchange. However, the presence of a few projectile points made from distant sources in the Ouachitas and Ozarks indicates woodland bands may have infrequently traveled north or come in contact with northern bands.

Raw material sourcing reveals significant differences among populations living on the plains. Plains groups acquired exotic raw materials more frequently likely reflecting increased mobility in the more open grassland environment. Mobile hunter-gatherers visited nearly every high quality lithic outcrop in the region, however, plains groups still focused primarily on local raw material sources.

These results, when combined with recent research at the Big Eddy site in southwestern Missouri (Lopinot et al. 1998, 2000), sharpen our understanding of San Patrice mobility strategies across the plains-woodland border. Raw material sourcing and subsistence data (Hughes and Willey 1978; Hurst 2006; Redder 1985) indicates plains groups transported plains stones to a variety of locations throughout the region in pursuit of plant and animal resources.

Although woodland groups utilized exotic raw materials less frequently, woodland mobility patterns appear similar. San Patrice populations within the "heartland" rarely traveled long distances, but when they did the distances were great. Evidence from Big Eddy, a tremendously unique site, sheds light on this pattern. The site apparently represents an aggregation location where one or more San Patrice bands traveled potentially hundreds of kilometers north to visit other Paleoindian groups (Ray 1998b). Maintenance of social relations and exchange likely motivated the rendezvous. Expanding the Big Eddy model, the few examples of northern raw materials in Louisiana may result from similar journeys through the Ouachitas and Ozarks for the purposes of social interaction.

Thus, the San Patrice mobility pattern appears to mirror trends seen throughout the Plains and Southeast (Anderson 1996; Anderson and Smith 2003; Ellis et al. 1998; Meltzer 2002; Morse et al. 1996) of decreasing territory size during the Early Holocene (Fig. 52). While their movements were certainly not purely circular, Figure 52 illustrates a general pattern of movement across the plains and woodlands intersecting a number of lithic source areas. Raw material sourcing suggests San Patrice bands occupied at least three distinct territories. A fourth may have existed in the Arkansas area. San Patrice bands occasionally left these territories, traveling 200 km or more for the purposes of exchange and social interaction. Importantly, San Patrice groups living on the plains rarely interacted with woodland groups and vice versa. Social interaction as evidenced by exotic raw material movement occurred in a north-south pattern.

Using raw material sourcing to examine the mobility patterns of prehistoric hunter-gatherers is an exceedingly difficult task (Meltzer 1989; Bamforth 2002). In the end, it may not be possible to distinguish between San Patrice territories. However, if we are to have a chance, much more research is required, particularly in the void between Louisiana and Missouri. While San Patrice sites occur in Arkansas (Jeter et al. 1989), little is known regarding the San Patrice presence along the eastern faces of the Ozarks and Ouachitas. San Patrice points manufactured on Ozark cherts have been recovered in northern Louisiana, central Oklahoma, and now southwestern Missouri (Lopinot et al. 1998, 2000). The movement of Ozark cherts south, west, and north suggests the area may yield unique information regarding San Patrice exchange practices and the maintenance of social relationships with each other as well as neighboring cultures such as Dalton.

