From the Continental Divide to the Plains-Woodland Border: Clovis and Folsom/Midland Land Use and Lithic Procurement

By

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ABSTRACT

The terminal Pleistocene represents a dynamic period of environmental flux and resultant species extirpation, extinction, and reorganization of biotic communities. Assessment of Clovis and Folsom/Midland artifacts offers an opportunity to address human response to these changing conditions. Clovis sites range in age from ca. 11,590-10,800 RCYBP (13,550-12,850 CALBP) with Folsom technology well expressed from ca. 10,800-10,200 RCYBP (12,800-11,700 CALBP). Although firm radiocarbon assessments of Midland sites are largely lacking, it is suggested Midland technology is a different expression of the same organizational system as Folsom groups. This research outlines environmental change during this dynamic period and develops models of diverse land use strategies between Clovis and Folsom/Midland groups. It is suggested that a small change in adaptive systems can result in noticeable differences in the archaeological record when compounded through redundant activity and time. This change is in part attributed to shifting ecosystems and resource availability of the terminal Pleistocene.

Spatial patterning in Clovis and Folsom/Midland artifact distributions, particularly projectile points, preforms, and channel flakes is addressed at a variety of analytical scales in this research. Private artifact collections and isolated artifact discoveries from the Continental Divide of Colorado to the eastern Kansas border are used to characterize Clovis and Folsom/Midland land use and lithic procurement across the Central Great Plains. This research demonstrates that Clovis and Folsom/Midland artifact distributions are not homogenous across the study region, and are influenced by a variety of factors including ground surface visibility and geomorphic filtering, artifact collector activity and research intensity, and diverse land use and resource procurement strategies between Clovis and Folsom/Midland groups.

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This research is the product of many thousands of miles and countless days behind the wheel, frequent late night drives, and the occasional sleeping in the back of the well-traveled, rusting out and breaking down ’99 Chevy s10 that has become acquainted with all corners of Kansas and most small towns of eastern Colorado. As such, this dissertation represents the culmination of thousands of hours invested in the discovery of artifacts by many unique and knowledgeable individuals. This research would not have been possible without the generosity of private collectors who invited me into their homes and allowed me access to their artifact collections. These visits were often at the sacrifice of their own busy daily routines, a spare bedroom, many fine meals, and countless pots of coffee. During the course of this research, I visited over 30 different private collections. For reasons of privacy, I omit individual names here and offer a collective thank you for their efforts.

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CHAPTER 1

INTRODUCTION AND DISSERTATION OVERVIEW

The antiquity of human presence in the Americas is a contentious issue with resolution constantly under criticism, revision, and resultant paradigm shifts in deeply ingrained traditional understandings. The chance discovery of a human manufactured chipped stone projectile point in direct association with an extinct species of bison at the 12 Mile Creek site in Logan County, Kansas in 1895 (Williston 1902) represents one of the first in a series of significant discoveries that mark a pivotal turning point in the development of American archaeology. A similar style of point would be found near Folsom, New Mexico in 1926 (Cook 1927; Figgins 1927), again associated with the remains of an extinct species of bison. This discovery was followed six years later by the recognition of a larger style of projectile point with distinct flaking characteristics at Dent, Colorado and the Blackwater Draw locality near Clovis, New Mexico, both found in association with mammoth remains (Cotter 1937, 1938; Howard 1935; Figgins 1933; Sellards 1952). These discoveries called for a critical reevaluation of antiquity of man in the New World as they established a human presence in the Americas of much greater time depth than was previously accepted (Meltzer 2006:22-23; Willey and Sabloff 1980).

As word of these important discoveries spread, many individuals realized they had similar projectile points in their private collections (Cook 1931). Invariably, when these point styles were found in association with bone, the remains were of Pleistocene species. It became increasingly apparent that these chipped stone point styles were relatively common throughout the Great Plains, and could be used as technological as well as chronological markers across a large geographic space. However, considerable typological variability was often noted (Renaud

1931, 1932), resulting in subsequent, often confusing classification into broad typological categories including “Folsom-like”, “Folsomoid”, “Generalized Folsom”, and the erroneous “Folsom-Yuma Complex” (Sellet 2011:99; Wormington 1957). Not until 1941 following a symposium on terminology and typology in Santa Fe, New Mexico were these other categories dropped in favor of “Folsom Point” and “Clovis Point” (Wormington 1948, 1949, 1957).

Since that time, resolution and refinement of the age range of Clovis and Folsom artifacts has been well established through radiocarbon dating (Table 1). However, interpretation of radiocarbon estimates is variable and contingent on inclusion of the earliest and youngest dated sites, producing a maximum age range, or subscribing to age determinants for the most sites, resulting in an averaged time range. Most Clovis sites date between 11,100 and 10,800 RCYBP, or approximately 13,150-12,850 CALYBP (Waters and Stafford 2007). However, two earlier dates of 11,542 +/- 111 and 11,590 +/- 93 RCYBP have been obtained from the Aubrey site in northern Texas (Ferring 2001), suggesting earlier Clovis occupation from about 13,500 CALYBP (Fiedel 2015). Depending on the dates subscribed to, the Clovis tradition lasted for a maximum of 450 calendar years, or as little as 200 calendar years as a minimum estimate (Prasciunas and Surovell 2015). Folsom artifacts appear in the archaeological record about 10,900 RCYBP (Haynes 1993; Haynes et al. 1992; Waters and Stafford 2007), with others artifact styles including the Western Stemmed tradition proliferating by 10,700 RCYBP (Fiedel 2015; Fiedel and Morrow 2012; Goebel and Keene 2011; Reid 2011). The Midland point, included in this analysis as a separate technological expression of the same organizational system as Folsom groups (Amick 1995), likely dates to the same period, although firm radiocarbon assessments for this point style are lacking. The Folsom tradition lasts until about 10,200 RCYBP, producing an age range of approximately 12,800-11,700 CALYBP, representing a span between 1,100 and 900 calendar years (Ahler and Geib 2002; Fiedel 1999; Hofman 1995b; Taylor, Haynes, and Stuiver 1996; Williams 2015). Importantly, the transition from Clovis to Folsom also marks the onset of the Younger Dryas at 10,900 RCYBP (Carlson and Bement 2013) and represents a pivotal period of climatic change and resultant floral and faunal alterations. The Younger Dryas comes to an end about 10,000 RCYBP, which is occasionally suggested as the transition from the Pleistocene to Holocene period (Gibbard and Head 2010; Pillans 2007). However, this transition took place over several thousand years, from at least 12,000 RCYBP until about 9,000 RCYBP (e.g. Mandel 2006b). Although the Clovis and Folsom traditions are no longer considered the product of the colonizing populations of the Americas, they still represent two of the earliest, best documented, easily recognizable and widespread chipped stone technologies throughout the Great Plains of North America.

Table 1. Radiocarbon and calendar ages of Clovis and Folsom sites, the Younger Dryas, and the Pleistocene-Holocene transition.

	RCYBP	CALBP	Source
Clovis	11,100-10,800 11,590 (Aubrey)	13,150-12,850 13,550 (Aubrey)	Fiedel 2015; Waters and Stafford 2007 Ferring 2001
Folsom	10,900-10,200	12,800-11,700	Collard et al. 2010; Haynes 1993; Haynes et al. 1992
Younger Dryas	10,900-10,000	12,800 -11,600	Carlson and Bement 2013; Mangerud et al. 1974
Pleistocene-Holocene Transition	10,000 12,000-9,000	11,700	Gibbard and Head 2010; Pillans 2007 Mandel 2006b

Available samples of Clovis and Folsom points and preforms have grown considerably in recent years. Regional patterning in Clovis, Folsom, and Midland biface technology, particularly projectile points and preforms from site assemblages and isolated discoveries are used herein to elicit patterns of long term land use and lithic procurement. This study explores distributions of Clovis and Folsom artifacts from the Continental Divide of Colorado to the eastern Kansas border, and offers explanatory models to account for observed patterning. Uneven distributions are derived in part from diverse subsistence practices resulting from ecological reorganizations of floral and faunal resources during a time of critical environmental changes of the terminal Pleistocene period.

Impetus for Study

This study supplements existing distribution studies of Clovis and Folsom artifacts within the Great Plains (Amick 1994a, 1994b, 1994c, 1996, 1999; Anderson and Faught 1998; Anderson et al. 2005; Asher and Hofman 2011, 2013; Billick 1998; Blackmar 1998, 2001; Blackmar and Hofman 2006; Brown and Logan 1987; Davis 1988; Fischel 1939; Gebhard 1949; Hofman 1991, 1992, 1993, 1994a, 1994b; 1999; Hofman and Asher 2011; Hofman and Hesse 1996, 2002; Hofman, Holen, and Hannus 1999; Hofman and Gottsfield 2010; Hofman and Wyckoff 1991; Holen 2001, 2003, 2014; Kehoe 1966; LeTourneau 2000; LeTourneau and Weber 2004; McLean 2002; Meltzer 1995; Myers 1987; Pertulla and Nelson 2010; Prasciunas 2008; Prasciunas et al. 2008; Renaud 1931, 1932; Root and Taylor 2002; Sellet and Fosha 2000; Yapple 1968; Wetherill 1994; Williams and Hofman 2010; Williams 2015). Importantly, most previous scholarship has focused on either Clovis or Folsom technology, with few drawing comparisons between the two or attempting to explain observed differences in spatial patterning. Clovis and Folsom artifact distributions are not ubiquitous across the study region (Asher 2015; Asher and Hofman 2011, 2013), but rather occur patchily clustered in particular regions. This patterning must be interpreted at the local and regional levels as groups were operating at different scales of mobility and land use, and geomorphic filtering biases the current sample in some areas. Geomorphic or geologic filters as defined by Bettis and Mandel (2002), and expanded by Mandel 2006b include sedimentation, soil formation, and erosion that differentially affect the landscape at regional scales and impact site visibility and artifact recovery.

The majority of previous research into Clovis and Folsom land use for the Great Plains has focused on the Southern Plains and Southwest (Amick 1994a, 1994b, 1994c, 1996; Hofman 1991, 1992; 1999; Johnson 1991; LeTourneau 2000; Meltzer 2006), regions north of the study area (Ellis 2011; Frison 1991; Frison and Todd 1986), or generalized subsistence models at a much larger geographic scale (Bonnichsen and Turnmire 1991; Kelly and Todd 1988; Meltzer 1993, 2009; Prasciunas 2008, 2011). Updated or revised synthesis of material from the Central Plains is largely lacking, with a few notable exceptions (Blackmar 2001; Blackmar and Hofman 2006; Hofman 1996; Holen 2001, 2003, 2014). Traditional models of Clovis and Folsom land use are derived from information gathered outside the study area, and then expanded across underreported or understudied regions where artifacts are poorly represented (LaBelle 2005:20). Such practice is flawed in that it assumes people were operating under similar restraints across large geographic ranges, but resource availability and human response to local environmental conditions was not homogenous across physiographic barriers. Although the overall organizational systems of Clovis and Folsom groups may have been relatively constant, these systems are unevenly expressed across the landscape as local environmental constraints influenced land use intensity for particular regions. Similarly, it will be demonstrated that a small change in adaptive systems can result in large observable differences in the archaeological record when compounded through redundant activity over extended periods of time.

The study region represents the crossroads of the Great Plains, and an intersection which has traditionally been viewed as primary home-ranges or territories of Clovis and Folsom groups (Figure 1). Clovis points are reported from southern Canada, and throughout subglacial North

America into northern South America (Bradley, Collins, and Hemmings 2010; Ives et al. 2014; Miller, Holliday, and Bright 2013; Pearson 2002; Sanchez et al. 2014; Stanford et al. 2005). The oldest Clovis sites are found in the Southwest (Collins 1999; Ferring 1995, 2001), and within the Great Plains, the largest concentrations of Clovis artifacts are found on the Southern Plains, particularly in Texas (Meltzer 1995). However, heavy concentrations of Clovis points are also reported from southeastern states, including Alabama, Tennessee, Kentucky, Virginia, and North Carolina (Andersen 1996; Futato 1982:33; Goodyear 2005:437; McCary 1975; Peck 1988; Perkinson 1973; Prasciunas 2008, 2011; Smallwood 2012; Williams and Stoltman 1965:675). Clovis points from these eastern states are associated with areas rich in high-quality chipped stone materials, faunal, and floral resources, and are often typologically distinct from classic Western Clovis points found throughout the Great Plains that are considered in this study.

Folsom points are documented but rare from Alberta and Saskatchewan, Canada in the north (Ives et al. 2014:157; Wormington 1957:29), with a similar style of point, the Barnes type, well represented in the Great Lakes region of Canada (Wright and Roosa 1966). Folsom point distribution extends to southern Texas and Mexico in the south, with only eight points currently reported from Mexico (Canales et al. 2006; Pearson 2002). They are rarely found in Nevada, Utah, and Idaho in the west, with none reported for California or Oregon (Davis and Shutler 1969; Hutchinson 1988; Rondeau 2014:45). Folsom points are found into the Midwestern states of Iowa, Minnesota, Indiana, Illinois, Wisconsin, and eastern Missouri, but are typically associated with the open grassland landscapes of the Great Plains (Chapman 1975; Morrow and Morrow 1999; Munson 1990).

Several significant Clovis and Folsom sites are found within the study area (Tables 2 and 3), as well as many unreported but recorded Clovis and Folsom occurrences. These site assemblages and isolated discoveries provide a sufficient sample of artifacts to critically examine differences in Clovis and Folsom distributions across the Central Plains. The lithic landscape of this region is ideal for addressing lithic procurement and movement of artifacts across geographic space as few high quality stone source locations are present, and isolated to specific regions separated by large expanses of land deprived of quality lithic source outcrops (Holen 2001, 2014). In addition, these materials are typically identifiable at the macroscopic level, allowing for reconstruction of land use and lithic transportation patterns across the landscape.

This research characterizes Clovis and Folsom land use across the Central Plains, while synthesizing a large amount of recorded but previously unreported Clovis and Folsom finds from within the study region. This facilitates reconstructing land use patterns at much larger geographic scales as it fills a large gap in existing fluted point datasets between the Northern and Southern Plains.

Organization of the Dissertation

The study region is defined and each physiographic and sub-physiographic province within the study area is characterized in Chapter 2. Unique geologic aspects, floral and faunal resource availability, and significant Clovis and Folsom sites are highlighted for each region. Potential biases that may influence site visibility in each region are noted. Climate change during the Pleistocene/Holocene transition is discussed in Chapter 3, with particular attention given to two traditional models of faunal response to climate change. Aspects of both models are then applied to develop a framework from which to model human response to changing environmental conditions of the terminal Pleistocene. Clovis and Folsom subsistence is reviewed and characterized in Chapter 4, and used to develop separate land use models for Clovis and Folsom groups. Diverse subsistence strategies impacted chipped stone technology, which is discussed in Chapter 5, with particular attention given to biface technologies. The role of fluting in Clovis and Folsom chipped stone technology is discussed and explained in terms of the proposed land use models. Chapter 6 reviews data collection methodologies, and makes an argument for use of private collections, surface discoveries, isolates, and projectile points as meaningful data sets. Scales of analysis are discussed, and a method for rectifying county boundaries with geophysical barriers is outlined. The strategies employed for identifying lithic material types are outlined, with difficulties and shortcomings of macro-level lithic identification noted. The study sample of Clovis and Folsom projectile points and preforms is summarized in Chapter 7, and lithic material type frequencies are characterized for each physiographic region. Chapter 8 explores differential distributions of Clovis, Folsom, and Midland projectile points and preforms through frequency, density, and ubiquity analysis, the results of which are reviewed in Chapter 9 and discussed in terms of the proposed Clovis and Folsom land use models, lithic procurement, and potential biases skewing the observed distributions. Concluding remarks and directions for future research are outlined in Chapter 10.

Table 2. Clovis and Folsom Sites within the Study Area.

Site	**ST.**	**Site No.**	**Affiliation**	**Physio. Region**	**Setting**	**Site Type**
12 Mile Creek	KS	14LO2	Folsom (?)	High Plains	Terrace	Kill
Anton Site*	CO	5WN232	Clovis	High Plains	Anton Escarpment	
Bijou Creek	CO	5MR355	Clovis/Folsom	Colorado Piedmont		Open Lithic
Black Dump*^	CO	5CF1573	Clovis/Folsom	Rocky Mountains	Eroded Upland	Open Lithic
Black Mountain*^	CO	5HN55	Folsom	Rocky Mountains	High-Elevation Slope	Camp
Bredthauer^	KS	14RP327	Clovis	Smoky Hills	Terrace	
Busse	KS	14SN1	Clovis	High Plains	Pasture	Cache
Cattle Guard*#	CO	5AL101	Folsom	San Luis Valley	Blowout/Deflated	Kill/Camp
Claypool^	CO	5WN18	Clovis/Folsom	High Plains	Dune Field, Deflated	Camp/Kill
Coffey*	KS	14PO1	Folsom	Glaciated Region	Terrace	Camp?
Cutsinger-Bailey^	KS	14WN388	Clovis	Osage Cuestas	Agricultural Field	Cache
CW Cache	CO	5L_	Clovis	High Plains	Playa Lake, Eroded	Cache
DB Ridge*^	KS	14LV1071	Folsom	Glaciated Region	Loess Ridge, Missouri R.	Camp/Overlook
Dent*^	CO	5WL269	Clovis	Colorado Piedmont	Kersey Terrace, Channel Fill	Kill
Diskau^	KS	14RY303	Clovis	Flint Hills	Terrace, Eroded	Camp
Drake^	CO	5LO24	Clovis	Colorado Piedmont	Low Ridge, Agricultural Field	Cache
Dutton^	CO	5YM37	Clovis	High Plains	Natural Pond	Camp/Kill
Eckles^	KS	14JW4	Clovis	Smoky Hills	Terrace, Eroded	Camp/Kill
Fisher-Filipi^	KS	14RP8	Clovis	Smoky Hills	Terrace	Isolated find
Fowler-Parrish^	CO	5WL100	Folsom	Colorado Piedmont	Playa Lake, Blowout	Kill
Fox^	CO	5WL_	Clovis	Colorado Piedmont	Dune Field, Deflated	
Graham^	KS	14RP10	Clovis/Folsom	Smoky Hills	Ridge Toe, Hill Slope	Open Lithic
Hahn	CO	5EP1	Clovis/Folsom	Colorado Piedmont	Eroded Upland	Open Lithic
Johnson*^	CO	5LR26	Folsom	Rocky Mountains	Foothills, Deflated	Camp
Kanorado^	KS	14SN101,105,106	Clovis/Folsom	High Plains	Terrace	Kill/Processing
Klein^	CO	5WL1368	Clovis	Colorado Piedmont	Kersey Terrace	Camp
Lamb Spring	CO	5DA83	Clovis	Colorado Piedmont	Pasture	Bn. Processing
Larson^	KS	14RP11	Clovis	Smoky Hills	Ridge Toe, Hill Slope	Isolated find
Lindenmeier*#	CO	5LR13	Folsom	Colorado Piedmont	Terrace	Camp/Kill
Linger*^	CO	5AL91	Folsom	San Luis Valley	Blowout/Deflated	Kill
Mahaffy	CO	5BL_	Clovis	Foothills/Piedmont	Gregory Creek Alluvium	Cache
Powars	CO	5WL1369	Folsom	Colorado Piedmont	Terrace, Deflated	Camp
Reddin	CO	5SH77	Folsom	San Luis Valley	Deflated	
Sailor-Helton	KS	14SW302	Clovis	High Plains	Eroded Upland	Cache
Smoky Folsom^	CO	5KC_	Folsom	High Plains	Open lithic	Open Lithic
Vincent Donovan^	KS	14BA308	Folsom	Red Hills	Eroded terrace Remnant	Camp
Watts	CO	5LR_	Clovis	Colorado Piedmont	Cache la Pouder terrace	Cache
Westfall^	CO	5EL_	Folsom	Colorado Piedmont	Bijou Creek, Eroded	Open Lithic
Zapata	CO	5AL90	Clovis/Folsom	San Luis Valley	Deflated	Kill

*Sites containing excavated Clovis or Folsom projectile points
^Sites with projectile points or preforms included in this analysis
#Sites considered separately from distribution analysis

Table 3. Published Sources for Clovis and Folsom Sites within the Study Area.