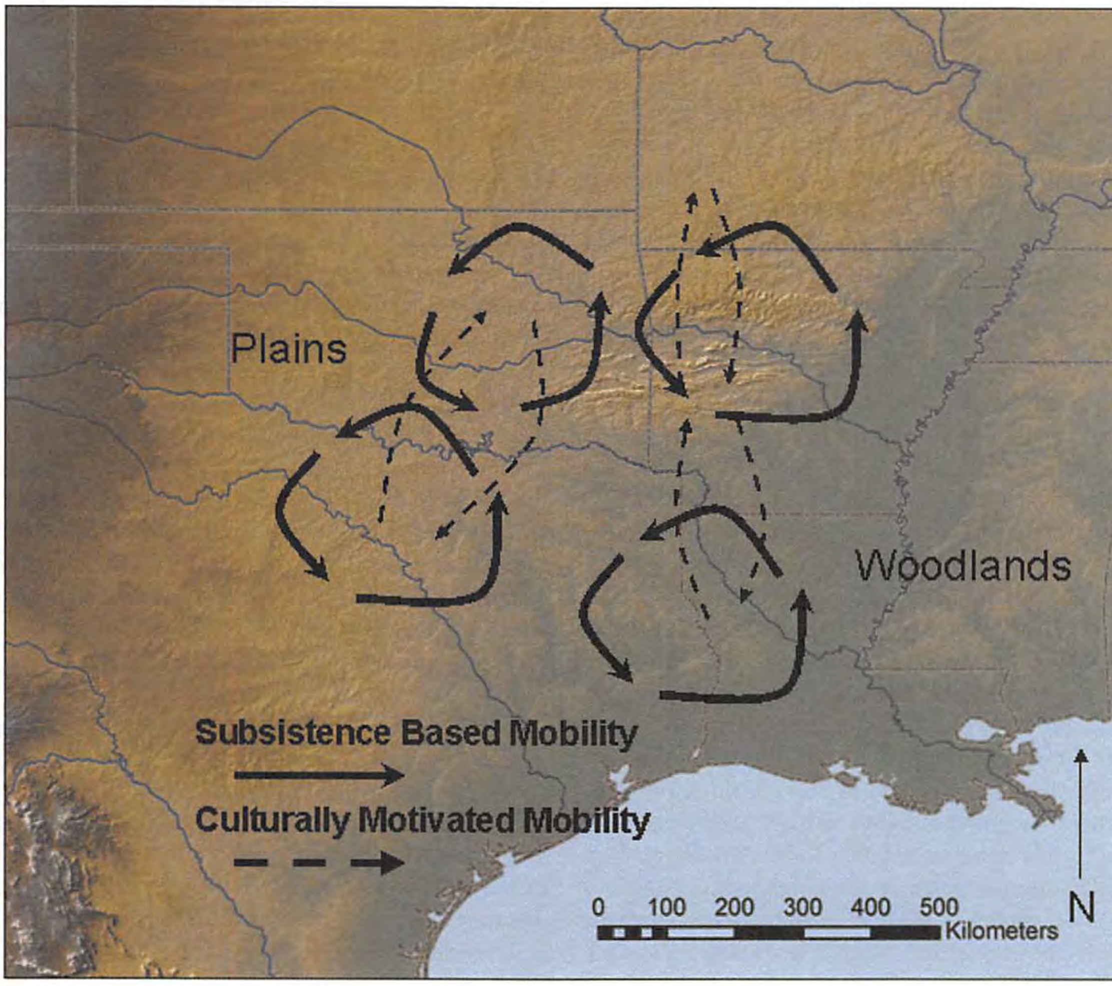


Figure 52. Map showing hypothetical San Patrice mobility patterns in the Plains and Woodlands around 10,100 years ago.

Summary

The results from this study provide new insights into our understanding of the Late Paleoindian San Patrice projectile point. In 1986, Ensor (1986:77) stated that San Patrice technologies, "reflect local adaptations to microenvironments." Twenty years of subsequent research, including the results presented in this thesis, reveal those words to still ring true. San Patrice groups developed environmentally specific subsistence and mobility strategies geared towards survival in the Coastal Plain woodlands or in the open grasslands of the Southern Plains.

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Appendix A

San Patrice Point Data

Key:

NWS = Northwestern State University
FP = Fort Polk
P = Private
H = Horn Shelter No. 2
TARL = Texas Archeological Research Laboratory
SN = Sam Noble Oklahoma Museum of Natural History

G = Gravel outcrop
OZ = Ozarks
OU = Ouachitas
AL = Alibates
AN = Antlers gravels
E = Edwards
FH = Flint Hills

H= *Hope*
SJ= *St. Johns*
B=*Brazos*

y=yes
n=no

Collection	Sp. #	County	Raw Material	Variety	Total Lgth	Blade Lgth	Blade Wdth	Thick-ness	Base Wdth	Base Lgth	Con-cavity	Beveled /Serrated
NWS	1	Caddo, LA	G		33.94	26.42	20.29	4.43	17.06	7.52	2.47	y
NWS	2	Caddo, LA	G		34.51	28.76	22.54	4.18	14.55	5.75	1.81	y
NWS	3	Caddo, LA	G		25.32	20.87	18.15	4.47		4.45		n
NWS	4	Caddo, LA	OZ		34.51	28.75	22.78	3.96	13.43	5.76	2.95	n
NWS	5	Caddo, LA	G		28.61	20.19	19.16	4.28		8.42		n
NWS	6	Caddo, LA	G		46.87	35.65	26.13	4.99		11.22		n
NWS	7	Natchitoches, LA	G		35.03	28.54	22.15	5.16	19.5	6.49	1.92	y
NWS	8	De Soto, LA	G		35.08	28.86	17.94	4.19	15.49	6.22		y
NWS	9	De Soto, LA	G		18.86	10.31	20.35	4.28	20.94	8.55	3.72	n
NWS	10	Caddo, LA	OZ		51.35	42.09	27.83	5.47	17.92	9.26	4.47	n
NWS	11	Caddo, LA	G		40.75	33.38	22.24	4.32	21.3	7.37	4.26	n
NWS	12	Caddo, LA	G		40.03	27.89	29.87	6.63	30.83	12.14	2.92	y
NWS	13	Caddo, LA	G		27.35	20.64	20	4.21		6.71		y
NWS	14	Tensas, LA	OU		20.98	14.27	18.9	4.49	17.83	6.71	2.1	n
NWS	15	Caddo, LA	G		33.4	26.19	19.6	5.71	18.54	7.21	1.96	n
NWS	16	Caddo, LA	G		28.89	22.04	20.54	4.28	16.17	6.85	2.14	n
NWS	17	Caddo, LA	G		32.63	28.85	21.95	5.31	16.75	6.78	1.66	y
NWS	18	Caddo, LA	G		26.67		18.83	4.65		8.93		n
NWS	19	Caddo, LA	G		31.08	19.63	20.4	7.18	25.71	11.45	2.06	n
NWS	20	Caddo, LA	G		29.64	19.53	23.79	4.7	18.81	10.11	3.05	n
NWS	21	Caddo, LA	G		32.54	22.43	21.47	5.58		10.11		n
NWS	22	Caddo, LA	G		35.62	27.38	20.86	5.07		8.24		n
NWS	23	Caddo, LA	G		29.22	22.28	21.37	5.54	19.86	6.94	0	n
NWS	24	Caddo, LA	G		41.81	33.55	25.66	6.28	19.07	8.26	2.07	n
NWS	25	Caddo, LA	OU		41.77	25.14	25.56	6.71	24.57	16.63	6.65	y
NWS	26	Caddo, LA	G		35.05		20.65	3.53	16.52	6.81	3.06	n
NWS	27	Caddo, LA	G		35.55	28.14	20.4	4.62	15.49	7.41		y
NWS	28	Caddo, LA	OU		38.15		21.82	5.1	18.06	7.02	1.86	n
NWS	29	Caddo, LA	G		56.81	41.51	30.24	5.36		15.3		n
NWS	30	Caddo, LA	G		40.86	24.77	28.11	6.48	25.67	16.09	5.11	n
NWS	31	Caddo, LA	OU		31.54		25.96	5.41				n
NWS	32	Caddo, LA	G		45.33	26.29	30.12	6.46	28.67	19.04	5.51	n
NWS	33	De Soto, LA	G		29.5	14.49	23.11	6.75	20.3	15.01	4.14	n
NWS	34	De Soto, LA	G		37.32	19.07	32.03	5.78		18.25		n
NWS	35	De Soto, LA	G		35.49	28.83	22.88	5.52	18.06	6.66	3.21	y
NWS	36	De Soto, LA	G		33.3	14.46	25.03	6.58	19.17	18.84	5.67	y
NWS	37	De Soto, LA	G		30.36	21.45	23.76	5.01		8.91		n
NWS	38	De Soto, LA	G		45.81	30.81	25.89	6.3	22.49	15	3.99	n
NWS	39	De Soto, LA	G		29.97	22.81	21	5.51		7.16		n
NWS	40	Caddo, LA	G		31.72		21.52	4.89	18.2	7.91	2.79	n
NWS	41	Caddo, LA	G		27.39	20.26	19.78	3.61		7.13		n