Site Name	**Source**
12 Mile Creek	Hawley 2009; Hill 1994, 1996, 2002; Hill, Hofman, and Martin 1993; Rogers and Martin 1984
Anton Site	Holen and Noe 2006; Noe 2010
Bijou Creek	Greiser 1985
Black Dump	Prasciunas and Denoyer 2005, 2007
Black Mountain	Jodry 1993; Jodry et al. 1996
Bredthauer	Hofman and Asher 2010
Busse	Hofman 1995b, 1996, 1997; Hofman and Hesse 2002; Kilby 2008; Wyatt 2011
Cattle Guard	Jodry 1987; Jodry & Stanford 1988
Claypool	Bradley and Stanford 1987; Dick and Mountain 1960; Malde 1960; Stanford and Albanese 1975
Coffey	Hofman 1994; Schmits 1980; Yaple 1969*; Ziegler 1976
Cutsinger-Bailey	Hofman 2014; Smith 2002
CW Cache	Holen and Muniz 2005; Muniz 2014
DB Ridge	Logan 1998; 2001; Logan and Johnson 1997; Logan, Hatfield, Johnson, and McLean 1998
Dent	Bilgery 1935; Brunswig and Fisher 1993; Figgins 1933; Wedel 1961; Wormington 1957
Diskau	Schmits 1987; Schmits and Kost 1985
Drake	Stanford 1997; Stanford and Jodry 1988
Dutton	Stanford 1979; Stanford and Graham 1985
Eckles	Hoard et al. 1992; Holen 1989, 2001, 2010
Fisher-Filipi	Hofman and Asher 2010
Fowler-Parrish	Agogino and Parrish 1971; Lahren 1972
Fox	Haynes et al. 1998
Graham	Hofman and Asher 2010
Hahn	Zier and Kalasz 1999
Johnson	Galloway 1961
Kanorado	Mandel et al. 2004; Mandel, Holen, and Hofman 2005; Ryan et al. 2006
Klein	Zier et al. 1993
Lamb Spring	Elias 1996; Fisher 1992; McBrinn et al. 2013; Rancier et al. 1982; Stanford et al. 1981; Wedel 1965
Larson	Hofman and Asher 2010
Lindenmeier	Cotter 1935, 1978; Roberts 1935; Wilmsen 1974; Wilmsen and Roberts 1978
Linger	Dawson and Stanford 1975; Hurst 1941, 1943; Wormington 1957
Mahaffy	Yohe and Bamforth 2013; Bamforth 2014
Powars	Roberts 1937, 1940
Reddin	Jodry 1999b; Stanford 1983
Sailor-Helton	Helton 1957; Hofman 1996; Kilby 2008, 2014, 2015; Mallouf 1994
Smoky Folsom	Johnson 2013
Vincent Donovan	Ryan, Bruner, and Hofman 2004; Widga 2005; Wyatt 2011
Watts	Kilby 2008, 2014; Patten 2003
Westfall	Hofman, Westfall, and Westfall 2002; Williams, Ryan, and Hofman 2004
Zapata	Stanford 1990; Jodry 1999b; Pitblado and Brunswig 2007

*At least one of the Folsom points, and possibly both from the Coffey site reported by Yaple (1969) and included in subsequent later reports is likely a McCormick reproduction. Recent investigations at the site have recovered legitimate Folsom artifacts.

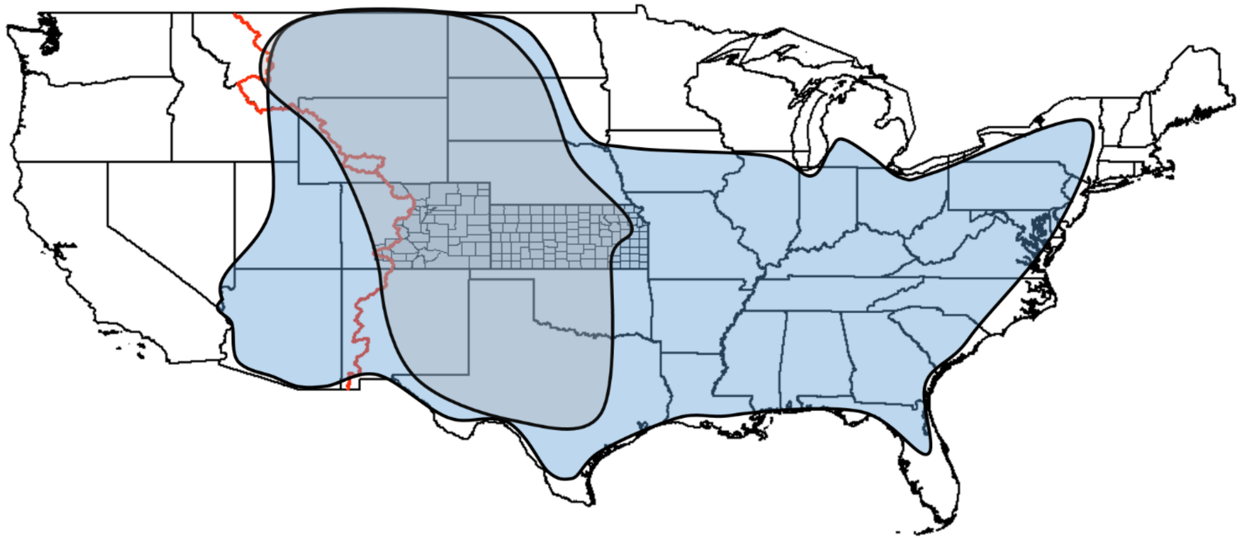

Figure 1. Generalized Clovis (blue) and Folsom (tan overlay) distributions in relationship to the study area. The study area is denoted by the individual counties depicted in Colorado and Kansas. The red line represents the Continental Divide. Clovis and Folsom areas outside of the United States are not included.

CHAPTER 2

THE STUDY REGION: PHYSICAL SETTING, AVAILABLE RESOURCES, AND NOTABLE CLOVIS AND FOLSOM SITES

Efforts to understand landscape formation processes and the implications of prehistoric use of those landforms is of primary concern to geographers and anthropologists. Understanding landscape dynamics allows for critical consideration of prehistoric land use choices and provides a staging ground for evaluation of factors that affect modern archaeological survey and artifact collector activities. The study region, defined here as Colorado east of the Continental Divide and Kansas, exhibits a diverse range of landscapes in a confined geographic space, allowing for critical examination of environmental factors that influence human activity. The total area of the principal study zone is approximately 397,764 km^2, encompassing 46 of the 64 counties of Colorado, and all 105 counties of Kansas (Figure 2). Although county boundaries, used as analytical units in this study, have no bearing on prehistoric land use, they provide a means of partitioning an otherwise cumbersome land mass into manageable units of analysis. The advantages and shortcomings of different scales of analysis are addressed further in Chapter 6.

Dramatic changes in topography, elevation, and latitude across the study region influence climates which in turn result in corresponding vegetation and wildlife differences (Robbins 1910:256). Non-mobile resources such as wood and chipped stone are restricted to particular landforms whereas mobile prey animals may cross many physiographic barriers during the course of a single year. Understanding differences in distribution and availability of both mobile and non-mobile resources within each physiographic region allows for reconstruction of prehistoric scheduling events and annual movement patterns. Human adaptations to diverse ecosystems were undoubtedly varied and specific to geographic region, and are observable in the archaeological record.

This research focuses primarily on landscapes east of the Southern Rocky Mountain massif physiographic province, with these mountains viewed as a natural, albeit not insurmountable barrier that heavily influenced prehistoric environments, land use, and economies. Moving from west to east, the study area is portioned into three large physiographic provinces: The Southern Rocky Mountains, the Great Plains, and the Central Lowlands (Fenneman 1931). A fourth physiographic province, the Ozark Plateau, infringes into the southeastern corner of Cherokee County in extreme southeastern Kansas. Because of its limited distribution within the study area, The Ozark Plateau is not considered further. Within the Rocky Mountains are high elevation intermontane basins and river valleys which offer unique mobile and non-mobile resources. Of these, the San Luis Valley is given particular attention in this study. The foothill belt serves as a transitional zone between the Rocky Mountains and the Great Plains. The Great Plains are further subdivided into the Colorado Piedmont, the High Plains, the Raton Basin, the Arkansas River Lowlands, the Wellington-McPherson Lowlands, the Red Hills, and the Smoky Hills (Fenneman 1931; Mandel 2006a:11). Major river systems predominantly flow from west to east across these regions and likely served as natural corridors of travel during prehistoric times. To the east of the Great Plains is the Glaciated Region of northeastern Kansas, the Osage Cuestas, the Cherokee Lowlands, the Chautauqua Hills, and the Flint Hills which together comprise the Central Lowlands province.

Below, each of these physiographic and sub-physiographic provinces will be sequentially addressed and described, moving from west to east, and spatially defined based on physical attributes. Emphasis is given to conditions that potentially inhibited or encouraged

Paleoindian activity within each region. Notable Clovis and Folsom sites are highlighted and summarized in Table 2 and Figure 3. Modern conditions and geomorphic process are discussed to demonstrate how the landscapes have changed since the terminal Pleistocene, and how these changes may bias our current sample of Clovis and Folsom artifacts. Lithic resources and their distributions are mentioned, but addressed in greater detail in Appendix A.

The Southern Rocky Mountains

High-Elevation Mountain Settings

The western boundary of this study follows the Great Divide (or Continental Divide) which transects Colorado irregularly through the north-south trending Southern Rocky Mountains (Figure 4). This divide is hydrological in origin, separating watersheds that drain to the west towards the Pacific Ocean from those that drain towards the Gulf of Mexico and the Atlantic Ocean in the east (Gonzalez 2002:2-3). The Southern Rocky Mountain massif is separated into seven subranges, trending from north to south, of which the Colorado Front Range encompasses the largest portion within the study area (Hudson 2002:281). These ranges are separated by large intermountain basins of varying elevations (Hudson 2002:281). The Front Range stretches over 300 km from the Arkansas River in the south to north of the Wyoming border, where it terminates in the Laramie Basin, which separates the Laramie and Medicine Bow Ranges (Hudson 2002:281; Peet 1981:4). The majority of snowmelt runoff from the Front Range within the study region drains into the South Platte River and associated tributaries. South of the headwaters of the Arkansas River, the Front Range belt merges with the Wet Mountains and the Sangre de Cristo Range, both of which drain into the Purgatoire and Arkansas Rivers. The Sangre de Cristo Range is separated from the San Juan Mountains by the San Luis Valley, which serves as the headwaters for the Rio Grande River (Hudson 2002:281). The western flank of the Front Range is dissected from the Park Ranges by the North and Middle Park Basins, with the South Park Basin separating the Front Range from the Sawatch Range (Hudson 2002:281). North Park serves as the headwaters for the North Platte River, with South Park contributing seasonal snowmelt runoff to the South Platte River.

Within these ranges, truly mountainous terrain is limited to elevations over 1,600 meters in elevation, with the highest peak in Colorado, Mount Elbert in the Sawatch Range reaching 4,401 m above sea level (Peet 1981:4). These peaks are composed primarily of Precambrian granites, gneisses, and schists that uplifted beginning in the late Cretaceous during the Laramide orogeny 70-80 million years ago, dramatically transforming the landscape of Colorado (Bird 1988:1501; Lovering and Goddard 1950; Peet 1981:5). Mountain building continued into the Eocene, waning by 30 million years ago (Bird 1988:1501). Because of this, Colorado exhibits an altitudinal range of over 3,500 m, with the lowest elevation just over 1010 m where the Arikaree River crosses the High Plains into the state of Kansas (Robbins 1910:259).

Extreme gradients in elevation dictate climates and attendant biotic communities. It is these extreme differences in altitude that control rainfall, wind speed, temperature, and length of growing season, which in turn compresses radically different ecotones within a relatively small geographic space. For this reason, a universal description of mountain settings is impossible, but a few characteristics are standard (Pitblado 2003:33). In general, rainfall amounts and frequency increase with increase in elevation, which in turn influences local vegetation (Robbins 1910:263). Typically, the sides of the mountains are shrouded in a band of arboreal vegetation at mid-elevation, with grassland and shrub plants populating elevations above 3,500 m and below 1,700 m (Peet 1981:4; Ramaley 1907). Within the arborescent zone, xerophytic (dry habitat) species populate the lower elevations while higher altitudes are predominantly mesophytic (moderate moisture) species, a result of vertical zonation of plant species influenced by differential precipitation (Robbins 1910:263). Tree species change along altitudinal gradients and can be classified into three forest zones: A lower mountain forest (1,800-2,400 m), an upper mountain forest (2,440-3050 m), and a subalpine forest (3,350-3,500) (Morris and Moses 2005:247). Above the subalpine forest is the alpine zone, typically characterized as a tundra environment (Pitblado 2003:35).

The lower mountain forest is composed primarily of Ponderosa pines (*Pinus ponderosa*) and Douglas fir (*Psuedotsuga menziesii*), with Douglas fir typically forming dense groves on cooler north-facing slopes (Morris and Moses 2005:247; Pitblado 2003:34). The more arid, warmer south-facing slopes are characterized by an open grassland/woodland environment populated with Ponderosa pine (Morris and Moses 2005:247; Pitblado 2003:34). This zone experiences long, warm summers, and cold winters with snow fall rarely exceeding 25 cm in depth (Pitblado 2003:34). Other plant species occupying this zone include juniper, aspen, blueberry, strawberry, gooseberry, cow parsnip, dandelion, and valerian (Pitblado 2003:34). The upper mountain forest is similar, but with more frequent occurrences of aspen and lodgepole pine (*Pinus contorta*) (Morris and Moses 2005:247). The subalpine forest zone includes the addition of the Engelmann spruce (*Picea engelmanii*) and Subalpine fir *(Abies lasiocarpa*) which grow on all slopes and terminate in a tundra environment at the tree line (Morris and Moses 2005:247). The subalpine zone has short summers and long winters, with an average of 60-90 cm of precipitation annually, primarily in the form of snow (Pitblado 2003:34). Modern animal occupations of these zones include mule deer, elk, coyote, porcupine, marmot, black bear, bobcat, bighorn sheep, red fox, lynx, weasel, ermine, marten, porcupine, cottontail, hare, and various rodents, which are often seasonally limited at higher elevations (Pitblado 2003:34-35). Above the tree line, precipitation is greater, averaging 90-130 cm a year, mostly in the form of snow, but strong winds, bitter temperatures, and a frost-free season of a month or less limits vegetation (Pitblado 2003:35). Modern animal species adapted to this zone are limited, with mule deer, elk, bighorn sheep, coyote, bobcat, jackrabbit, marten, various rodents, and mountain goats utilizing the area only when it is assessable (Benedict 1991; Pitblado 2003:34-35). Only 19 species of animals live here year round, including weasel, pika, and the yellow-bellied marmot (Pitblado 2003:35).

The role of grasslands in the mountains is often overlooked, but many areas are best described as "open growth of grassland and scattered pines over a dry and partly bare upland of granitic hills" (Vestal 1917:354). Vestal (1917:354) notes that the Ponderosa pine, the most widely distributed of the conifers, typically grows scattered in an open grassland environment while forming very few true forests. Vestal stresses the importance of grasslands within mountain settings, especially at lower elevations, which is further echoed by Andrews (2010:7), who notes the occurrence of bison in mountain settings in historic times as well as during the late Pleistocene and early Holocene. Recent research at a high elevation (2,705 m) Pleistocene lake near Snowmass, Colorado has demonstrated that many more mammalian species were occupying high elevation mountain settings during the late Pleistocene than previously thought (Sertich et al. 2014). At least 34 different mammalian taxa have been identified from this locality thus far, including mastodon, mammoth, camel, bison, sloth, deer, and horse.

Elevation has a direct impact on temperature which dictates local floral and faunal communities. Annual temperature ranges between the warmest month and coldest month are greatest for lower elevations, with a decrease in annual temperature range with increase in altitude (Robbins 1910:265-266). As a result, lower elevations experience more seasonal climates, which in Colorado is expressed most strongly in the Platte and Arkansas River valleys of the High Plains (Robbins 1910:265-266).