NWS	42	Caddo, LA	G		32.71		18.52	4.91	17.56	6.84	3.45	n
NWS	43	Natchitoches, LA	G		28.49	19.02	24.34	3.67	21.22	9.47	3.88	n
NWS	44	Natchitoches, LA	G		19.62		19.52	6.42		11.04		n
NWS	45	Rapides, LA	G		37.4	24.46	21.18	5.57	18.93	12.94	2.35	n
NWS	46	Caddo, LA	G		33.11	18.57	23.3	5.33	20.69	14.54	4.23	n
NWS	47	Catahoula, LA	G		33.05		23.43	4.97	17.12	8.11	2.19	n
NWS	48	Caddo, LA	G		41.1	30.76	27.67	5.08	23.38	10.34	3.19	n
NWS	49	Natchitoches, LA	G		40.77		26.49	7.51	23.98	16.43	5.82	n
NWS	50	Caddo, LA	G		32.26		22.02	6.06	20.35	9.33	2.32	n
NWS	51	Rapides, LA	G		32.98		20.04	4.37	17.21	8.4	2.62	n
NWS	52	Rapides, LA	G		40.12	29.64	22.49	5.33		10.48		n
NWS	53	Rapides, LA	G		36.84	16.37	32.09	7.1	26.78	20.47	4.33	n
NWS	54	Caddo, LA	G		29.95	21.32	20.28	5.74	21.84	8.63	2.3	n
NWS	55	Franklin, LA	G		45.89	38.01	21.52	5.87	17.76	7.88	1.92	n
FP	56	Vernon, LA	G	H	38.33	26.86	19.38	7.41	31.31	18.95	3.2	n
FP	57	Natchitoches, LA	G	SJ	35.8	19.11	28.25	6.41	22.52	7.55	4.11	n
FP	58	Natchitoches, LA	G	SJ	29.06	10.12	20.42	5.03	20.99	8.64	1.97	n
FP	59	Natchitoches, LA	G	SJ	37.66	14.58	29.28	4.82	22.26	8.38	5.78	n
FP	60	Natchitoches, LA	G	H	39.9	28.61	22.53	6.17	31.7	17.37	4.41	n
FP	61	Natchitoches, LA	G	H	32.28	17.18	15.94	6.32		16.34		n
FP	62	Natchitoches, LA	G	SJ	42.47	20.63	34.52	4.96	19.16	7.95	3.6	n
FP	63	Sabine, LA	G	H	39.94	15.73	29.15	6.35	23.75	10.79	4.34	n
FP	64	Natchitoches, LA	G	H	32.86	22.56	1.29	6.41		31.57		n
FP	65	Vernon, LA	G	SJ	34.68	12.84	28.14	4.45	18.55	6.54	3.48	n
FP	66	Vernon, LA	G	SJ		12.66		3.91	17.29		1	n
FP	67	Sabine, LA	G	SJ	36.63	15.46	25.86	6.68	24.1	10.77	3.23	n
P	68	Washita, OK	G		40.02	30.54	25.82	5.16	17.75	9.48	3.02	n
P	69	Washita, OK	AL		49.46	38.99	27.42	8.46	21.41	10.47	5.6	n
P	70	Washita, OK	AL		46.21	36.53	21.96	6.18	20.47	9.68	2.96	y
P	71	Washita, OK	E		37.89	22.96	20.83	4.38	19.19	14.93	2.46	n
P	72	Washita, OK	G		34.26		23.95	4.37	9.01			n
H	73	Bosque, TX	E	B	54.19	43.19	28.31	6.49		11		n
H	74	Bosque, TX	E	B			28.14	5.59		8.09		n
H	75	Bosque, TX	E	B	62.06	51.52	32.93	8.34	23.55	11.08	3.79	n
H	76	Bosque, TX	E	B	52.04	43.32	19.73	5.5				n
H	77	Bosque, TX	E	B	69.65	61.04	28.26	7.17		8.61		n
H	78	Bosque, TX	E	B	50.75		26.88	6.94	24.79	15.54		n
H	79	Bosque, TX	E	B	40.84	30.88	27.66	5.48	22.49	9.96	3.02	n
H	80	Bosque, TX	E	B	44	32.68	25.78	7.12	26.1	11.32	4.22	n
H	81	Bosque, TX	E	B	34.76	25.14	22.27	6.89	19.24	9.62	2.21	n
P	82	Tulsa, OK	OZ		42.22	30.72	25.82	6.01		11.5		n
P	83	Tulsa, OK	AL		51.3	35.41	25.91	9.4	23.21	15.89	4.91	y
P	84	Tulsa, OK	FH		39.69	29.38	23.1	6.28		10.31		n
P	85	Tulsa, OK	G		54.26	4.78	26.06	4.89	19.58	6.46	3.65	n
P	86	Wagoner, OK	OZ		49.92	39.22	22.23	5.13	20.71	10.7	5.31	n
P	87	Kay, OK	FH		68.59	57.65	24.71	6.68		10.94		n
P	88	Caddo, OK	E		79.24	63.92	33.67	7.22	23.3	15.32	3.88	n
P	89	Sequoyah, OK	OZ		34.84	19.88	26.75	8.2	26.15	14.96	6.25	y
P	90	Haskell, OK	OU		27.74	14.16	23.25	6.71	21.58	13.58	3.91	y
P	91	Marshall, OK	G		46.6	36.76	25.6	6.68		9.84		y
P	92	Marshall, OK	AN		43.01	26.25	25.35	7.13		16.76		n
P	93	Marshall, OK	OU		30.2		26.62	4.42	21.41	9.36	4.03	n
P	94	Marshall, OK	E		26.56	18.32	23.87	3.93	20.65	8.24	3.92	n
P	95	Marshall, OK	OZ		42.88		22.62	4.73	15.25	10.3	1.89	n
P	96	Marshall, OK	E		40.26	33.17	20.46	4.32	18.04	7.09	1.73	n
P	97	Marshall, OK	OZ		33.68	25.67	20.06	4.34	14.97	8.01	2.18	n
P	98	Marshall, OK	G		24.48		27.83	5.67		11.44		n
P	99	Marshall, OK	AL		28.43	20.47				7.96		n
P	100	Choctaw, OK	G		37.09	30.05	23.51	5.96	17.09	7.04	1.72	n
P	101	Choctaw, OK	AN		34.92		22.29	4.99				n
P	102	Choctaw, OK	AN		28.53	17.09	20.72	4.85	22.59	11.44	3.8	n
P	103	Choctaw, OK	AN		30.77	22.2	22.74	5.19	20.63	8.57	3.38	n
P	104	Choctaw, OK	AN		33.25	27.81	19.08	4.56	16.25	5.44	1.97	n
P	105	McCurtain, OK	OZ		10.75	2.61	22.96	4.24	16.52	8.14	2.22	n
P	106	Choctaw, OK	OZ		34.01		20.93	4.63	17.9	7.37	3.6	n
P	107	McCurtain, OK	AN		36.19	25.88	25.28	5.15	22.93	10.31	3.72	y
P	108	McCurtain, OK	AN		41.26	35.95	24.41	3.92	14.42	5.31	3.04	n
P	109	McCurtain, OK	OZ		52.34	41.84	28.19	5.68	22.79	10.5	4.55	n
P	110	Blaine, OK	OZ		43.77	32.56	26.33	5.81	20.06	11.21	4.91	y
P	111	Blaine, OK	OZ		58.16	43.13	29.96	8.35	29.47	15.03	3.15	n
P	112	Haskell, OK	OZ		35.84	27.01	23.7	6.62	19.17	8.83	1.97	n
P	113	Haskell, OK	OZ		40.16		29.17	6.15	27.36	17.68	6.19	n
P	114	Haskell, OK	OZ		42.26	30.87	23.97	5.19	19.01	11.39	3.83	n
P	115	Haskell, OK	OU		30.28		21.03	6.49	18.56	14.45	3.69	n
P	116	McIntosh, OK	AL		35.89		23.6	4.83				n
P	117	McIntosh, OK	OU		32.83	26.47	22.42	4.52	16.46	6.36	1.69	n
TARL	118	San Augustine, TX	G	H	26.43		23.16	7.37	22.23	14.02	3	n
TARL	119	San Augustine, TX	G	H	29.73	19.98	18.53	4.63	19.13	9.75	1.17	n
TARL	120	San Augustine, TX	G	H	29.77	15.19	24.95	7.91		14.58		n
TARL	121	San Augustine, TX	G	H	28.26	13.86	22.06	6.22	20.39	14.4	2.19	n
TARL	122	San Augustine, TX	G	H	31.26	18.05	22.54	5.53	20.26	13.21	3.88	n
TARL	123	San Augustine, TX	G	H	19.45	11.28	19.78	5.57	19.64	8.17	1.91	n