Soils within the mountains are typically rocky, coarse-textured, poorly developed, and slightly acidic (Peet 1981:5). These soil conditions are attributed to the generally steep topography with a predisposition for erosion, further strengthened by frequent forest fires which effectively strip surface vegetation (Peet 1981:5). Due to these conditions, in places no soil development has occurred and eroded bedrock outcrops at the surface. In most locations, a thin colluvial soil of decomposed granite exists (Morris and Moses 2005:245). More extensive stable soils are occasionally found above 2,300 m on remnant till from the most recent glacial advance, dating to the latest Pleistocene, with pockets of older soils found on localized tills of slightly older age (Peet 1981:5; Richmond 1960). It is generally believed that soil formation in these areas postdate 15,000-12,000 RCYBP, as it is often suggested that deglaciation was complete in Colorado around this time (Elias 1996; Prasciunas and Denoyer 2005; Reed and Metcalfe 1999). However, it has been demonstrated that glacial advance reinitiated during the Younger Dryas (around 10,800-9,600 RCYBP) in Alaska (Briner et al. 2002), and similar suggestions have been made for the Colorado Rocky Mountains (Berger 1990; Jodry 1999a). However, the scale of glacial advancement in the Colorado Front Range during this time is probably minor (Menounos 1997). It is important to note that Clovis-age living surfaces may have been obliterated through subsequent glacial advancement, and Folsom activity may have been restricted from certain locations; intact late Pleistocene surfaces in the high country are likely limited (Lipe, Varien, and Wilshusen 1999). Also, at least two minor glacial advances are recorded after the Altithermal maximum around 3,000-5,000 RCYBP, which certainly affected localized soils and archaeological deposits within cirques and associated high elevation valleys, but likely had no impact on lower elevation alluvial deposition (Benedict 1973).

Known Clovis and Folsom archaeological finds are sparse in the truly mountainous regions of Colorado, partially a factor of limited visibility and difficulty in conducting archaeological reconnaissance in these settings, but also due to the ephemeral nature of mountain sites (Lipe, Varien, and Wilshusen 1999). Only three Clovis sites are documented for this region east of the Continental Divide, all from surface context (Prasciunas and Denoyer 2005:5). It has been reasoned that these settings held little interest for Clovis peoples, perhaps because of "differential resource utilization of certain ecological zones", suggesting only specialized usage of the high country (Prasciunas and Denoyer 2005:10). Similarly, Greiser (1985:59) has noted that the mountains may not have been extensively utilized because other locations (i.e. the High Plains) may have expressed greater economic potential. If this is the case, any finds in the high country may be a reflection of mobility to a different ecological region, rather than the actual targeting of that location (Husted 1974). The recent discovery of the Clovis-age Mahaffy cache in Boulder, Colorado demonstrates that Clovis people did traverse the high elevation country and were familiar with lithic source areas west of the Continental Divide (Bamforth 2014).

The seeming absence of any stratified in-situ Clovis sites in this region has led to the suggestion that Clovis points found here may simply be the product of curatorial practices by later peoples that were known to occupy mountain settings (Benedict 1992; Reed and Metcalf 1999:57). However, the presence of Clovis artifacts produced of lithic sources found in the mountains suggests otherwise. Others suggest the paucity of Clovis finds in high-elevation mountain settings is a product of survey bias since most survey efforts are conducted at much lower elevations (Pitblado 1998:343).

Folsom occupations in high elevation mountain settings are also rare in Colorado, but Folsom sites containing in-situ material have been recorded at elevations over 3,095 m (e.g. Black Mountain Site, Jodry 1993; Jodry et al. 1996). Several Folsom localities have been documented west of the Continental Divide, including at least nine Folsom sites, including the Mountaineer site in the Gunnison Basin (Andrews 2010; Morgan 2015), and a large Paleoindian adaptation including the Barger Gulch and Upper Twin Mountain sites, in the Middle Park Basin (Kornfeld 1998, 2002; Kornfeld and Frison 2000; Kornfeld et al. 1999; Naze 1986, 1994; Surovell and Waguespack 2007; Surovell et al. 2001; Surovell et al. 2005). Although west of the study region designated here, these sites demonstrate an adaptability to mountain environments that traditionally has not been credited to Folsom (or Goshen, i.e. Upper Twin Mountain) peoples (Wormington 1957:9), including possible habitation structures at the Mountaineer site (Stiger 2006). Finds west of the Continental Divide attest to familiarity with traversing high-elevation rugged mountain terrain. However, most Folsom localities within the mountains are restricted to intermountain basins and valleys, many of which exhibit environments reflective of Plains ecosystems (Frison 2005:264). Perhaps not surprisingly, many Clovis sites exist in these basins as well.

Intermontane Basins and Valleys

Significant Folsom and Clovis sites within the high country are primarily limited to one of three high-altitude intermountain basins (North Park, Middle Park, and South Park), the San Luis valley, and the previously mentioned Gunnison Basin, not included in this study. In general, these valleys, ranging in elevation from 1,800 m to over 3,040 m, can be described as synclines, or troughs formed during orogeny events, followed by intense fluvial erosion resulting in flat peneplain landscapes (Robbins 1910:257). Middle Park and North Park were once a continuous synclinal basin, but were separated by volcanic uplift during the Oligocene and Miocene, with the former displaying greater topographic relief as a result of tectonic faulting (Brunswig 2007:263; Mayer et al. 2005:601). As a result of this uplift, Middle Park is on the west side of the Continental Divide and serves as the headwaters of the Colorado River (Mayer et. al 2007). It will not be considered further here, although as mentioned, there is a large Paleoindian presence in Middle Park.

In general, intermountain basins are characterized as being relatively flat and treeless semi-arid expanses with each serving as the headwaters for a major river. Environments are best described as monotypic, with resultant homogenous plant species, primarily grasses, throughout. However, conditions during the Pleistocene/Holocene transition were likely more mesic than those observed today, with a moister climate resulting in widely distributed surface water by the end of the Folsom interval (Brunswig 1992:14). As a result, several Folsom sites have been found around playa lakes or marshes that are dry today. In addition, possible renewed glacial cooling during the Younger Dryas period may have served to compress Folsom occupations to within intermountain basins where bison were plentiful (Pitblado and Brunswig 2007:64).

The San Luis Valley, considered in greater detail here, is the largest intermountain basin in the study region and one of the largest in the Rocky Mountains. This basin is distinct from the others in that the southern end is not blocked by mountains, allowing for easy passage into and out of the valley through a southern mountain-free corridor (Jodry 1999b:15; Upson 1939:721). This observation will become key when discussing prehistoric land use and lithic migration patterns in Chapters 8 and 9.

The majority of the San Luis Valley is comprised of the Alamosa Basin, a seemingly flat barren expanse of land flanked on the east by abrupt alluvial fans originating in small streams of the Sangre de Cristo Mountains, and on the west by wide broad fans and longer streams running out of the San Juan Mountains (Upson 1939:726). A defining characteristic is an extensive alluvial fan emerging from the headwaters of the Rio Grande River in the San Juan Range. Because of the widespread nature of these fans, the Alamosa Basin is viewed primarily as an alluvial depositional basin (Upson 1939:732). Soils, when encountered, are often associated with alluvial terrace systems, shallowly buried, not well developed, and occasionally underlain by a layer of Pleistocene gravels outwashed from glacial retreat during the terminal Pleistocene.

Although in the watershed for the Rio Grande, the northern portions of the valley are internally contained, with snowmelt runoff not directly entering the Rio Grande drainage, resulting in an area of marshland and playa lakes (Jodry 1999b:18). The semi-arid climate and frequent droughts influenced by a rain-shadow effect lead to frequent wind deflation events. Thousands of years of wind deflation and eolian transport have built the Great Sand Dunes, now a National Park, along the western slopes of the Sangre de Cristo Mountains.

Notable archaeological sites in the area have been discovered in blowout settings, resulting from deflation of modern surfaces through aeolian erosion. Abundant deflation is often suggested as the primary reason for a large number of Paleoindian site discoveries in the San Luis Valley (Prasciunas and Denoyer 2005:10), and will be discussed as a potential bias in Chapters 8 and 9. Amongst these are the Linger (Hurst 1943, Wormington 1957), Zapata (Jodry 1999b), and Reddin (Jodry 1999b; Stanford 1983) Folsom sites, all located near currently dry playa lakes, and the Stewart's Cattle Guard Site (Emry and Stanford 1982; Jodry 1987, 1992, 1996, 1998, 1999a, 1999b; Jodry and Stanford 1988, 1992; Stanford 1983; 1990), located in a well-drained grassland replete with biomass for large herbivores. Clovis sites discovered in the San Luis Valley are typically limited to isolated projectile point finds, but also include the Zapata

Mammoth where two Clovis points were found associated with mammoth remains in a deflated blowout context (Stanford 1990).

The Foothill Belt

Moving east out of the high elevation settings of the Rocky Mountains is an intermediate elevation range, the foothill belt, which serves as a transitional zone between the dramatic topography of the high country and the Great Plains. The foothill belt ranges in width from 5-20 km, and generally decreases in elevation moving from west to east towards the lower relief of the Colorado Piedmont (Peet 1981:4). More specifically, the foothills are confined to those elevations from 1,500-1,800 m at the Colorado Piedmont, to the mid-mountain elevations around 2,400 m on the western edge (Vestal 1917:353).

Whereas the majority of the high elevation country is comprised of Precambrian granites and quartzites, the foothills are composed of a mixture of Paleozoic, Mesozoic, and Tertiary sedimentary units (Boos and Boos 1957:2608). These include four lithologic units: 1) Cambrian and Mississippian marine sandstones and limestones that lay uncomformably on top of the Precambrian crystalline rocks and form an inner foothill belt; 2) Terrestrial and littoral shales and sandstones of Paleozoic and Mesozoic age; 3) Marine Cretaceous formations; and 4) Tertiary beds and gravels (Boos and Boos 1957:2621-2622). Important to note is that many of these units outcrop in locations well to the east of the foothills and contain cherts and quartzites that were occasionally used as tool stone in Clovis and Folsom assemblages. In certain regions of the foothills, the faulted and tilted nature of these sedimentary units is exposed through erosion, especially predominant in ridges separated from the mountains proper. These tilted ridges of more resistant rock form a series of cuestas and hogbacks that often shelter and preserve more friable and easily eroded sediments, and offer protection from relentless winds and harsh weather occasionally experienced immediately east of the foothills.

The elevations of the foothills correspond with the mixed Ponderosa pine and Douglas fir forest altitudinal gradient found in the high country (Morris and Moses 2005:247). However, moist-forest meadows are limited within the foothills because of the well-drained nature of the soils and a rain shadow effect, receiving only 20-40 cm of precipitation annually, which also limits the occurrence of bogs and marshes (Pitblado 2003:34; Vestal 1914, 1917:355). Vegetation is characterized by mixed grassland and scattered woodland environments dominated by xerophytic species. However, both mesophytic and xerophytic plants are found in localized environmental conditions in the foothills, primarily on northern slopes or in ravines, and especially around large boulders where moisture is retained (Vestal 1917:358). Within the pinon pine and juniper woodlands, associated species such as prickly pear cactus, milk vetch and other edible plants are found (Pitblado 2003:34). Hilltops and side-slopes are often thinly covered with decomposed granitic soils and rocky debris, with more resistant outcrops of rock with no to very little soil covering common (Vestal 1917:355). Unlike soils found in the more dramatic topography of the high country, some soils within the foothills region are well developed and deeply stratified, influenced by local conditions including slope, drainage, exposure to wind, and exposure to sunlight and resultant vegetation (Vestal 1917:355). Extensive valleys are found where rivers flow out of the mountains into the foothills and Colorado Piedmont, forming corridors for riparian species and likely routes for human travel.

Historic bison populations often migrated seasonally, occasionally overwintering in the protected intermontane basins and foothills where winter conditions are less severe than on the open Plains or higher elevation mountain settings (Amick 1994; 1996:412; Bement 2003;

Hofman 1999a; Jodry 1999a; Meltzer 2006:79). Amick (1996:412) has suggested that prehistoric bison likely behaved similarly, and that other large game animals including bighorn sheep, elk, and deer are often driven to lower elevations during times of heavy snow in the high country. Other animal species occupying this region include jackrabbit, cottontail, gray fox, porcupine, skunk, weasel, and an assortment of snakes and lizards (Pitblado 2003:34). It is therefore reasonable to suggest that people targeting these faunal resources, as well as non-mobile resources including lithics and wood which are more plentiful in the foothills than on the Plains, would have behaved similarly, occupying this region on a seasonal basis.

Although suggested as a prime seasonal habitation area by Amick (1994; 1996) and others (Bement 2003; Hofman 1999a; Jodry 1999a; Meltzer 2006:79), the foothills have relatively few recorded Clovis and Folsom sites. This may be supportive of Greiser's (1985:59) suggestion that the region held little interest to prehistoric groups. Alternatively, the paucity of sites may be explained by geomorphic processes and site visibility; sites may be deeply buried in localized deposits or completely eroded away. One site, the Johnson Folsom Site, is located within a simple v-shaped hogback fold remnant of the foothills of the Colorado Piedmont section, a feature that likely served to protect the site from complete deflation and that also would have served as a windbreak to prehistoric peoples occupying the area (Galloway 1961:205). This site was discovered because of deflation, with all artifacts collected from the surface or immediately subsurface (Galloway 1961:205; Wormington 1957). Unfortunately, the whereabouts of these artifacts is currently unknown. The Lindenmeier Site, although very near the foothills and in a similar setting is 5 km east of the foothills proper in the Colorado Piedmont.

The Great Plains

The Colorado Piedmont

Immediately east of the foothills of the Front Range is the Colorado Piedmont section of the Great Plains. This section is characterized by deposits resultant from geologic uplift during the formation of the Rocky Mountains during the Cretaceous and Tertiary periods, and is defined by erosion. In fact, the High Plains and the Colorado Piedmont surfaces are differentiated based only on the degree of erosion that has occurred, with the latter characterized by a greater erosional history. During the Tertiary period, the High Plains and Colorado Piedmont physiographic regions were an extensive fluviate plain that extended beyond the eastern border of the Great Plains, resultant from mountain uplift to the west (Hazlett 1998:3; Thornbury 1969). As the mountains were forming, and with subsequent eperiogenic uplift (non-mountain forming uplift during the late Miocene), these surfaces were actively eroding, producing large quantities of sediment that was carried down slope and deposited onto the Plains to the east by a series of braided streams and river deltas (Hudson 2002:306; Meltzer 2006:56). In places, these deposits are over 460 m thick (Hudson 2002:306). Four periods of tertiary sedimentation are recognized: 1) White River (Oligocene), 2) Arikaree (lower Miocene), 3) Hemignord (Miocene), and 4) Ogallala (Miocene) (Hazlett 1998:3). The Ogallala formation is the most extensive of these sedimentary cycles and contains gravels suitable for chipped stone tool production, including basalts, quartzites, and cherts which occur as localized deposits of small nodules throughout the western High Plains, and in isolated uneroded remnant packages in the Colorado Piedmont and the adjacent Raton section (Banks 1990:90). During the latest Tertiary, the Colorado Piedmont section experienced massive erosion by the South Platte and Arkansas Rivers and associated tributaries which striped much of the Tertiary deposits that characterize the buried High Plains to the east (Greiser 1985:12; Holliday 1987:320). In certain locations, resistant cap rock has protected underlying sediment from erosion, resulting in the formation of buttes and chalk bluffs on an otherwise relatively flat landscape (Hazlett 1998:3). One such uneroded escarpment known as the Gangplank defines the northern boundary of the Piedmont area (Greiser 1985:12; Hazlett 1998).

The Colorado Piedmont is primarily characterized as a gently undulating to rolling plain surrounded by High Plains surfaces to the north and east, with dramatic topographic change often found at the interface of the two (Crabb 1981:1). The southern edge is more arbitrarily defined, extending roughly to the area dissected by igneous dikes which characterize the Raton Basin. Within the Piedmont are two extensive watersheds, the South Platte River to the north, and the Arkansas River to the south. These watersheds are separated by the Palmer Divide, a topographic high extending perpendicular from the Rocky Mountains between the two drainage troughs of the South Platte and Arkansas Rivers (Freidman and Lee 2002:410; Trimble 1980). Water draining from this area stems from intense seasonal thunderstorms during the spring and fall that have historically caused severe flooding events in the lower elevation river valleys (Friedman and Lee 2002:410; Friedman, Osterkamp, and Lewis 1996:2179). This raised surface is characterized by vegetation and climates similar to those found in the foothills, providing an ecotone suitable for Ponderosa pine populations; a contrast to the adjacent treeless High Plains to the east (Robbins 1910:264). The Palmer Divide also serves as a barrier to some plant species, with Pinon pine, Chandelier cactus, scrub oak, and the Rio Grande cottonwood limited primarily to south of the divide (Robbins 1910:257-258). Vegetation elsewhere within the Colorado Piedmont is characterized by low rainfall and composed primarily of blue grama (*Bouteloua* *gracilis*) and buffalo grasses (*Buchloe dactyloides*), shrubs, and forbs which constitute the Central Shortgrass Prairie Ecoregion (Hazlett 1998:4).

Soils within the Colorado Piedmont vary based on local conditions, with well-developed deeply buried loess capped soils occasionally found overlying Cretaceous-age shales and sandstones (Hazlett 1998:3; Holliday 1987:320). Other portions have shallow soils with areas of Cretaceous bedrock exposed at the surface through erosion (Hazlett 1998:3). Alluvial soils associated with terrace systems are predominant in river valleys and associated tributaries. Other areas are characterized by sand dunes with frequent deflation events, especially in the northeastern section of the Piedmont and adjacent High Plains along the South Platte River valley. Sand dunes probably began forming during the Altithermal maximum, and are composed primarily of sediments blown out of the South Platte River valley (Muhs 1985:572). Dune formation in this region has been correlated with post-Altithermal glacial interstadial events, and most are dated to the mid-late Holocene (Muhs 1985:578). Soils within the dune fields are weakly developed and rarely contain B horizons, and are too young to contain Clovis or Folsom artifacts, which are confined to blowouts that have eroded the underlying older sediments (Muhs 1985:578). Most areas of the dunes are stabilized by yucca, prickly pear cactus, sage, and short grass prairie flowers (Muhs 1985:568).