TARL	124	San Augustine, TX	G	SJ	28.68	19.86	23.12	6.79	16.79	8.82	1.27	y
TARL	125	San Augustine, TX	G	SJ	32.77	25.96	17.77	4.32	17.96	6.81	2.41	y
TARL	126	San Augustine, TX	G	SJ	25.6	17.53	17.81	4.02	16.37	8.07	3.11	y
TARL	127	San Augustine, TX	G	SJ	32.22		17.51	5.55	22.34	9.19	2.04	y
TARL	128	San Augustine, TX	G	SJ	40.06	31.1	18.57	5.82		8.96		n
TARL	129	San Augustine, TX	G	SJ	30.7		24.13	5.86		10.41		n
TARL	130	San Augustine, TX	G	SJ	30.5		22.23	5.58		9.13		n
TARL	131	San Augustine, TX	G	SJ	25.06	18.42	20.6	3.52	17.99	6.64	3.4	n
TARL	132	San Augustine, TX	G	SJ	19.81	11.97	18.33	4	19.22	7.84	3.62	y
TARL	133	San Augustine, TX	G	SJ	20.37		20.06	6.34	18.34	9.81	1.73	n
TARL	134	San Augustine, TX	G	SJ	29.46	20.81	23.23	4.58	22.46	8.65	3.96	n
TARL	135	San Augustine, TX	G	SJ	34.12	26.88	26.76	4.88	20.1	7.24	1.79	n
TARL	136	San Augustine, TX	G	SJ	31.29	20.53	19.91	5.79	20.49	10.76	2.09	n
TARL	137	San Augustine, TX	G	SJ	21.43	14.9	19.46	3.76	17.14	6.53	2.06	y
TARL	138	San Augustine, TX	G	SJ	28.47	18.96	22.3	5.21	19.93	9.51	3.17	n
TARL	139	San Augustine, TX	G	SJ	28.11	20.02	20.32	4.14	17.1	8.09	3.11	n
TARL	140	San Augustine, TX	G	SJ	24.75		19.49	4.68	18.09	7.44	2.11	n
TARL	141	San Augustine, TX	G	SJ	36.89	28.22	22.88	4.89	20.56	8.67	3.58	n
TARL	142	San Augustine, TX	G	SJ	39.14	31.06	22.67	5.82	18.93	8.08	1.74	n
TARL	143	San Augustine, TX	G	SJ	30.44	22.99	23.19	4.49	17.31	7.45	3.32	n
TARL	144	San Augustine, TX	G	SJ	24.31	14.92	18.6	5.31		9.39		n
TARL	145	San Augustine, TX	G	SJ	27	20.61	17.06	4.51		6.39		n
TARL	146	San Augustine, TX	G	SJ	30.17		22.06	4.39		13.41		n
TARL	147	San Augustine, TX	G	SJ	24.57	15.85	17.81	4.15		8.72		n
TARL	148	San Augustine, TX	G	SJ	25.52	18.59	20.06	5.09	17.86	6.93	1.32	y
TARL	149	San Augustine, TX	G	H	34.03		25.05	7.05	24.62	14.81	4.41	n
TARL	150	San Augustine, TX	G	H	54.19	32.22	32.17	8.89	24.64	21.97	9.17	n
TARL	151	San Augustine, TX	G	SJ	27.97	20.44	20.86	4.38	18.11	7.53	3.56	n
TARL	152	San Augustine, TX	G	SJ	34.68	25.22	25.63	4.39	21.13	9.46	3.83	y
P	153	Caddo, LA	G		24.99	16.58	17.39	5.92	21.12	8.41		n
P	154	Hunt, TX	OU		36.8	25.11	22.78	8.26	21.44	11.69	4.84	n
P	155	Fannin, TX	G		39.62	24.59	25.86	10.37	23.92	15.03	4.08	n
P	156	Fannin, TX	G		28.07	12.57	20.13	6.6	19.34	15.5	4.19	n
P	157	Hunt, TX	G		32.86	22.01	20.74	7.03		10.85		n
P	158	Angelina, TX	G		28.76	20.82	25.73	5.38	21.95	7.94	3.87	n
P	159	Angelina, TX	G		28.61	20.72	23.85	4.02	18.94	7.89	4.15	n
P	160	Cass, TX	G				22.41	4.71	16.65	6.98	2.1	n
P	161	Fannin, TX	G		39.16	30.54	26.21	5.96	23.73	8.62	1.75	n
P	162	Montgomery, TX	G		40.33	31.44	24.54	5.15	22.9	8.89	3.28	n
P	163	Sabine, LA	G				24.28	5.88	24.41	11.56	2.43	y
P	164	Fannin, TX	G		38.71	30.19	22.61	6.8	20.25	8.52	1.49	n
P	165	Cass, Tx	G		40.46	33.34	22.17	4.09	16.41	7.12	1.96	n
P	166	Hunt, TX	G				20.92	3.72	18.53	7.78	3.85	n
P	167	Hunt, TX	G				19.74	4.46	16.9	6.72	2.7	n
SN	168	McCurtain, OK	OU		25.52		21.16	5.04		10.73		n
SN	169	Marshall, OK	G		20.12		17.52	4.65	19.67	7.79	1.08	n
SN	170	McCurtain, OK	OZ		18.41	11.91		3.77	15.76	6.5	2.59	n
SN	171	McCurtain, OK	OU		26.53	17.24	25.87	4.77	19.02	9.29	2.17	n
TARL	172	Morris, TX	G	H	32.48	19.75	30.95	6.21	31.37	12.73	4.01	n
TARL	173	Morris, TX	G	H	38.49	21.22	21.12	6.01	21.56	17.27	3.09	n
TARL	174	Anderson, TX	G	H	28.68		21.74	6.07	19.38	13.62	5.14	n
TARL	175	Wood, TX	G	H	30.99		21.9	5.92	21.85	15.59	2.46	y
TARL	176	Anderson, TX	G	H	23.9	15.11	22.12	4.85	22.23	8.79	3.79	n
TARL	177	Sabine, TX	G	SJ	22.85	17.39	20.54	3.54	15.61	5.46	2.02	n
TARL	178	Nacodotches, TX	G	SJ	20.15	12.17	19.87	5.23	22.33	7.98	3.27	n
P	179	Caddo, OK	AL		36.47	29.21	20.2	5.02		7.26		n
P	180	Caddo, OK	E		44.12	34.26	25.72	5.47	17.7	9.86	4.83	y
P	181	Marshall, OK	G		31.04	23.29	19.99	4.6	18.23	7.75	2.49	n
P	182	Marshall, OK	G		46.6	39.91	21.35	4.05	15.74	6.69	2.23	n
P	183	Marshall, OK	G		45.18		23.63	5.87	19.17	13.07	5.29	y
P	184	Marshall, OK	G		25.82	18.34	17.92	3.69	15.93	7.48	2.54	n
P	185	Marshall, OK	G		28.64		21.51	4.99	19.22	7.33	2.86	n
P	186	Marshall, OK	G		27.87		19.43	5.82	17.2	8.28	3.01	n
P	187	Marshall, OK	G		31.97	20.48	25.66	5.65	21.29	11.49	5.15	n
P	188	Marshall, OK	E		20.61		25.38	5.94	26.05	11.38	5.37	n
P	189	Jackson, OK	E		50.46	42.1	26.81	6.64		8.36		n
P	190	Kay, OK	FH		44.77	33.95	26.42	5.2	22.37	10.82	4.78	n
P	191	Kay, OK	AL		34.95	25.45	23.2	6.55	21.9	9.5	3.87	n
P	192	Kay, OK	G		39.77	28.32	24.76	6.17	20.14	11.45	3.98	n
P	193	Dallas, TX	G				25.4	5.99	21.92	9.09	4.47	y
P	194	Rusk, TX	OU		19.21	12.88	20.8	4.53	19.85	6.33	2.28	n
P	195	Navarro, TX	G		21.34	14.85	20.54	3.83	17.62	6.49	2.23	n
P	196	Dallas, TX	G		25.49	14.96	17.26	5.66	15.06	10.53	1.98	y
P	197	Nacodotches, TX	G		51.06	40.02	27.58	5.34	20.78	11.04	3.8	y
P	198	Rusk, TX	G		23.61	15.62	18.49	5.31	17.07	7.99	1.37	n