Comparatively speaking, there is an abundance of Clovis and Folsom sites in the Colorado Piedmont and adjacent High Plains sections of northeastern Colorado, most associated with alluvial terrace systems of the South Platte River or blowouts within sand dune fields. Clovis sites on alluvial terraces of the South Platte River are associated with the Pleistocene-age Kersey Terrace, which aggraded during the Pinedale glaciation in the Front Range between 12-15,000 RCYBP (Haynes et al. 1998:215). These sites include the Dent site, notable for being the only excavated Clovis site with buried deposits in Colorado (Albanese 2000:205; Figgins 1933; Wormington 1957:44), the Klein site and Drake cache, both located in modern agricultural fields or pasture (Gilmore et al. 1999; Holliday 1987:318; Stanford and Jodry 1988; Zier et al. 1993), and the Clovis and Folsom-age Bijou Creek site on a tributary to the South Platte River (Greiser 1985:57). The Folsom-age Lindenmeier site, only 5 km east of the foothills, is on an alluvial terrace in a small valley of a tributary stream to the Cache La Poudre River, which flows into the South Platte River (Albanese 2000:205; Greiser 1985:62; Wilmsen and Roberts 1978; Wormington 1957). This large, open-air campsite is dated 10,780 +/- 135 RCYBP, and the terrace it occupies has been correlated with the Kersey Terrace of the South Platte River (Bryan 1941:510; Bryan and Ray 1940; Haynes and Agogino 1960). A single Clovis point was found at Lindenmeier as well (Sellet, Personal Communication 2012). The Watts Clovis cache was found in an agricultural field on a terrace of the Cache La Pouder River near Fort Collins, Colorado (Kilby 2008, 2014; Patten n.d.), and the Mahaffy Clovis cache was discovered in a residential area of Boulder, Colorado near the foothills interface with the Colorado Piedmont (Bamforth 2014).

Significant Clovis and Folsom sites located in the sand dunes around the South Platte River include the Fowler-Parrish Folsom site (Agogino and Parrish 1971), the Fox Clovis site along with the Powars Folsom Site in Quaternary dunes overlying the Kersey terrace (Haynes et al. 1998:203; Holliday 1987:318; Roberts 1937), and 5MR338, a blowout site containing Clovis and Folsom artifacts (Greiser 1985). The Hahn Site, which contains Clovis and Folsom artifacts is unique to the Piedmont in that it occupies an open gravel ridge, possibly reflective of a non-winter occupation exposed through deflation that likely served as a lookout location (Greiser 1985:103). Other Clovis or Folsom-age sites in the Piedmont section include the Westfall Site, a large deflated Folsom campsite (Hofman, Westfall, and Westfall 2002), and the Lamb Spring site with radiocarbon dates of early Clovis age on fractured mammoth bone associated with a large stone cobble (Fisher 1992; McBrinn et al. 2013; Rancier, Haynes, and Stanford 1982). It is likely many other sites of Clovis or Folsom age exist throughout the Colorado Piedmont, especially around playa lakes and springs, but remain buried today (Greiser 1985:103).

The Raton Section

South of the Arkansas River Valley where igneous dikes infringe on the Piedmont surface is the northern extent of the Raton section (Trimble 1980). This region is defined by volcanism which has dramatically altered the landscape, and stretches from the Sangre de Cristo Range of the Rocky Mountains in the west to the edge of lava extension in the east at the High Plains border. Similar to the Piedmont region, the Raton section was once covered by an extensive fluviate plain and has experienced a drastic history of erosion. However, the Raton section is topographically more diverse and dissected than the adjacent Piedmont because of volcanic influences on the land surface. Unlike the Piedmont, prior to eroding to the present level the Raton section experienced several volcanic intrusions resulting in molten lava flows which hardened to resistant basalts (Lee 1921:385). These basalt flows effectively served to protect the more easily eroded sediments below, namely shales and sandstones of late Cretaceous and Tertiary age that have otherwise been stripped from the surrounding areas through erosion (Lee 1921:385). The result is a landscape dominated by extensive high vertical-sided tabletop mesas and isolated volcanic intrusions that form sharp peaks, some over 2,400 m, such as the Spanish Peaks which intruded during the late Oligocene 26-22 million years ago and have since been exposed through erosion of the surrounding sediments (Hunt 1967:220-221; Trimble 1980:6-7; Meltzer 2006:51). Radiating from intrusion centers are hundreds of igneous dikes that formed from molten lava filling fractures in the ground surface, forming high vertical ridges of igneous rock (Trimble 1980). It is these dikes that help define the northern boundary of the section. Isolated deposits of knappable quartzites and cherts are occasionally found within this region, including late Cretaceous-age Dakota quartzites (Banks 1990:90; Meltzer 2006:54).

Seeps and springs are plentiful in the Raton section, and two major rivers, the Purgatoire and Apishapa dissect the region (LaBelle 2005:48). Riparian resources are abundant in these areas and likely attracted game and people in prehistoric times. However, there are very few recorded archaeological sites in the Raton section, perhaps because the igneous dikes, mesas, and otherwise broken terrain likely served as a barrier to easy north-south movement (Meltzer 2006:61). Most notable is the Folsom type-site, which occurs immediately outside of the study area near Folsom, New Mexico. This region has been described as a “near total gap in the archaeological record” (Zier and Kalasz 1999:80), and no Clovis or Folsom sites have been excavated within the portion of the Raton section considered here, although a few isolated surface discoveries have been made. Meltzer (2006:10) suggests that the region, although replete with diverse flora and fauna, is not suitable for supporting long-term forager residence or overwintering by hunter-gatherers. Also, he states: “Given the lack of farming and regular plowing of the soil, and the dearth of people walking the landscape, it comes as no particular surprise that the area has not produced the richness or density of sites seen elsewhere, as for example, on the High Plains to the east” (Meltzer 2006:80). It is possible the Raton section was utilized frequently by Clovis and Folsom peoples, if only temporarily or on a seasonal round, and that evidence for these ephemeral visits has been little documented. Lack of recorded sites in this region is likely due in part to the scarcity of archaeological investigations within the area, but also because of limited exposure of sub-surface deposits through modern agricultural practices which primarily focus on raising livestock rather than crop production within the region.

The High Plains

The High Plains are found immediately to the east of the Raton Basin and Colorado Piedmont, and just south of the Wyoming border extending to the foothills along the northern edge of the Piedmont where the Gangplank escarpment is located (Hazlett 1998; Kornfeld et al. 2007:259). This physiographic region stretches east into Kansas and is dissected by the Arkansas River Lowlands, and terminates in central Kansas in the Smoky Hills and Flint Hills of the Central Lowlands.

The High Plains is differentiated from the Piedmont and Raton sections to the west in that the Tertiary deposits resultant from fluviate outwash during uplift of the Rocky Mountains have not been stripped away through subsequent erosion (Hudson 2002:306). In places these Tertiary deposits, primarily composed of the Ogallala formation, outcrop at the surface exposing localized packages of knappable stone (Banks 1990).

The vegetation of the High Plains today is monotypic, characterized by extensive dry grasslands composed primarily of blue grama (*Bouteloua gracilis*) and buffalo grass (Buchloe *dactyloides*), a product of a rain shadow effect directly linked to its downwind location of the Rocky Mountains (Mandel 2006a:20; Pitblado 2003:31). Other plant species include chokecherry, sego lily, prickly pear cactus, and arrow-leaf balsam root (Kindscher 1987; Pitblado 2003:31). Because of the rain shadow, an average of only 20 cm of precipitation annually is not uncommon for the Plains of eastern Colorado and western Kansas, a condition that also retards tree growth (Manning 1995; Pitblado 2003:30-31). The treeless, flat terrain exacerbates wind velocities, which further intensify aridity and stress on existing vegetation

(Pitblado 2003:31), and result in extensive surface erosion and blowouts. High winds also aid in suppressing winter temperatures, which typically average around -10˚C to -18˚C with the wind chill (Pitblado 2003:31). Temperatures often reach 30-35˚C in the summer, with occasional extreme diurnal temperature fluctuations (Pitblado 2003:31).

Similar to flora, biotic communities during the extreme terminal Pleistocene (near the end of the Clovis interval ~ca. 10,900 RCYBP) and early Holocene were dominated by a single species, namely bison, with other large-bodied mammalian species occurring in smaller populations (Andrews 2010; Bement 1999; Carlson and Bement 2013a; Frison 1991). Bison populations likely fluctuated dramatically from year to year and on a seasonal basis, depending on rainfall, grass availability, and the presence of water (Baker 1978; Frison, Haynes, and Larson 1996; Hill 2007; Pitblado 2003; Shelford 1963). These fluctuations and resulting impact on Folsom technology and land use are discussed further in Chapters 3 and 4. Other modern large mammalian species include mule deer, coyote, and pronghorn, with the later often found in more arid areas than bison because of their ability to subsist on sagebrush (Hylander 1966; Pitblado 2003). Smaller mammals on the Plains include badger, chipmunk, bobcat, cottontail and jackrabbit, red and Swift fox, black-footed ferret, prairie dog, and a variety of other rodents (Pitblado 2003:31). Reptiles include bull snake, prairie rattlesnake, and various lizards. Riparian regions of the High Plains, including rivers and playa lakes, likely served as stop-over locations for numerous migratory bird species (Pitblado 2003:31), and may have been selectively targeted by Clovis hunters.

From the terminal Pleistocene and through the early Holocene, the High Plains underwent continued warming and drying which served to depress vegetation zones that are otherwise found in higher elevation settings today (Brunswig 1992:14; Kornfeld et al. 2007:260;

Mandel 2006a). It is not unlikely that deciduous trees were restricted to mesic habitats in riparian environments by Folsom times (Kornfeld et al. 2007:260). Today, these mesic habitats are found where the Arkansas and South Platte Rivers, and the Arikaree River near the Kansas border intersect the High Plains surface (Andrews 2010:3; Bamforth 1988). Cassells (1992:22) suggests it is these riparian environs that served as corridors for prehistoric travel across the Plains and perhaps acted as entryways into the foothills and Rocky Mountains. The notion of rivers viewed as corridors across the landscape is echoed by Hofman (1999), and may have dramatic implications for site distributions across the Plains as all major rivers flow east-west while their tributaries are oriented northwest-southeast or southwest-northeast (Meltzer 2006:59).

The tributaries to the South Platte and Arkansas Rivers are characterized by low flow volumes, fed by local rainfall that is occasionally short in duration but very large in magnitude, resulting in extreme flood events (Friedman and Lee 2002:410). It is these flood events that occasionally expose archaeological sites in tributaries and draws. The South Platte and Arkansas rivers are less affected by extreme floods because they typically experience high flow volumes of long duration seasonally from mountain snow melt (Follansbee and Sawyer 1948; Friedman and Le 2002:410).

Similar to the Piedmont, several significant Clovis and Folsom sites are located in the High Plains section of Colorado and Kansas. Because of the relative frequency of Folsom points that are concentrated in this region, it is suggested that Folsom is primarily a Plains-adapted life way (Wormington 1944:9). However, these seeming concentrations are partly due to visibility bias, an idea discussed further in Chapters 8 and 9. Most Clovis and Folsom artifacts from this region have been recovered as isolates from streambed gravel deposits or have been discovered because of deflation, at sites such as Claypool, best known for its Cody complex artifacts but that also contains Folsom material and a Clovis point associated with mammoth bones (Albanese 2000:213). Claypool is located in an extensive sand dune field that extends into the Piedmont section. Dunes within this region are more prone to deflation during the winter months when they experience strong winds out of the northwest (Ramaley 1939:5). Periods of extensive drought when aeolian deflation is intensified tend to correlate with archaeological discoveries, supporting Holliday's (1997) suggestion that only easily eroded sites are being discovered. This results in biased interpretations of prehistoric land use practices (Seebach 2006:71). Other sites found in a deflated context in the High Plains include the Dutton and Selby sites, characterized by fractured mammoth bone, but with an associated Clovis point at the Dutton locality (Stanford 1979).

Three Clovis cache sites are reported for the High Plains in this study area, including CW (Holen and Muniz 2005; Muniz 2014), Busse (Hofman 1995, 1996), and Sailor-Helton (Helton 1957; Hofman 1996; Mallouf 1994). Other important sites include Kanorado that contains stratified Clovis and Folsom/Midland-age deposits at three separate localities (Mandel et al. 2004; Mandel, Holen, and Hofman 2005), the Smoky Folsom site, a deflated open-lithic Folsom workshop (Johnson 2013), and the 12 Mile Creek Site, representing the earliest recognized association of man-made artifacts with extinct faunal remains (Hawley 2009; Hill 1994, 1996, 2002; Hill, Hofman, and Martin 1993). Clovis artifacts were also found on the Anton escarpment near the Colorado Piedmont and High Plains border in Washington County, Colorado (Holen and Noe 2006; Noe 2010). It is likely more Clovis and Folsom sites are scattered throughout the High Plains but deep burial in alluvial settings inhibits site visibility (Mandel 2008).

The Arkansas River Lowlands

As the Arkansas River exits the narrow canyons of the Rocky Mountains, it flows across the Colorado Piedmont, and begins to fan out to form a lowland near the Piedmont and High Plains interface. This expansive lowland formed as the river meandered throughout the Quaternary, and extends from the High Plains of eastern Colorado across western Kansas, and dissects or infringes on the Smoky Hills, Wellington-McPherson Lowlands, and Flint Hills before crossing into Oklahoma at the Cowley County border. The complex alluvial deposits of the Arkansas River are characterized by sands and gravels, which in many places have formed low dunes through aeolian transport (Mandel 2006a:14). Some of the dune formations in the Arkansas River Lowlands likely began aggrading during the late Pleistocene, and soils in excess of 11,000 RCYBP have been documented (Arbogast 1996). However, most of these formations are dated to the mid-late Holocene (Arbogast 1996), and some are active today and exacerbated by periods of drought in excess of 30 days duration that occur two out of three years on average between April 1 and October 1 (Platt 1974). Increased irrigation and drought often leave entire sections of the river depleted of surface water in central and western Kansas today.

The Arkansas River Lowlands are characterized by a sandy matrix with poor drainage that results in a diverse wetland habitat of at least 90 documented different wetland plant species (Platt 1974). It is not uncommon to encounter small groves of willows in the river lowlands, with extensive thickets along upland settings (Platt 1974). The Arkansas River corridor likely served as a major prehistoric transportation route across the High Plains, offering unique riparian resources in an otherwise treeless and arid landscape. However, no Clovis or Folsom sites are currently recorded for this region, but isolated artifact discoveries are reported from sand dune blowouts, particularly in the Kearny and Hamilton County area of western Kansas.

The Red Hills

The Red Hills, also called the Cimarron Breaks, stand in stark contrast to the gently rolling hills of the High Plains to the west (Schoewe 1949; Mandel 2006a). Composed of Permian-age “red beds”, this highly dissected country is characterized by flat-topped red hills typically capped with gypsum or dolomite, forming a butte-and-mesa topography (Buchanan 2010:20; Mandel 2006a:16; Swineford 1955). This unique landform is exposed in Clark, Comanche, Barber, and Harper counties, Kansas.

The rugged landscape of the Red Hills restrains and limits archaeological survey efforts and site visibility, and undoubtedly impacted prehistoric behavior. Only one Folsom-age site is recorded for the region, the Vincent-Donovan site. At this site, Folsom artifacts were found exposed at the surface and shallowly buried in an eroded terrace remnant (Ryan, Bruner, and Hofman 2004; Widga 2005; Wyatt 2011).

The Smoky Hills

Bounded by the High Plains to the west and the Flint Hills and Glaciated Region to the east are the Smoky Hills of north-central Kansas. This region is characterized by Cretaceous-age rock units, primarily chalks formed when Kansas was inundated by a great inland sea (Buchanan 2010:27). The Smoky Hills serve as one of the primary lithic source areas for chipped stone manufacture in Kansas, as knappable quartzites and cherts are found within these Cretaceous-age rock units (Stein 2005, 2006). The western edge of the Smoky Hills exhibits high flat-topped buttes and mesas, creating a rugged “badlands” landscape in the easily eroded chalk (Mandel 2006a:17). The eastern edge is poorly defined, but terminates where Cretaceous-age sediments give way to the Permian-age deposits of the Flint Hills. Major rivers transecting the region include the Solomon, Saline, and Smoky Hill Rivers, as well as the Republican River in the extreme northeastern portion of the Smoky Hills. The southern boundary of the region is demarcated by the Arkansas River lowlands. These regions offer diverse riparian habitats. Faunal species are transitional from those found in the more arid High Plains to the west and damper conditions of the Flint Hills to the east, with vegetation characterized as a mixed bluestem-grama short-grass prairie (Mandel 2006a:20).

A number of Clovis and Folsom sites are reported for this region, primarily eroded from primary context as surface discoveries. These include the Bredthauer, Graham, Fisher-Filipi, and Larson sites, all located near the eastern periphery of the Smoky Hills with the Flint Hills in upland settings associated with springs or marshes (Hofman and Asher 2010). The best documented Clovis site in the region is the Eckles Site, notable for its contribution to interpretations of long-range Clovis lithic transportation (Hoard et al. 1992; Holen 1989, 2001, 2010).

The Wellington-McPherson Lowlands

South of the Smoky Hills and bounded by the Red Hills on the west and Flint Hills to the east are the Wellington-McPherson Lowlands. The Arkansas River Lowlands transects this region, with the Wellington Lowlands found south and west of the Arkansas River, and the McPherson lowlands found northeast of this divide (Mandel 2006a:15). The two are further differentiated by the sediments underlying each. The McPherson Lowlands north of the Arkansas River are a flat plain composed of sands, gravels, silts and clays overlying Permian-age shale (Frye and Leonard 1952:190; Mandel 2006a:16). In places, this flat plain is capped with loess, and sand dunes are prominent closer to the Arkansas River (Frye and Leonard 1952; Mandel 2006a:16; Platt 1974). South of the Arkansas River, the Wellington Lowlands are underlain by deposits of salt, shale, gypsum, siltstones, and sandstones, with the Permian-age “red-beds” that characterize the Red Hills to the west exposed where erosion has dissected the landscape (Mandel 2006a:15; Swineford 1955). Flora and fauna are similar to those discussed for the Arkansas River Lowlands and Red Hills. No Clovis or Folsom sites are currently reported for the Wellington-McPherson Lowlands.