Appendix B

Dalton Point Data

Adapted from Ballenger (2001)
Key:

I = Impact fracture **OZ = Ozarks**
S = Snap fracture **OU = Ouachitas**
B = Burin-like fracture **KC = Flint Hills**

Spec #	Length	Base Width	Blade Width	Blade Length	Thick ness	Breakage	Raw Material	Notes
1	91.7	17.6	21.3	76.1	6.6	I	OZ	Ear missing
3	98.0	24.0	25.5	70.0	8.8		OZ	
4	61.4	24.0	24.0	46.0	8.4		OU	
5	70.5	22.8	23.1	54.0	7.2		OZ	
6	53.3	20.1	20.3	35.0	6.5	I	OZ	Ear missing
9	69.7	19.4	19.1	54.0	7.5		OZ	
10	68.5	19.7	19.0	58.0	7.5		OU	
12	54.2	23.0	21.7	39.0	7.5		OZ	
14	60.6	19.4	18.1	47.0	6.6		OZ	
16	101.5	25.8	24.1	86.0	6.5		OZ	
17	78.9	25.7	23.8	63.0	7.8		OZ	
22	110.6	21.0	18.6	87.0	8.8		OU	
24	64.4	20.0	17.5	50.0	9.0		OZ	
27	71.6	23.3	19.4	57.0	7.0		OZ	
28	67.5	22.9	18.9	55.0	6.8		OU	
33	59.5	25.0	20.0	48.0	8.6		OZ	
34	66.7	21.1	16.7	49.0	8.0		OZ	
35	59.8	24.6	19.5	43.0	7.5		OU	
38	47.3	20.5	15.7	35.0	7.8		OU	Spokeshave
40	58.0	24.0	18.3	40.0	6.8		OZ	
41	75.3	23.0	17.4	62.0	6.7		OZ	
42	52.5	24.0	17.9	38.0	7.1		OZ	
43	66.0	25.2	18.4	51.0	7.0		OZ	
44	56.5	23.0	16.8	40.0	7.9		OZ	
46	99.3	25.0	18.0	77.0	8.2	I	OZ	
49	84.1	24.2	16.8	67.0	8.3		OZ	
50	73.6	25.0	17.2	55.0	8.1		OZ	
51	60.4	27.2	18.7	47.0	6.5		OU	
52	44.9	21.1	14.4	31.0	6.5	S	OZ	Tip missing
54	45.5	19.1	12.8	30.0	5.5		OZ	
55	63.0	19.8	13.2	53.0	6.9		OZ	
56	56.0	25.5	17.0	36.0	5.5		OU	
57	64.7	23.2	15.2	45.0	8.2		OU	
58	63.6	17.8	11.6	49.0	11.6		OZ	Awl