The Central Lowlands

The Flint Hills

The Smoky Hills and Flint Hills border, although poorly defined, is the approximate transition between the Great Plains and the Central Lowlands physiographic provinces. This transition is marked by different annual precipitation rates and vegetation, which has resulting impact on attendant faunal communities. The Flint Hills represent another primary source region for knappable lithics in Kansas, as numerous Permian-age cherts are found throughout, often scattered at the surface. The occurrence of these cherts has a dramatic impact on the topography of the area, as chert is more soluble and less resistant to dissolution than the limestone that contains it (Wilson 1984:19). This results in clay-rich soils with numerous chert fragments that slow erosion of the more soluble limestone below, resulting in gently rolling flint-covered hills separated by highly dissected landscapes where these cherts do not occur (Mandel 2006a:13; Wilson 1984). Streams are deeply entrenched in the region, and strath terraces are common (Mandel 2006a:14).

In contrast to the drier High Plains to the west, the Flint Hills receive on average 75 cm of precipitation annually (Commerford, McLauchlan, and Sugita 2013). Winters are also typically less sever with low temperatures ranging between -6 and -12˚C, but often characterized by heavy snowfall events particularly in the northern Flint Hills (Commerford, McLauchlan, and Sugita 2013). Summer high temperatures usually range between 25˚C and 38˚C (Commerford, McLauchlan, and Sugita 2013). Vegetation is characterized by tallgrass prairie species, including big bluestem (*Andropogon gerardi*), little bluestem (*Andropogon scoparius*), and Indian grass (*Sorghastrum nutans*) (Mandel 2006a:20). More than 300 species of forbs are recorded in the Flint Hills, including goldenrod, ragweed, sage, and sunflower, with burr oak (*Quercus macrocarpa*), Cottonwood (*Populus deltoids*), and Eastern red cedar (*Juniperus virginian)* common in riparian corridors (Commerford, McLauchlan, and Sugita 2013; Freeman 1998). This vegetation extends to the eastern deciduous forest of the Glaciated Region of northeastern Kansas (Mandel 2006a:20).

The Flint Hills are a transitional zone for faunal communities, with at least 163 different faunal species found immediately to the west or within the Flint Hills, including 69 mammalian species, and 189 species found within or immediately east of this region, 67 of which are mammal species (Blasing 1986:96-97; Geir 1967). The prairie vegetation of the Flint Hills is prime habitat for bison, and modern bison populations still play a key role in maintaining this ecosystem (Knapp et al. 1999).

The Flint Hills likely held great interest for Clovis and Folsom groups as high-quality chipped stone resources are abundantly expressed at the surface, and a diversity of floral and faunal resources would have been available. However, only one Clovis site is documented for the Flint Hills, with isolated discoveries in streambed context more common. This discrepancy between expected number of sites and actual recorded sites is in part attributed to heavy erosion of upland settings and deep incision of streams characterized by prominent strath terraces. The only recorded site in the region is the Diskau Clovis site, a surface scatter perhaps representing a residential camp (Schmits 1987). Clovis and Folsom materials have been found on a Pleistocene terrace above the Archaic-age Coffey site in Pottawatomie County near the Flint Hills eastern border, but within the Glaciated Region of northeast Kansas (Mandel et al. 2010; Schmits 1980:84-85; Ziegler 1976:34). Ongoing research at this site has revealed a buried Folsom component.

The Glaciated Region

The landscape of northeastern Kansas has been dramatically altered by glacial activity, with the last glacial advance to directly impact the area occurring around 600,000 years ago during the Pre-Illinoian glacial stage (Mandel and Bettis 2001). This event left behind thick deposits of glacial till and drift, which conceal the Pennsylvanian and Permian-age bedrock of the region (Frye and Walters 1950). Subsequent late Pleistocene glacial advances did not reach Kansas, but still impacted the area through accumulation of thick mantels of wind-blown loess on upland settings. As such, landscapes north of the Kansas River are characterized by gently rolling hills on upland surfaces comprised of thick deposits of glacial till and loess that become deeply incised and steep-sided slopes along river valley margins (Mandel 2006a:12). These slopes, particularly in the eastern-most counties along the Missouri River, are characterized by a dense oak-hickory forest, dominated by bitternut hickory (*Carya corniformis*), shagbark hickory (*Carya ovata*), white oak (*Quercus alba*), red oak (*Quercus borealis*), and black oak (*Quercus velutina*) (Logan 1998:14). This distinctive landscape would have offered an abundance of resources to prehistoric people, including lithic resources that occur in glacial gravels and secondarily redeposited in stream gravels. However, only one site is reported to contain buried Folsom artifacts from this region, the DB Ridge site, which occupies a prominent ridge and possibly served as a strategic lookout location (Logan 1998, 2001; Logan and Johnson 1997). Most other recorded Clovis and Folsom occurrences are derived from streambed contexts, particularly the Kansas and Delaware Rivers.

The Osage Cuestas

The majority of southeastern Kansas falls within the Osage Cuestas region, which is separated from the Flint Hills to the west by a rocky escarpment of resistant cherty limestone, and bounded on the north by the Kansas River (Mandel 2006a:14). These east-facing escarpments characterize the Cuesta topography, and are comprised of more resistant limestone ridges interspersed with softer shale, creating a landscape dominated by low, wide rolling hills dissected by shallow stream valleys (Mandel 2006a). Vegetation in this region is transitional between the bluestem prairie to the west and the oak-hickory forest north of the Kansas River. Similar to the Glaciated Region, most Clovis and Folsom artifacts from the Osage Cuestas are found as isolates in streambed contexts. However, one notable exception is the Cutsinger-Bailey site which likely represents a Clovis cache displaced through modern agricultural activities (Hofman 2014).

The Chautauqua Hills

Within the Osage Cuestas is a thin belt of north-south trending rounded hills called the Chautauqua Hills. These hills, formed through erosion of Pennsylvanian-age sandstone, stand in contrast to the surrounding ridges of the Osage Cuestas (Mandel 2006a:13). There are currently no recorded Clovis or Folsom sites in the Chautauqua Hills.

The Cherokee Lowlands

In extreme southeastern Kansas are found a relatively flat and featureless landscape known as the Cherokee Lowlands. This region is characterized by erosion, with few broad rolling hills capped with resistant sandstone eroded from the otherwise soft Pennsylvanian-age shales found in the area (Mandel 2006a:13). The Cherokee Lowlands are bounded by the Osage

Cuestas to the west, and infringed by the Ozark Plateau in extreme southeastern Cherokee County. No Clovis or Folsom sites are recorded for this region.

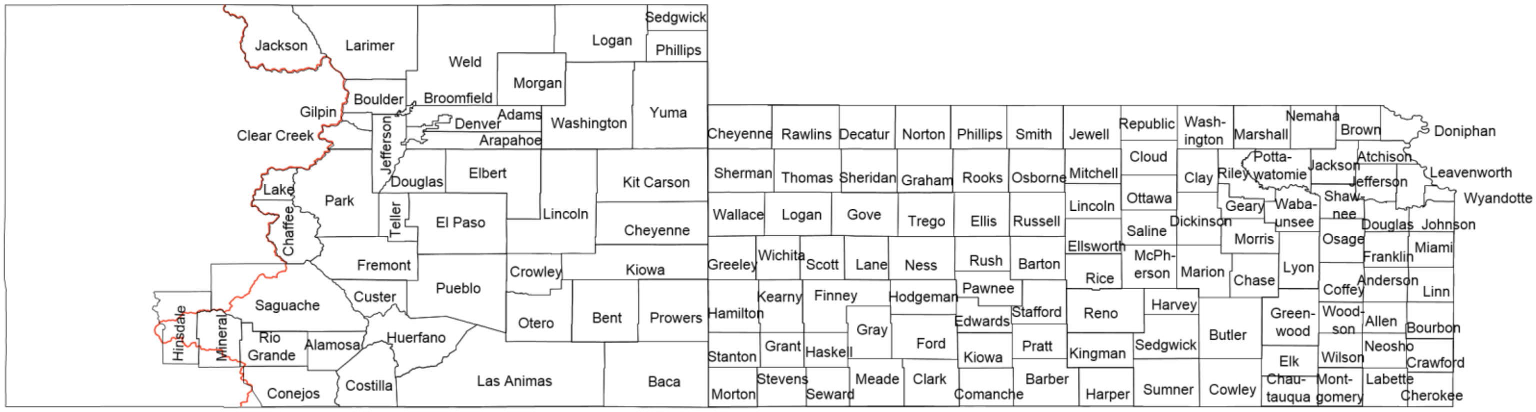

Figure 2. Counties within the study area. The red line represents the Continental Divide.

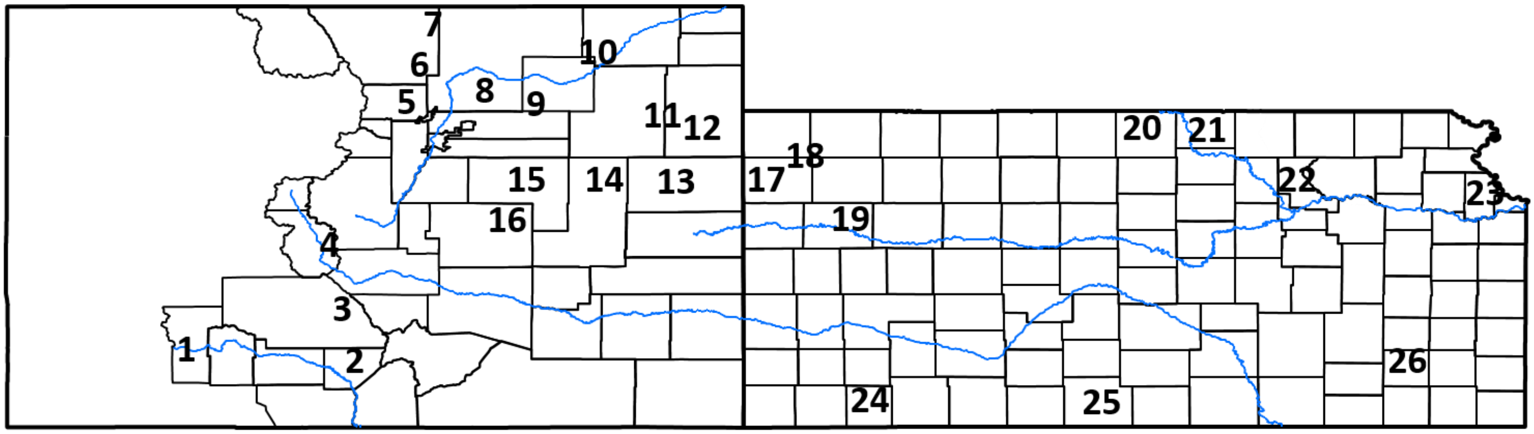

Figure 3. Clovis and Folsom/Midland sites within the study area. 1) Black Mountain, 2) Cattle Guard, Linger, Zapata, 3) Reddin, 4) Black Dump, 5) Mahaffy, 6) Watts, 7) Lindenmeier, Johnson, 8) Dent, Fox, Klein, Fowler-Parrish, Powars, 9) Bijou Creek, 5MR338, 10) Drake, 11) Anton, Claypool, 12) Dutton, 13) Smoky Folsom, 14) CW, 15) Westfall, 16) Hahn, 17) Kanorado, 18) Busse, 19) 12 Mile Creek, 20) Eckles, 21) Bredthauer, Fisher-Filipi, Graham, Larson, 22) Coffey, Diskau, 23) DB, 24) Sailor-Helton, 25) Vincent-Donovan, 26) Cutsinger-Bailey. Of these, only 8 contain intact Clovis or Folsom age components that have been professionally excavated: Black Mountain (5HN55), Cattle Guard (5AL101), Coffey (14PO1), DB Ridge (14LV1071), Dent (5WL269), Dutton (5YM37), Kanorado (14SN101, 14SN105, 14SN106), Lindenmeier (5LR13).

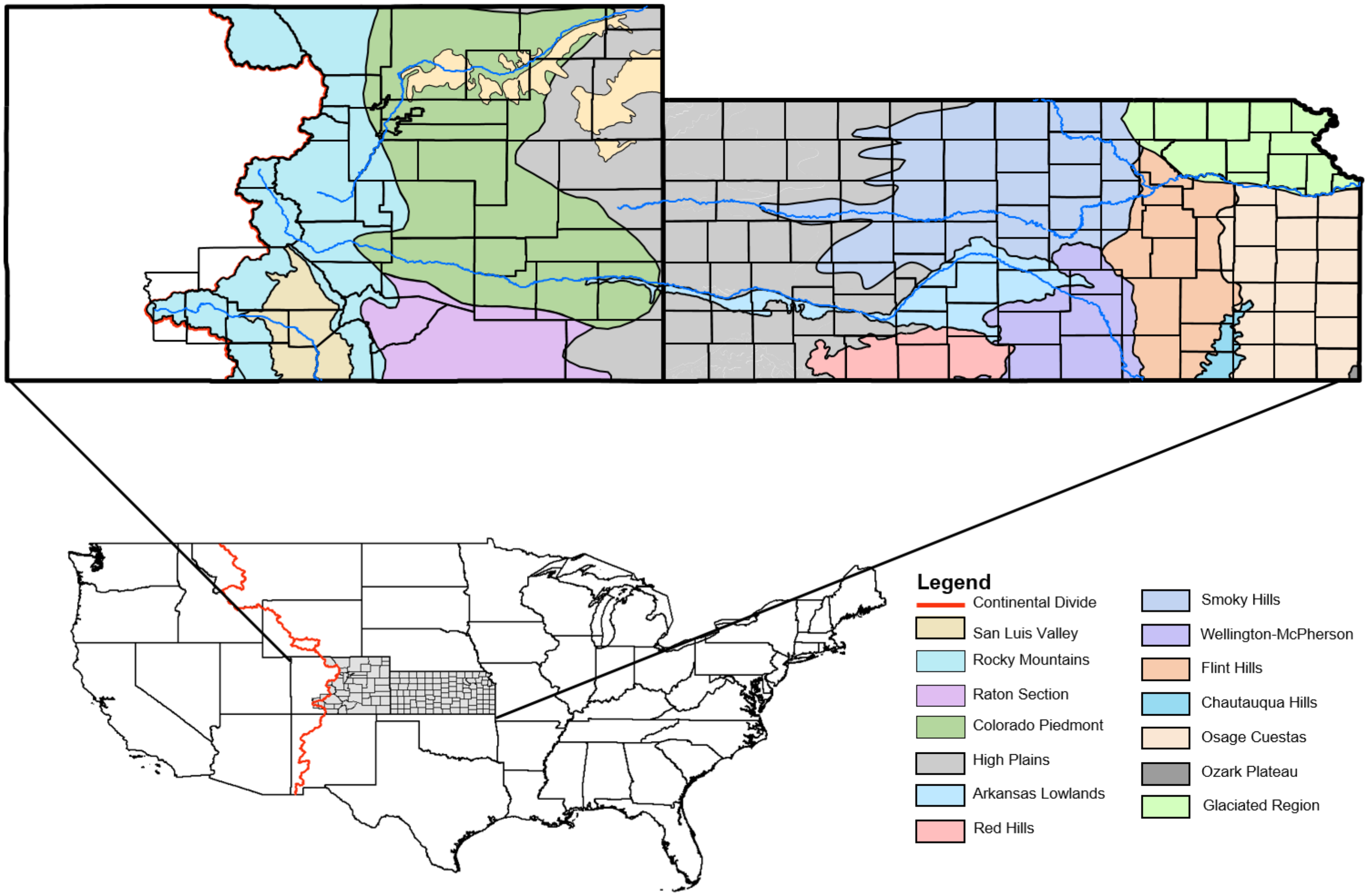

Figure 4. Physiographic regions within the study area. Adapted from Fenneman 1931, Mandel 2008, and U.S. Environmental Protection Agency 2003.

CHAPTER 3

MODELING CLIMATE CHANGE AT THE PLEISTOCENE-HOLOCENE INTERFACE

Any comprehensive study of Clovis and Folsom technological or social organization must take into consideration changing environmental conditions and the way human groups responded to those differences. Clovis technology enters the North American archaeological record around 11,500 RCYBP during a major climatic episode (AllerØd-Younger Dryas transition) that saw changing environments and resultant extirpation, reorganization, and extinction of many different biotic communities (e.g. Grayson 2007; G. Haynes 2002). By Folsom times, beginning around 10,900 RCYBP with the onset of the Younger Dryas, the ecosystems familiar to earlier Clovis groups had changed to the extent that a new species-specific focus to subsistence had emerged. The following will outline these climatic changes and the resultant effects observed in floral and faunal communities in the Central Great Plains of North America. Changes in available resource bases will be used to highlight the differences between Clovis and Folsom subsistence patterns, land use, and technological organization, which are elaborated in Chapters 4 and 5.

Environmental conditions as they existed during the late Pleistocene in North America lack modern counterparts (Graham et al. 1996; Holen 2001:188; Kelly and Todd 1988:232). Admittedly, “detailed understanding of the dynamics of the late Pleistocene environment across North America as it was found by Clovis people is poor” (Huckell and Haynes 2007:217). The Clovis tradition appears during a time characterized by overall increased insolation and consequential warming climates resulting in melting ice sheets and sea level rise (Meltzer and

Holliday 2010:3). This general trend of warming was punctuated by climatic reversals, in part driven by massive meltwater releases from the retreating glacial ice sheets (Meltzer and Holliday 2010:3), creating a relatively unstable and unpredictable heterogeneous environment. A general warming trend with decreasing effective moisture during this time is supported by research at a number of stratified sites on the Southern Plains, including Blackwater Draw, Lubbock Lake, and Mustang Springs, where Clovis deposits associated with alluvial settings are overlain by Folsom deposits associated with lacustrine or palustrine conditions (Cotter 1937; Haynes 1975, 1995; Holliday 1985, 1995, 2000; Holliday, Meltzer, and Mandel 2011; Meltzer 1991; Sellards 1952; Stafford 1981). It was probably around this time that at least some localized sheet sands begin to accumulate in the dunes of the Arkansas River Lowlands (Platt 1974), although accumulation of these dune features in south central Kansas are dated primarily to the mid-late Holocene (Arbogast 1996).