59	62.0	27.1	17.7	50.0	7.7		OU	
61	47.8	20.0	12.7	31.0	6.0	S	OU	Ear missing
62	56.9	25.7	15.8	45.0	6.5		OZ	
63	47.4	22.5	13.7	31.0	5.5		OZ	
64	45.6	26.8	16.1	27.0	7.6		OZ	
66	45.7	22.5	13.3	30.0	6.0		OZ	
68	45.0	21.6	12.5	33.0	6.2		OZ	
70	46.3	21.0	12.0	29.0	6.0		OZ	
71	43.4	22.1	12.4	30.0	6.8		OU	
73	35.9	17.5	9.4	18.0	6.7	S	OZ	Tip missing
74	42.1	19.1	10.1	26.0	5.9		OZ	
76	68.0	28.3	14.8	51.0	6.5		OU	
78	44.8	23.9	12.2	30.0	6.5		OZ	
79	35.2	20.4	10.4	25.0	6.9		OZ	
81	49.0	22.8	11.4	39.0	7.3		OZ	
82	58.2	21.3	10.5	47.0	6.6		OU	Awl
83	41.6	25.8	12.5	29.0	7.0		OZ	
84	51.8	19.7	9.4	40.0	5.5		OZ	
85	50.4	21.8	10.2	36.0	6.8		OZ	
86	44.7	22.8	10.7	35.0	5.6		OZ	
87	50.6	23.7	11.0	38.0	5.2		OU	
88	35.7	20.0	9.2	19.0	6.5	T	OZ	Tip repaired
89	64.6	21.7	10.0		6.0	S	OZ	Awl, refit
90	41.5	22.6	10.3	24.0	7.7	S	OZ	Tip repaired
91	31.0	22.5	10.2		7.0		OU	Tip & ear missing
92	57.3	23.7	10.7	41.0	6.5	B	OZ	
93	39.5	16.9	7.6		5.8	S	OZ	Awl, tip & ear missing
94	33.4	21.3	9.5		5.8	S	OZ	Awl,tip missing
95	61.6	18.0	7.8	40.0	7.1		OZ	
96	51.0	19.5	8.2	48.0	5.4		OZ	Awl
97	37.1	21.0	8.8		5.9	S	OZ	Awl
98	58.9	20.9	8.7	45.0	6.3		OZ	
99	38.5	23.2	9.6	29.0	7.5		OU	
100	61.5	24.9	10.3	50.0	7.5		OU	
101	45.0	20.3	8.4	34.0	7.1		OZ	Awl
102	40.0	26.2	10.8	25.0	5.0	B	OZ	
103	42.1	27.0	11.0		5.5	S	OU	Tip & ear missing
104	54.5	22.3	8.9	37.0	5.8		OZ	
105	34.2	22.0	8.8	22.0	7.5		OZ	
106	40.2	20.3	8.0		6.5	B	OU	Awl
107	46.2	21.8	8.5	30.0	5.6		OZ	Awl
108	66.6	24.8	9.5	50.0	7.0		OZ	
109	41.5	25.2	9.5	24.0	6.9	B	OU	
110	60.3	25.0	9.2	43.0	6.6	S	OZ	Ear missing
111	72.9	24.4	9.0	56.0	7.4		OZ	Awl
112	47.3	24.0	8.7	39.0	6.1		OZ	
113	52.3	26.4	9.0	40.0	6.6		OZ	Awl

114	35.5	25.1	8.5	22.0	6.8	B	OZ	
115	50.6	17.0	5.7	38.0	6.7		OU	
116	40.6	24.1	7.4	28.0	5.7		OZ	
117	23.7	23.2	7.0		6.1	S	OZ	
118	46.0	23.3	6.7	36.0	6.2		OZ	Awl
119	49.6	26.0	6.6	39.0	6.8		OU	
120	36.5	21.6	5.4	27.0	5.0		OZ	Awl
121	29.0	21.0		21.0	5.8		OZ	
122	30.5	21.9	3.6	20.0	6.5		OZ	
123	41.8	23.4	10.9		6.7	S	OU	Awl
124	54.4	16.9	9.3	42.0	7.4		OU	Awl
125	32.8	20.0	6.2		5.4	S/B	OZ	
126	29.5	26.1		20.3	6.0		OZ	
127	29.1	33.0			6.2		OU	
128	34.0	23.2		20.6	7.0	S/B	OU	Both ears missing
129	24.9	25.7			6.5	S	OZ	Tip missing
130	28.0	21.8			5.3	T	OU	Tip missing
131							KC	Severely reworked
132	31.8	21.6			5.8	T	OU	Tip missing
133		30.0				S	OU	Base
134		29.4				T	OZ	Base
135		23.0				S	OZ	Base
136		20.8				S	OZ	Base