Increased annual temperature and aridity at the end of the AllerØd interstadial period is supported by Greenland ice core data, and is synchronous with the emergence of Clovis technology around 11,500 RCYBP (Alley 2007; Hald et al. 2007; Haynes 2008:6522; Taylor et al. 1997; Yu and Wright 2001). Grayson (2007:190) suggests these conditions resulted in major range adjustments and extinctions within large mammal communities, accompanied by significant range changes for smaller mammals. These changes were well underway by the time Clovis technology appears in the archaeological record (Boulanger and Lyman 2014; Wright 1991), and many prey species apparently went extinct about 11,000-10,800 RCYBP (Holen 2014:179). As such, early Clovis groups likely experienced a mosaic framework of ecological niches rich in biotic diversity but unevenly distributed across the landscape (Guthrie 1982, 1984). An estimated half to two-thirds of the species of North American large mammals went extinct about this time, a rather punctual ending to an otherwise slow process (Grayson 1989; 2007:192; Martin and Martin 1987; Martin and Wright 1967; Meltzer and Mead 1983). Although diverse discussions have been offered as to the cause of these extinction events, it is apparent that loss of habitat played a key role (Graham 1979, 1985, 1991; Graham and Lundelius 1984; Lambert and Holling 1998; Lundelius 1989; Guthrie 1982, 1984, 2006). Climate change and resultant habitat loss was for the most part gradual, but variable in its timing and nature across the landscape.

Near the end of the AllerØd, and with the onset of the Younger Dryas around 10,900 RCYBP (Mangerud et al. 1974), the heterogeneous mosaic framework of Great Plains floral communities transition to one dominated by short grass in the High Plains and mid to tall grasses in the eastern Central Plains by the end of Clovis times (Bement and Carter 2010:910; Carlson and Bement 2013b; Haynes 1991; Holen 2001:207). Particularly, C4 grasses which store most of their energy in their roots and turn brown during summer droughts and winter begin to replace the less seasonal C3 grasses that remain greener longer and store most of their energy in their vegetative parts (Bement et al. 2007; Guthrie 1984; Martin and Martin 1987:125; Meltzer, Seebach, and Byerly 2006; Nordt et al. 2002; Twiss 1987). C4 grasses are better adapted to withstand climatic extremes associated with seasonality and climatic variability in general (White, Campbell, and Kemp 2001; White et al. 2001). A shift to more evenly distributed C3 and C4 grasslands had dramatic implications for animals reliant on grazing for subsistence, the pressures of which would be intensified for those species that synchronized birthing to the first spring growth of C3 grasses, which are more digestible than C4 grasses (Bamforth 1988; Hill, Hill, and Widga 2008; Martin and Martin 1987:125). This is concurrent with the onset of a strongly seasonal climate during the Younger Dryas, with an ~18-20°C swing between summer and winter months (Denton et al. 2005; Kutzbach and Webb 1993; Lie and Paasche 2006).

Animals such as bison (*Bison antiquus)* adapted well to these changes (Martin, Rogers, and Neuner 1985:26; McDonald, Personal Communication 2013). Bison, as ruminants, can survive on varieties of C4 grasses (Guthrie 1984; Knapp et al. 1999) that are not favorable forage for monogastrics, including mammoth, horse, and camel (Guthrie 1984; Hill et al. 2014:102; Hill, Hill, and Widga 2008). Around this time, there is a drastic restructuring of angiosperms, the effects of which were also detrimental to monogastric species (Willersllev et al. 2014). The change in floral composition favored a seasonally-dictated migratory lifestyle as available high quality forage became restricted spatially at different times of the year. Increased aridity resulted in many perennial streams drying into marshes or ponds, and many playa lakes diminishing in size or disappearing which necessitated movement to other water sources (Haynes 1991; Holliday 2000). Also, the occurrence of more frequent wildfires may have impacted suitable forage for grazing animals (Mandel 2006a:20; Knapp et al. 1999). Animals that successfully responded to these changes, particularly bison, thrived in these mixed grassland ecotones and outcompeted other species including the horse and camel, accelerating the extinction of these less adaptable groups, and allowing for bison population explosion and range expansion (Guthrie 1984:261; Hill, Hill, and Widga 2008; Lewis et al. 2010). Although the systematic nature of bison movements is debated as to their seasonal basis (cf. Roe 1951), there is increasing evidence to suggest that at least some movements were seasonally dictated, and driven by the need to obtain high quality forage (Bamforth 1988:83-84; Hanson 1984:102-103; Meltzer 2006:79; Roe 1951:520-600). By the end of Folsom time, bison migration patterns at least on the

Southern Plains were of long distance, and were highly patterned and redundant (Carlson 2015; Carlson and Bement 2013; Graves and Bement 2012; Graves 2010).

Modeling Change

Two traditional models are offered to explain environmental conditions as they existed at the end of the Pleistocene, and faunal community response to these conditions. These models primarily attempt to explain mass extinction events of megafauna that occurred during this time, with each focusing on environmental change as the mechanism driving faunal reorganization. However, the models differ in the magnitude and range of environmental change, as well as the degree of change in faunal community composition. The basic premise of both models are outlined below, followed by a discussion as to which aspects likely impacted Clovis and Folsom groups.

Equability (Clementsian) Model

Martin and Martin (1987) argue that immediately prior to the appearance of the widespread Clovis tradition, environments were equable with plentiful resources to support human subsistence within limited geographic ranges. The need for large scale human mobility may have been minimized as resources were readily available locally. Biomes contained a greater number of species, more diversity amongst species, and larger mammalian species overall than observed today (Kelly and Todd 1988:232). Animals and plants that today are found at different elevation zones or at different latitudes were compressed into smaller and overlapping geographic ranges, resulting in very complex biotic community structures during the late Pleistocene (Guthrie 1984; Martin and Martin 1987). This in part was because temperatures were less seasonally intense, with cooler summers and warmer winters than observed today. These conditions allowed for northern and southern taxa to overlap in geographic ranges, creating heterogeneous mammalian faunal communities (Graham et al. 1996:1605; McDonald, personal communication 2013).

Under this model, it is assumed that large groups of species are in equilibrium with each other, and can be tracked through space and time moving across the landscape as dictated by climatic warming and cooling events (Graham et al. 1996:1601). This model, also referred to as the Clementsian model (Clements 1916), suggests that biotic communities are long-lived geologically, maintaining equilibrium by shifting ranges through time as dictated by climatic events (Graham et al. 1996:1601). As such, species that today are allopatric and separated by different latitudes or elevations were sympatric and populating the same geographic regions during the late Pleistocene (Martin and Martin 1978:124). These are variously termed “disharmonious faunas”, or non-analog communities, which are associations of animals that today cannot be found living together, and hence are not in “harmony” with modern conditions (Semken 1974). Alternatively, the Gleasonian model (Gleason 1925), elaborated below, argues that individual species respond separately to environmental change as dictated by their own individual tolerance levels to climatic conditions (Graham et al. 1996:1601).

Gleasonian Model

According to Graham (1981), faunal communities are collections of animal populations that require similar environmental conditions to survive. Martinez-Meyer et al. (2004) suggest that ecological niches throughout the Americas provided long-term stable environments in which plant and animal species could co-exist during drastic climate change events of the late Pleistocene. Holliday, Meltzer, and Mandel (2011) have demonstrated the importance of interpreting environmental change at the site or local level as geomorphic systems do not behave synchronously to climatic changes. As such, particular regions may be preferred for habitation whereas others may be little utilized or entirely ignored, even if the same general climatic pressures are acting on both regions. Similarly, Lorenzen et al. (2011) demonstrate that during the late Quaternary of Eurasia, animal populations tended to aggregate in patches of high-quality habitat during times of great environmental stress. Likewise, Cannon (2004) has demonstrated that faunal distributions during the terminal Pleistocene in the Americas were driven by energy (more broadly defined as primary productivity) and habitat heterogeneity, not latitude or elevation as suggested by models based on seasonality and equability.

The Gleasonian model relies on the premise that response of individual plant or animal species to changing climatic conditions results in “range shifts with varying rates, at different times, and in divergent directions” (Graham et al. 1996:1601). Similarly, plant dispersal varies independently, with different taxa expanding “at different rates, in different directions, and at different times” (Grimm and Jacobson 2004:385) in response to climate change, seed dispersal, and establishment (Meltzer and Holliday 2010:12).

Arguments for animal and plant distributions and population dynamics due to equability or seasonality during the terminal Pleistocene are generally not supported under the Gleasonian model. Arguments for equability rely on the premise that environmental conditions were homogenous over a large geographic space and that animal communities within these geographic ranges responded similarly to climatic change by shifting to a more favorable range, namely by changing elevation or latitude. As outlined above, late Pleistocene conditions as currently understood suggests a trend towards environmental heterogeneity, with more homogenous conditions not taking hold until the very end of Clovis times when grassland begins to dominate the Great Plains province. This shift is concurrent with megafaunal extinctions and the emergence of bison as a primary prey species in the late Clovis and Folsom diet (Carlson and Bement 2013).

Discussion

It is suggested here that non-analog floral and faunal communities were likely found coexisting in ecological niches that provided suitable environmental conditions during times of otherwise inhospitable circumstances at the end of the Pleistocene. These niches, and the faunal communities that inhabited them, run counter to arguments of equability that suggest animal communities will abandon territories and shift ranges when conditions are unfavorable. New biotic communities are continuously emergent, and the predictability of the composition of these communities decreases as one goes deeper into geologic time (Graham et al. 1996:1601). Although widespread non-analog communities were present during the late Pleistocene, these faunas were supported by geographically and chronologically variable environments (Semken, Graham, and Stafford 2010).

Faunal communities responded to climatic change and environmental conditions based on individual species tolerance levels, with non-analogue faunal communities congregating in ecological niches that suited their individual survival requirements. Analysis of individual mammalian species population dynamics suggests this likely was the case for the Great Plains during the late Pleistocene (Graham et al. 1996:1601). The need for large scale or long distance range adjustment was mitigated by the presence of suitable ecological niches in various sub-physiographic regions. This obscures movements of animal communities in response to seasonal differences and results in very complex biotic communities compressed within specific ecological zones, but unevenly distributed across the landscape. Congregation into or movement amongst niches happened at different rates and at different times for individual species (Graham et al. 1996:1602). Seasonal responses do not become a major factor in biotic community structure until development of a more homogenous grassland landscape that began to proliferate with the onset of the Younger Dryas about 10,900 RCYBP. This is also when the first evidence of large bison herds emerges in the archaeological record.

Changing environmental conditions do not directly determine how human groups are going to respond to those changes, but it does limit suitable adaptation options (Bonnichsen et al. 1992:288-289; Vayda and Rappaport 1968). As such, climate change is viewed as a variable that can induce change in cultural systems and result in observable differences in the archaeological record (Bonnichsen, Stanford, and Fastook 1987). Just as there is no single way to respond to environmental change, there is also no such thing as a universal Clovis or Folsom adaptation (Andrews, LaBelle, and Seebach 2008:465; Hemmings 2004:109-110; Surovell 2003:25). Although widespread continuities are noted between the two adaptive systems, there are differences expressed in Clovis and Folsom land use and technology, discussed further in Chapters 4 and 5.

CHAPTER 4

HUMAN RESPONSE TO CHANGING CONDITIONS: CLOVIS AND FOLSOM SUBSISTENCE AND LAND-USE

Clovis and Folsom chipped stone technologies are often considered collectively simply because of the shared occurrence of fluting on projectile points, resulting in an unsubstantiated conflation of the two technologies (Bradley, Collins, and Hemmings 2010:2). This assumed relationship by extension implies similar utilization of biface technology and resource provisioning, and continuity in lifestyles from Clovis to Folsom times (Kelly and Todd 1988:235). Widespread similarities are noted between the two adaptive systems, including the use of biface technology, the preference for high-quality cryptocrystalline materials for chipped stone production, and long distance transportation of these materials across the landscape. In general, population densities for both groups are thought to have been low, with high mobility linked to direct procurement of lithic materials. Hunting of large-bodied mammals was undertaken opportunistically by Clovis groups, and large-scale communal hunting events are documented by Folsom time (Bement and Carter 2010, 2014; Carlson and Bement 2013a, 2013b).

Clovis and Folsom adaptive systems share many characteristics, yet there are notable differences in treatment of chipped stone technology and artifact distributions across the landscape. It is suggested here that a small change in adaptive systems can result in noticeable differences when compounded through redundant behavior and time. A single change in the emphasis or focus of one variable in the adaptive systems between Clovis and Folsom groups will result in diverse land use patterns and technological differences expressed in the archaeological record. The timing and magnitude of these changes are variable and dependent on local environmental conditions. I am not implying that Folsom technology develops directly out of Clovis technology, nor do I think that is a viable assumption. Rather, I suggest that these groups were operating under unique and diverse environmental constraints across the landscape, and adjusted adaptive systems accordingly.

There is no such thing as a single universal Clovis or Folsom adaptation (Andrews, LaBelle, and Seebach 2008:465; LaBelle 2005; Meltzer 1993; Surovell 2003:333). Groups organized themselves differently at various stages throughout the year, and there are many different ways a particular group can move lithic materials and different types of resources across the landscape (Bamforth 2002; 2009:143, Sellet 2004:1562). Surovell (2003:25) correctly notes that “one model is unlikely to explain all of the variability in one aspect of behavior for all contexts”. Different artifact distributions and densities as well as lithic material types are expressed unevenly across physiographic and biogeographic boundaries within the study area as people were operating under unique and diverse constraints in these areas (Asher and Hofman 2011, 2013; LaBelle 2005; Surovell 2003:333). Subsistence choices had to be derived from those that were locally available, and availability was spatially bounded by unique conditions across the landscape (Frison, Haynes, and Larson 1996:211; Hemmings 2004:109-110; Meltzer 1993; Surovell 2003:334). Clovis and Folsom groups structured land use differently through years and seasons to take advantage of regional and local resource availability. This difference was in part driven by climatic and environmental circumstances of the terminal Pleistocene as outlined in Chapter 3, and as depicted in Figure 5.

Modeling Clovis and Folsom subsistence and land use is discussed below, followed by a review of chipped stone technology of the two traditions in Chapter 5, with particular emphasis given to the different treatment in biface technology between Clovis and Folsom groups. These difference are correlated to distinct land use strategies, and are supportive of the proposed land use models outlined below.

Modeling Clovis Subsistence and Land Use

Clovis sites are characterized by the common occurrence of large proboscidean remains, particularly mammoth, but also mastodon at the Kimmswick site in Missouri (Graham et al. 1981), and gomphothere at El Fin del Mundo in Sonora, Mexico (Sanchez et al. 2014; Sanchez et al. 2015). The El Fin del Mundo site is also significant for containing some of the earliest dated Clovis materials, ranging from 11,560 +/- 140 and 11,050 +/- 550 RCYBP (Sanchez et al. 2014; Sanchez et al. 2015). Redundancy in the occurrence of proboscidean remains at Clovis sites has resulted in considerable debate over the nature of Clovis subsistence, with recognition that this association may be more superficial than real; sites are biased due to visibility, preservation potential, and recovery techniques (Holen 2001; Meltzer 1993; Waguespack and Surovell 2003:347). In addition to proboscidean bone, camel, horse, and bison remains have been recovered at Clovis sites, and the presence of smaller mammals, reptiles, and amphibians are commonly noted (Bement and Carter 2010; Blackmar 2001:78; Lohse et al. 2014; Meltzer 1988). Hemmings (2004) lists 116 different plant and animal species that are documented from Clovis-age context and that were utilized by Clovis people. This is suggestive of an opportunistic or generalist Clovis subsistence adaptation, an interpretation that is ascribed to here, but with caution as discussed below.

A dichotomy in interpreting Clovis subsistence exists, with some suggesting Clovis specialization geared toward the procurement of large mammals, primarily proboscideans (e.g. Haynes 1966; G. Haynes 2002; 2007, 2013; Martin 1973; Sellards 1952; Surovell, Waguespack, and Brantingham 2005; Surovell and Waguespack 2008; Waguespack and Surovell 2003;

Waguespack 2003, 2014), and others arguing for a more generalist approach to resource acquisition (e.g. Bryan 1991; Dixon 1999; Johnson 1977; Meltzer 1993). Grayson and Meltzer (2002, 2003) found reliable associations of Clovis artifacts with proboscidean remains at only 14 sites throughout the Americas, calling into question the degree to which these animals were actually hunted by Clovis people. Similarly, Banks (2001) suggests that the widespread distribution and common occurrence of mammoth throughout North America may have led to chance associations with Clovis cultural materials, particularly at water source locations, accounting for associations at some sites that may be fortuitous co-occurrences.

Waguespack and Surovell (2003) attempt to quantitatively resolve this issue and conclusively subscribed to a specialized Clovis adaptation. In Waguespack and Surovell's model (2003; Surovell and Waguespack 2008, 2009), Clovis hunters are deemed specialists if they *underutilize* smaller mammalian species. Confusion stemming from subjective semantics like this leads to characterizations of Clovis groups that "are unproductive and polarizing and mask what must have been considerable flexibility in subsistence strategies" (Huckell and Haynes 2007:221). It is generally accepted that Clovis hunters harvested large mammals because mammoth and bison remains are relatively common at Clovis sites (Blackmar 2001:77), but the extent to which Clovis subsistence practices revolved around acquisition of these high-return species remains at question (Boulanger and Lyman 2014; Hoppe 2004:129; Lohse et al. 2014:154; MacNeish 1964:14, Speth et al. 2013:113). Therefore, to classify them as "specialists" in the traditional view is deemed inappropriate here. I argue that Clovis groups may have opportunistically hunted large megafauna as high-yield resources despite the inherent associated risks, but other diet choices, particularly a diversity of smaller plant and animal species, were equally or more important (Meltzer 1993).

The impetus of the generalist/specialist debate is inextricably linked to the overkill hypothesis (Martin 1973) and the role that Clovis hunters played in the demise of megafauna, particularly mammoth extinction. As outlined in Chapter 3, range adjustments and extinctions of plant and animal communities was taking place before Clovis technology appears in the archaeological record (Boulanger and Lyman 2014; Faith and Surovell 2009; Fiedel 2009; Guthrie 2006). These changes were for the most part gradual and dependent on local environmental conditions, resulting in landscapes where animals were suppressed and spatially structured in particular regions offering suitable habitat. Hunting likely did have an impact on some large-bodied species, and may have accelerated or resulted ultimately in the extinction of some species (Haynes and Huston 2013). However, these species were probably already stressed prior to Clovis arrival, and likely would have gone extinct even without human intervention (Graham 1979; 1985; 1991; Graham and Lundelius 1984; Lundelius 1989; Guthrie 1982; 1984; 2006). Modeling of Clovis prey choices, therefore, is contingent upon the premise that animal species were either widely distributed and abundant (Waguespack and Surovell 2003), or were already diminished and found only in select resource-rich refugia (G. Haynes 1991, 2002; G. Haynes and Hutson 2013). Working within the constraints of the environmental conditions summarized in Chapter 3, I outline a Clovis land-use model here.

Prior to the climatic changes and resultant biotic community reorganization of the terminal Pleistocene, human groups likely acquired plant and animal resources readily as food resources were less seasonally variable, more predictable, more abundant, and compressed and confined within ecological niches (Haynes and Hutson 2013:303; Martin and Martin 1987:125). Large proboscideans as well as bison populations did not routinely undertake long distance migrations during this time, and were spatially focused in regions where forage was locally abundant, primarily where water was present (Graves 2010; Haynes 2008:6522; Haynes and Hutson 2013:303; Hill et al. 2014; Hoppe 2004:141; LaBelle 2005; Muniz 2014:114). Locations to encounter large mammals were predictable on the landscape, an argument indirectly supported by the underutilization of mammoth carcasses observed at several Clovis localities (Frison 1978; Frison and Todd 1986; Haynes and Hutson 2013:295; Saunders 1977). Mobile as well as non-mobile resources were found in areas of resource convergence (Andrews, LaBelle, and Seebach 2008; LaBelle 2005; Surovell 2003), particularly in well-watered areas or at peripheries of physiographic regions where discontinuous environmental or geographic variables served to mix floral and faunal species (Brown 1984). Wood availability usually corresponds with water locations as well. However, if wood was scarce or unavailable, this shortcoming could have been mitigated through use of bone for technological needs and dung as fuel which would have been readily available along spoor trails that typically connect watering locations (Rhode et al. 2003). Riparian environments as well as playa lakes in upland settings were actively targeted and utilized by Clovis groups (Hill et al. 2014; Muniz 2014:114). A more focused use of riparian systems by Folsom groups, as discussed in Chapter 9, may have been in response to continued drying and playa diminishment throughout the Clovis interval and Younger Dryas (Bettis and Mandel 2002; Cordova et al. 2011; Mandel 2006b). Conditions experienced by Clovis groups throughout the Great Plains were likely very different than those experienced by Folsom groups, with the latter displaying one of the first true Plains-oriented adaptations (c.f. Hofman 2004)

On the Great Plains, locations of floral, faunal, and water convergence are often not congruous with high-quality lithic source areas, necessitating the role of a transportable toolkit and anticipated mobility. Lithic shortages at these locations could be provisioned with chipped stone through caching stockpiles of tool stone for future use. Several Clovis caches are reported from the study region (Figure 6). There is no way to account for recovered but unreported or unrecognized caches or caches that were recovered in prehistoric time and incorporated into active toolkits. As such, the sample depicted in Figure 6 represent only a fraction of what was likely a widespread and common practice.

The Clovis subsistence model proposed herein stems from Binford's (1980:10) observation that "logistically organized task groups are generally small and composed of skilled and knowledgeable individuals. They are not groups out 'searching' for any resource encountered; they are task groups seeking to procure *specific resources* in specific contexts" (emphasis in the original). Hill et al. (2014) draw from this quote to explain Clovis bison hunting strategies in the Des Moines and Middle River valleys of Iowa. Although it is likely that Clovis hunters sometimes targeted specific resources as dictated by availability, I argue for a shift in the emphasis of the quotation from *specific resources* to Clovis adaptations characterized by *specific contexts*. I suggest that Clovis groups structured land use to optimize encounters of a wide variety of plant and animal species, focusing on the most convenient or abundant resources found in different regions (Cannon and Meltzer 2008; Meltzer 1993). This allows for diverse and flexible resource procurement strategies, to the extent that Clovis people may have had one of the broadest diet breadths of any hunter-gather Paleoindian group in North America (Banks 2001; Collins 2002; Hemmings 2004:258).

It is argued here that Clovis groups targeted rich resource patches where large prey species were locally abundant rather than specifically specializing in the acquisition or perusal of these large prey species. Clovis hunting skills and biface technology were adequate and organized in such a way to be prepared to make a kill at any time if the opportunity presented itself (Bradley and Frison 1996; Frison 1989; Lohse et al. 2014; Stiner 1991). Intentional hunting or scavenging of large proboscideans and bison was occasionally undertaken as these species were abundant within but restricted to specific refugia zones that were patchily scattered across the landscape (G. Haynes 2002).

This model shares similarities with Anderson's (1990; 1996) staging model developed for the southeastern United States, but differs in that biotic communities are restricted to certain resource patches separated by large expanses of land where resources are limited or unavailable (c.f. Guthrie 1984). These targeted locations on the Great Plains during the Clovis interval correspond with a series of east-west trending river systems and playa lakes on uplands between these drainages. Anderson's model implies a more homogenous landscape of abundant biotic resources rather than the patchy mosaic framework characteristic of the Great Plains during the terminal Pleistocene. Unlike Anderson's model where Clovis groups could find all necessary resources in a single patch and effectively minimize the frequency of required movements (Smallwood 2012), high mobility is a necessity under the model proposed here as different resources will be found spatially structured in different areas separated by large tracts of resource poor real-estate. It is feasible that Clovis groups targeted certain restricted locations on the landscape while ignoring or only minimally utilizing much of the land between the targeted areas (cf. Ellis 2011).

Under the above assumptions, optimal foraging theory, particularly diet-breadth models adapted from ecology (Emlen 1966; MacArthur and Pianka 1966; Smith and Winterhalder 1992; Winterhalder and Smith 1981), and patch choice models and marginal value theorem (Figure 7) (Charnov 1976), suggests Clovis groups would have undertaken longer distance moves between resource patches, but would have stayed in any particular region longer than if specializing on a single prey species (G. Haynes 2002). The diversity of plant and animal materials encountered and utilized within these ecological niches would be significantly greater than if the group was targeting a single species alone. Movement to a different location was dictated by yield rates and diminishing returns (Winterhalder 1987; Winterhalder and Smith 1981). With this subsistence approach, caching of lithic materials and utilization of blades for processing of plant materials are feasible practices as landscapes were known, resource availability was predictable, and specific regions could be targeted as particular needs arose. Clovis movements were predictable in that they were targeting specific locations on the landscape as dictated by needs and resource yields. Movements may have also been constrained by preferred routes of travel. Clovis chipped stone technology is specifically organized to be flexible towards a wide variety of needs within these resource-rich zones. Clovis chipped stone technology with reference to land use and anticipated mobility is outlined in Chapter 5.

Modeling Folsom Subsistence and Land Use

By 10,900 RCYBP and with the onset of the Younger Dryas, the patchy mosaic landscapes familiar to Clovis groups were giving way to a more homogenous mixed grassland environment (Bement and Carter 2010:910; Carlson and Bement 2013b; Haynes 1991; Hill, Hill, and Widga 2008; Holen 2001:207; Mangerud et al. 1974). Increased seasonality and loss of habitat for animal species compressed within ecological niches results in extinction and extirpation of as many as 39 different animal species, allowing for bison population proliferation and range expansion (Graham 1991; Grayson 1989, 2007; Martin, Rogers, and Nuener 1985). The generalized focus on landscapes rich in flora and fauna, characteristic of early Clovis populations, shifts to a more specialized land use adaptation dictated by the movement of bison, an adaptation that has its beginnings in late Clovis groups and is fully expressed by Folsom time (Bement 2003a, b, 2014; Bement and Carter 2005, 2010; Carlson and Bement 2013a, 2013b;

Carlson 2015; Hill et al. 2014; Hofman 1996; Hofman and Graham 1998; Holen 2014). Carlson (2015), Carlson and Bement (2013a), and Graves (2010) have demonstrated that bison become increasingly migratory throughout the Folsom period on the Southern Plains, expanding home ranges and covering large geographic spaces in redundant, predictable patterns by the end of Folsom times. However, this migratory pattern may not be reflective of conditions experienced on the Northern Plains or in higher elevation settings, where C4 grasses are rare or absent. In these areas, increasing bison populations does not necessarily correlate with or imply increased seasonal migration (Carlson 2015). The largest Clovis bison kill site, the Jake Bluff site, post-dates all known Clovis mammoth kills at the end of the Clovis interval ca. 10,827 RCYBP (Bement and Carter 2015). This supports the notion that Folsom specialization in bison hunting had its beginnings at the end of the Clovis interval, with large-scale bison kill sites becoming more common in the archaeological record throughout the Folsom period (Carlson and Bement 2013a, 2013b).

Folsom group subsistence is almost exclusively characterized as a specialized bison hunting adaptation (Bonnichsen, Stanford, and Fastook 1987; Hofman 1996; Husted 1969; Frison 1991; Sellards 1952; Wormington 1957), and ethnographic research suggests that subsistence efforts in open grassland environments almost always resort to hunting as there are limited foraging alternatives for fulfilling daily caloric requirements (Waguespack 2003:41). Similarly, specialization in acquisition of a particular species occurs when there are few economically important species available, but high numbers of those species present, as was the case with bison on the Great Plains after the terminal Pleistocene extinction event (Jochim 1981; Meltzer 1993; Andrews 2010). Every Folsom site that contains faunal remains invariably contains bison bone, and bison remains are often the dominant species in numbers and almost always the most prevalent by volume (Amick 1994a:248; Hofman 1996:59; LeTourneau 2000:24). However, some suggest the possibility that this association may be more apparent than real because of differential preservation, site visibility and recognition, and recovery techniques (Kornfeld 1996; Meltzer and Smith 1986). Lesser species are noted from Folsom contexts, and include deer, bear, antelope, elk, camel, jackrabbit, wolf, fox, marmot, turtle, and various rodents (Amick 1994a:231-244; Johnson 1987:124; Hyland and Anderson 1990:109; Walker 1982; Davis and Greiser 1992; Wilmsen and Roberts 1978). Although the question remains if these represent primarily background fauna at Folsom sites or are species that were routinely hunted, it cursorily supports the notion that Folsom people used a variety of floral and faunal resources other than bison at least occasionally, and that their diet may be more broad than traditionally thought (Amick 1994c; Andrews 2010; Hofman 1990, 1994c, 1996; Kornfeld 2002; Davis and Greiser 1992). However, bison were the most common large prey animal to be encountered on the High Plains grassland during this time, bison were the animal hunted with the most regularity by Folsom people, and were the most important resource in Folsom diet.

Traditional models of Folsom land use propose high residential mobility by small groups structured around bison hunting and bison kill localities (Hofman 1996, 2002, 2003; Hofman and Todd 2001; Kelly and Todd 1988; Mason 1962; Roberts 1939). These models, variously called the “ABC” model after the Agate Basin and Cattle Guard sites (Hofman 2002), or the “Synthetic Folsom Model” by LeTourneau (2000), suggest frequent group moves from bison kill location to kill location, necessitating anticipated mobility and the role of a dependable and transportable toolkit (Ahler and Geib 2000; Sellet 2006, 2013). Movements were typically not of considerable duration in space or time, and occupation of separate kill localities was relatively short.

Folsom land use is structured differently than Clovis land use in that Folsom groups targeted a single species for at least parts of most years. Bison population size, structure, and spatial range fluctuated seasonally, annually, and potentially dramatically as determined by climate and the availability of water and suitable forage (Amick 1996; Bamforth 1988; Fawcett 1987; Frison 1974; Frison, Haynes, and Larson 1996:210-211; Hill 2007). The exact locations to find concentrations of bison could change rapidly and readily over short distances as dictated by local conditions (Frison, Haynes, and Larson 1996:210-211; Hill 2007).

When environmental variables can be accounted for, bison behavior is redundant and highly predictable. Folsom groups were intimately familiar with bison behavior and movement patterns, and could anticipate where to find herds of bison as dictated by local environmental and climatic conditions. Redundant seasonal bison movement patterns occasionally resulted in reoccupation of previously visited landscapes, and the simultaneous aggregation at specific sites by different Folsom groups, as suggested for Lindenmeier and Cattle Guard (Jodry 1999; LaBelle 2012; Wilmsen and Roberts 1978). This predictable aspect of bison behavior may have allowed for planned aggregation events and communal hunts during particular times of the year in particular settings (Carlson and Bement 2013a).

Knowledge of general migration patterns of bison offered considerable advantage to Folsom hunters as topographic features on the landscape, such as arroyos and sand dunes, could be utilized in conjunction with manipulation of bison herd movement patterns to dispatch large numbers of animals in single kill events (Carlson and Bement 2013a; Hofman 1996). Intercept hunting becomes a feasible practice as seasonal bison migration patterns placed herds in particular settings at particular times of the year (Carlson and Bement 2013a; Hofman 1999a; Hofman and Ingbar 1988; Stanford 1999). This pattern is consistently revealed at Folsom sites on the Southern Plains where seasonality estimates are available, with most kills taking place during the late summer or early fall when bison herds were comprised of cow-calf populations (Bement 1994; Carlson and Bement 2013a; Todd, Hofman, and Schultz 1990).

Unlike earlier Clovis groups who were less affected by seasonal differences, gearing up episodes, anticipated mobility and scheduling of activities is intrinsically seasonal for Folsom people, whose artifacts first appear in the archaeological record during the onset of strongly seasonal climates of the Younger Dryas (Denton et al. 2005; Lie and Paasche 2006). Temperature variations upwards of ~18-20°C between summer and winter months had dramatic influence on bison movement patterns as discussed in Chapter 3. A more seasonal climate would have made certain landscapes unattractive for habitation during winter months, particularly the High Plains where winters are characterized by relentless winds, occasional deep snow, and a general lack of shelter, wood, and water resources (Frison, Haynes, and Larson 1996:210). Folsom groups organized themselves differently at various stages of their seasonal round, with use of the open High Plains largely restricted to warm months (Amick 1996:412-413; LaBelle 2005; Sellet 2004:1562). During the colder months of the year, Folsom groups were less residentially mobile and occupying areas where water, wood, and tool stone were abundant. Gearing up episodes occurred during these times of reduced or limited residential mobility, permitting greater time investment in intensive chipped stone production which was not always permissible while on the hunt in a state of regular movement, often great distances from preferred stone material source locations (Sellet 2004:1563).

Suitable cold-weather habitation locations are restricted in geographic space within the study area, and particularly confined to the foothills of the Rocky Mountains and the mesic oak-hickory and transitional tall grass and oak-hickory forest areas of extreme eastern Kansas. Amick

(1996) has outlined the role of the foothills as a probable seasonal refuge used by Folsom groups on the Southern Plains. This pattern is played out in a sample of 37 Folsom sites tested by Sellet (2013:390). In this sample, gearing up activities are restricted to foothill and mountainous settings, or basin environments which afforded favorable wintering over conditions. The only exception is the main Folsom layer at Agate Basin, which is argued to possibly reflect the utilization of a cached stockpile of Knife River Flint (Sellet 2004), a trait not commonly attributed to Folsom groups.

Since Folsom economy was in-part dictated by the acquisition of bison, when or if a specific location on the landscape would be visited while on the hunt was not entirely predictable, even when seasonal bison range locations were known. This negates the effectiveness of caching tool stone, a technique common in Clovis adaptations throughout the Plains, but not explicitly demonstrated for Folsom groups (Collins 1999a:14; Meltzer 2002; Osborn 1999:199; Wyckoff 1999). Caching of artifacts for future use indicates anticipation of being within the same area at some point in the future (Kilby 2008; Kilby and Huckell 2013; Meltzer 2004). This insurance strategy only works if targeting specific landscapes where return trips could be planned. Similarly, the availability and predictability of encountering specific plant resources could not be anticipated for Folsom groups. Chipped stone blades, common in Clovis assemblages, are associated with processing of woody and fibrous plant materials (Shoberg 2010:156), and are nearly non-existent in Folsom toolkits (Root 2001). Rather, a unique biface form, the ultrathin, is found in Folsom assemblages that has no counterpart in Clovis toolkits. The occurrence of ultrathins in other bison hunting specialist groups (e.g. Agate Basin, Goshen) indicates it is processing of bison that results in selecting for this tool form (Sellet 2006). Ultrathins were highly curated specialized cutting implements specifically linked to the acquisition of bison meat and possibly jerky production, supporting the notion of Folsom groups as bison hunting specialists (Jodry 1998, 1999; Root et al. 1999).

Emphasis on the key role of bison in Folsom subsistence and land use has drawn criticism. Several researchers (Andrews 2010; Andrews, LaBelle, and Seebach 2008; Binford 2001) suggest that predictable non-mobile resources such as wood, water, and tool stone play a larger role in mobility and land use patterns than bison acquisition. Although these resources were certainly of paramount importance, it is argued here that acquisition of these resources was scheduled around the hunting of bison. Andrews, LaBelle, and Seebach's (2008) model is fitting for times of reduced residential mobility during colder months, but does not account for the remainder of the year when Folsom groups were highly mobile in pursuit of bison. The transported Folsom toolkit is structured to allow freedom of movement away from stationary resources during these parts of the year (Hofman 2003). Folsom chipped stone technology, and particularly the role of bifaces in Folsom technological organization, is reviewed in Chapter 5.

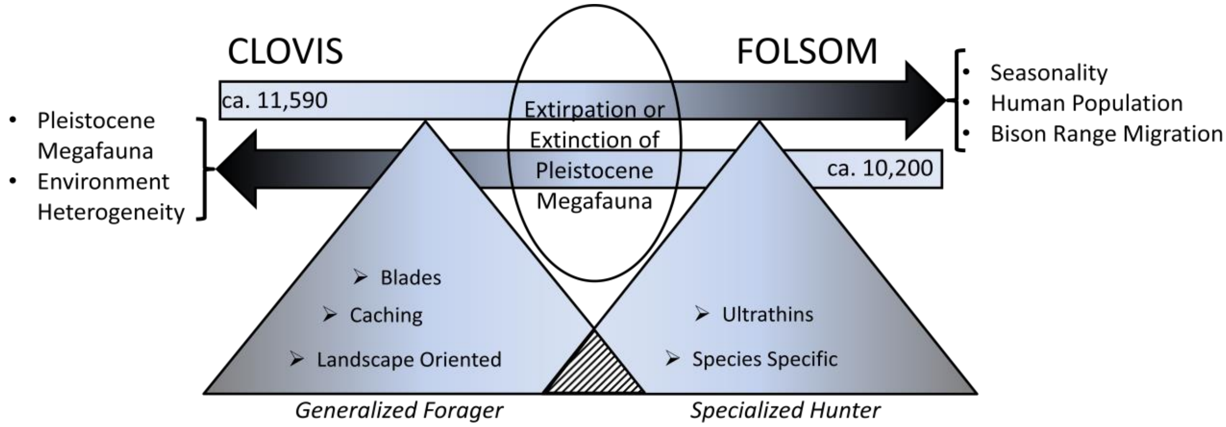

Figure 5. Generalized Clovis and Folsom subsistence model. Increasing environmental homogeneity and decreasing populations of Pleistocene megafauna result in a shift from generalized foraging to specialized hunting. This transition is viewed on a continuum with late Clovis and early Folsom groups exhibiting overlapping behaviors but different technological expressions.

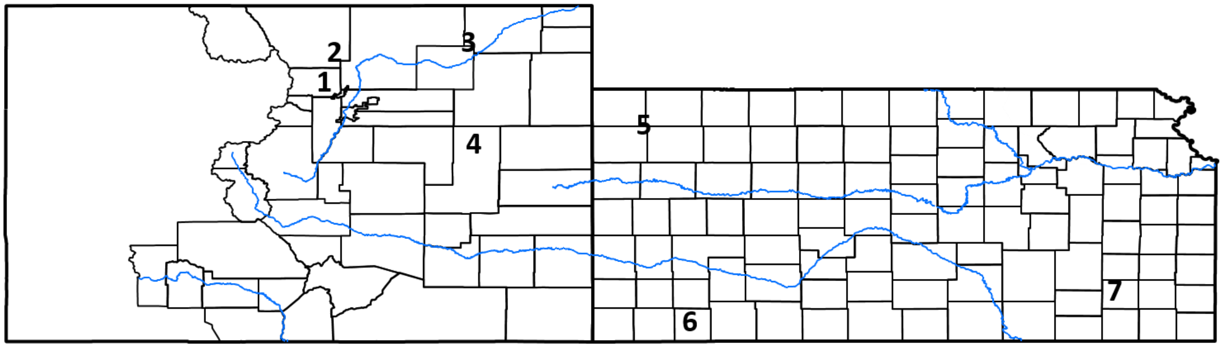

Figure 6. Clovis caches within the study area. 1) Mahaffy, 2) Watts, 3) Drake, 4) CW, 5) Busse, 6) Sailor-Helton, 7) Cutsinger-Bailey.

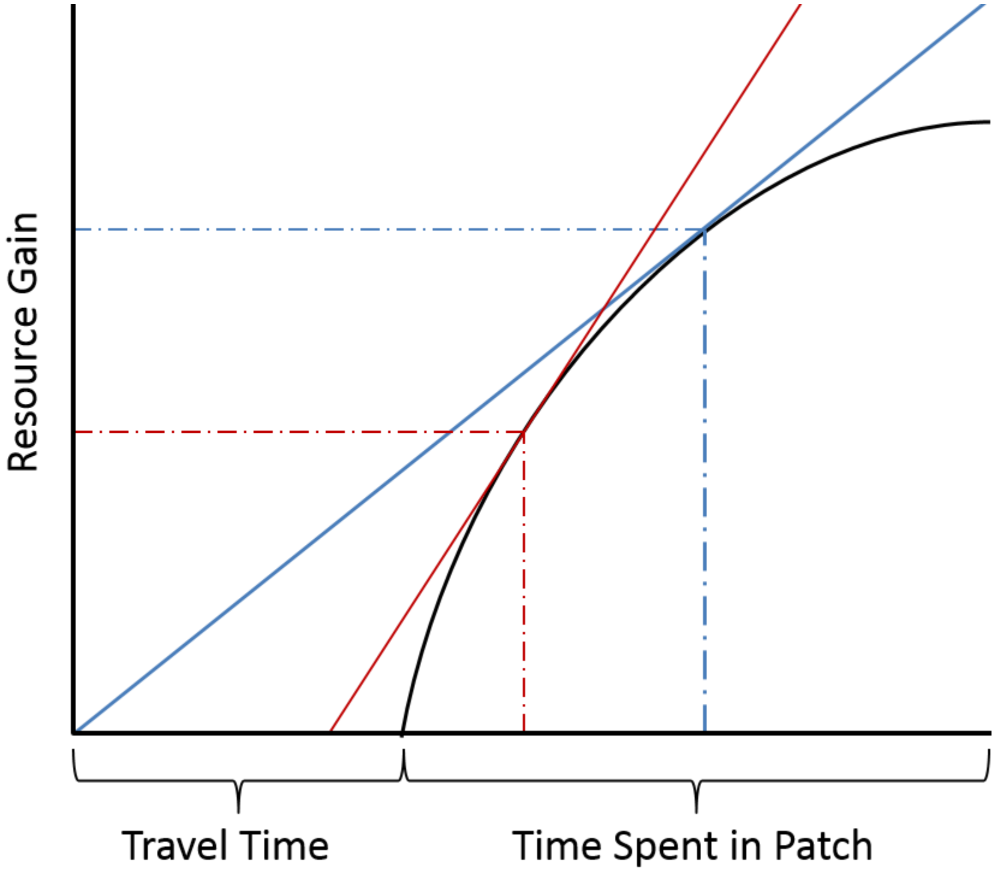

Figure 7. Optimal foraging model of Clovis (blue) and Folsom (red) land use. Clovis groups underwent longer distances moves between resource patches but spent more time within patches. Folsom groups moved steadily from location to location with duration of time spent at any kill site relatively short. Adapted from Emlen 1966; MacArthur and Pianka 1966; Smith and Winterhalder 1992; Winterhalder and Smith 1981.

CHAPTER 5

CLOVIS AND FOLSOM CHIPPED STONE TEHNOLOGY

Discussions of Clovis and Folsom chipped stone toolkits typically address specific technological aspects of the Clovis and Folsom projectile point production sequence (Baker 1997, 1999; Callahan 1979; Crabtree 1966; Flenniken 1978; Judge 1970; Sollberger 1985; Tunnell 1977; Winfrey 1990), attempt to characterize and understand how and why Clovis and Folsom points were fluted (Ahler and Geib 1999, 2000, 2002; Akerman and Fagan 1986; Baker 1997, 1999; Crabtree 1966; Frison and Bradley 1981; Gryba 1988; Ingbar and Hofman 1999; Rozen 1997; Sollberger 1986), or highlight the role of bifaces in the overall technological system (Bamforth 2003; Boldurian 1991; Broilo 1971; Goodyear 1989; Hofman 1992; Ingbar 1992; Kelly 1988; Kelly and Todd 1988; Stanford and Broilo1981).

Discussions of biface technology, especially with reference to mobility and technological organization are particularly applicable to understanding Clovis and Folsom lithic technology and assemblage structure throughout the Central Plains for a variety of reasons: 1) bifaces have long functional lives extended by periodic reduction, 2) bifaces are more easily transported than nodules, cores, or the equivalent volume of unmodified flakes, 3) the entire biface edge can serve as a cutting implement eliminating the frequency of necessary resharpening events and facilitating stone conservation, and 4) bifaces can be manufactured into other tool forms, including projectile points, as needs dictate (Huckell 2007:194). In this way, bifaces serve not only as blanks or preforms for the production of other bifacial tools, but are in themselves fully functional implements (Huckell 2007:194). Bifaces maximize the number of potential tools carried while minimizing the amount of stone required to be transported, a necessity for groups frequently on the move and often in areas where preferred tool stone availability was limited (Parry and Kelly 1987:303-304; Kelly and Todd 1988:237; Prasciunas 2007).

Several researchers question the paramount role of bifaces in Clovis (Ellis 2013; Eren and Andrews 2013; Prasciunas 2007; Smallwood 2012) and Folsom technological systems (LeTourneau 2000; Surovell 2003; Bamforth 2003), and argue instead for a core and flake technology. However, bifaces and flakes from bifacial cores are present in almost all Clovis and Folsom assemblages throughout the Central Plains, with biface technology serving as the primary production method for flake blanks, preforms, and projectile points. The following will review differences in Clovis and Folsom chipped stone technology and outline the defining characteristics of Clovis and Folsom projectile points. The chapter closes with a general discussion on the role of fluting in Clovis and Folsom assemblages, and highlights how dissimilar land use strategies may account for observed technological differences.

Clovis Chipped Stone Technology

Clovis chipped stone toolkits contain a diversity of formal and expedient tools. Huckell (2007:186) outlines four different possible tool trajectories for Clovis chipped stone technology: bifaces, flake tools, expedient tools, and blades. Biface technology dominates most aspects of the Clovis toolkit, and is used for the production of projectile points, preforms, knives and adzes, as well as a source of flakes for flake tools (Bradley, Collins, and Hemmings 2010). Even blade production is basically bifacial in nature (Bradley, Collins, and Hemmings 2010:56). Flake tools may also derive from amorphous cores not directly related to the bifacial aspect of Clovis technology (Prasciunas 2007). Flake tools include various side and end scrapers, gravers, utilized and retouched flakes (Boldurian and Cotter 1999:40-42). Expedient core tools may also be used with little to no apparent modification. Blades may be utilized without retouch, may be laterally retouched for use as cutting or scraping implements, or may be fashioned into end scrapers (Bradley, Collins, and Hemmings 2010:1). Conical cores as well as wedge-shaped cores associated with blade production are only found at a few Clovis sites, all located near lithic source materials, but blades are often found hundreds of kilometers distant from stone source locations (Bradley, Collins, and Hemmings 2010:20; Holen 2001; Kilby 2015). This consideration is of importance when addressing how scheduling and anticipated mobility influence the character of the transported toolkit (Collins 1999), and will be discussed further at the end of this chapter.

The Clovis Point

Although little variation is typically noted in Clovis biface production, there are multiple ways preforms were finished into points (Bradley, Collins, and Hemmings 2010:56). In general, classic Clovis points are lanceolate in shape with parallel to slightly excurvate or convex sides and slight to moderately concave bases (Figure 8) (Meltzer 2009:243; Morrow 1995:5). The basal concavity produces two protrusions, or ears, which are typically parallel with the sides of the point but occasionally exhibit a slight flare (Morrow 1995). Complete Clovis points are relatively long and thick, with lengths of complete un-reworked points occasionally in excess of 10 centimeters, and maximum thicknesses typically between 7-8 millimeters (Bever and Meltzer 2007; Morrow 1995). However, intentionally produced Clovis 'miniatures' are documented (Boldurian 1981; Hester 1972; Hofman and Graham 1998; Meltzer 2009:243), and reduction in size through breakage and reworking of points commonly results in points around 4 centimeters in length or shorter (Collins 1999:25). Un-reworked Clovis points are often in excess of 3 centimeters wide at the widest point. Lateral and basal edges are typically moderately to heavily ground on the lower portions. Basal thinning and fluting is variable, and sometimes absent or restricted to one side only. Differential fluting and basal thinning techniques are discussed further at the end of this chapter.

Folsom Chipped Stone Technology

A broad array of chipped stone tools are documented in Folsom assemblages. These include three separate biface forms: projectile points and preforms, ultrathins, and bifacial cores (Hofman 2003). A series of formal as well as expedient tools were created from bifacial cores including spurred end scrapers, side and other miscellaneous scrapers, gravers, perforators, denticulates, choppers, and various informal flake tools including channel flakes from projectile point production (Hofman 2003; Hofman and Graham 1998; Hofman, Amick, and Rose 1990; Judge 1973). The presence of large flakes from bifacial cores in Folsom assemblages suggest utilization of large bifaces similar to Frank's biface from the Mitchell Locality of Backwater Draw (Boldurian 1991; Hofman 1992; Hofman, Amick, and Rose 1990; Stanford and Broilo 1981). However, LeTourneau (2000:164-185) argues that cultural affiliation is questionable for this particular biface, and occurrences of such bifaces are rare if not entirely absent in Folsom assemblages (Amick 1999; Hofman 2003:231). Utilization of amorphous cores appears to be secondary to biface production, with the latter dominating almost all aspects of Folsom chipped stone technology throughout the Central Plains.

The Folsom Point

The classic Folsom projectile point is lanceolate shaped with moderate to deeply concave bases resulting in two, often sharp and well defined ears protruding from the base and oriented parallel with the sides of the point (Figure 9). Maximum length of complete Folsom points typically is less than 8 centimeters, and heavy reworking often results in points shorter than 3 centimeters in length (Collins 1999:26). Similar to Clovis, intentionally produced 'miniatures' are documented (Boldurian and Cotter 1999; Hester 1962; Tunnell 1977). Lateral edges typically exhibit fine marginal retouch produced by pressure flaking, and occasionally display a stacked series flaking effect with larger previous preform flake removals overlapped and infringed by fine marginal finishing flaking. Maximum width of Folsom points is typically around 2 to 2.5 centimeters. The lateral margins of the finished point are sometimes heavily ground near the basal portion (Roberts 1935:20), but lightly ground or un-ground bases are common, and distinct from Clovis technology.

The characteristic feature of classic Folsom points is the removal of two fluting or channel flakes that often extend more than half length of the point, creating a hollowed-out appearance in cross-section with the thinnest area found between the flute scars (Figgins 1934:4). These channel flake scars make Folsom points one of the most distinctive projectile point styles in the Americas (Judge 1970:44). However, considerable variability in fluting treatment is noted on Folsom specimens. Some points are fluted on one face only, others exhibit pseudo-flutes produced by retention of the ventral surface of the original flake blank, and others are not fluted at all. Variability in fluting is discussed in greater detail below.

Anticipated Mobility, Fluting, and the Effects of Land Use on Chipped Stone Toolkits

Understanding the production sequence of prehistoric chipped stone weaponry allows inference as to when and where certain manufacture techniques or steps are completed on the landscape. In particular, specific attention has been given to Folsom technology that allows critical examination into the role of anticipated mobility in shaping the archaeological signature of a given assemblage (c.f. Sellet 2013). Central to studies of this nature are artifact assemblages which retain aspects of the weaponry manufacture process, namely point preforms, channel flakes, and finished projectile points. By assessing the frequencies of these variables, it is possible to reconstruct aspects of knapper ability and skill, and to estimate projectile point production for specific sites (Sellet 2004; 2013). Comparing the number of estimated projectile points manufactured at a particular site to the number of points discarded allows for inquiry about anticipated mobility, particularly if strategies of gearing up, replacement, or conservation were taking place (Sellet 2013:386).

Addressing anticipated mobility is contingent upon the production of preforms and channel flakes through point production, and subsequent channel flake recovery and recognition in the archaeological record. However, significant variability is often observed in Clovis and Folsom fluting techniques, and transport and recycling of preforms and channel flakes can influence observed patterns. Importantly, in the Clovis projectile point reduction sequence, the removal of a channel flake was not always necessary as previous end-thinning flake scar removals from earlier biface shaping were occasionally incorporated into the final projectile form in lieu of a channel flake (Bradley, Collins, and Hemmings 2010:106). These flakes are often indistinguishable from other biface thinning flakes (Boldurian and Cotter 1999:36). In addition, Clovis flutes often exhibit irregularities in shape outline and positioning, and occasionally are produced by a series of small basal flake removals rather than a single channel flake (Howard 1990:258). This leads to inconsistencies in channel flake and basal thinning attributes not only among points from a single site, but often on opposite faces of the same projectile. Identification of Clovis channel flakes is conflated by the variable timing in the production sequence and considerable inconsistency observed in Clovis fluting techniques and treatment. As such, Clovis channel flakes are often unrecognizable as a distinctive archaeological signature. This poses a major disadvantage when compared to Folsom fluting techniques which are typically more standardized and leave a very distinctive easily identifiable archaeological fingerprint.

For reasons outlined above, occurrences and distributions of Clovis and Folsom channel flakes are considered separately and not included in the distribution density calculations in this study. Folsom channel flakes are invariably overrepresented in comparison to Clovis channel flakes due to recognition bias alone. Similarly, assemblage level information is largely lacking in data sets comprised mostly of isolated point discoveries. Even if assemblage level information was available, there is no direct correlation between point production and the number of channel flakes in the assemblage as some points exhibit only one flute, are pseudo-fluted, or not fluted at all (Ingbar and Hofman 1999). Assuming a correlation between number of channel flakes and number of points produced may result in erroneous interpretations of projectile point density for any particular region as the production of a Folsom or Clovis point often does not result in the production of exactly two channel flakes. Similarly, one side of a preform may exhibit multiple flute removals. For example, a Folsom preform from the Shifting Sands Site in western Texas was found broken in four fragments. This particular preform was fluted twice on one face, and once on the other surface, resulting in three channel flakes recovered in twelve different pieces, with additional fragments still missing (Figure 10). If not for the diligent record keeping and refitting efforts conducted on this assemblage, this single preform could result in an inflated count of four preform fragments and twelve channel flake fragments, or a total of sixteen artifacts which would dramatically skew distribution densities. This issue can be controlled in part by counting only proximal ends of channel flakes. Even though channel flake studies represent a level of analysis largely beyond the scope of this research, recognition of channel flakes and correlation of those flakes to known material types is invaluable in interpreting how tool stone was transported across the landscape.

Due to the difficulties inherent in channel flake recognition and correlation to single point production events, it is left to the researcher to develop theoretical models of land use and anticipated mobility to contextualize fluting activities in space and time. Critical to this discussion is an understanding of Clovis and Folsom land use and subsistence patterns as outlined in Chapter 4, and the staging of biface production and transportation in the overall organizational system. Clovis and Folsom land use is different, and these differences are exacerbated by the fact that land use strategies change continually in response to environmental change and resource availability. Even when the overall technological system is held constant, as suggested by the standardized manufacture techniques observed in Clovis or Folsom toolkits over large geographic areas (Bradley 1993; Bradley, Hemmings, and Collins 2010; Collins 1999; Eren, Buchanan, and O'Brien 2015; Morrow 1995; Sholts et al. 2012; Tankersley 2004), early Clovis chipped stone expressions across the landscape will look different than later Clovis adaptations. Late Clovis artifact distributions may look similar to early Folsom land use patterns but different than later Folsom land use strategies (Carlson and Bement 2013a, 2013b; Graves 2010; Graves and Bement 2012). This results in palimpsests of artifact distributions that may represent rather different land use strategies by groups using the same general technology, and perhaps similar strategies by groups using distinct technologies, that cannot be differentiated in the current sample. Reconstruction of the overall technological organizational system of Clovis and Folsom groups as related to land use assists in contextualizing these occurrences.

Under the Clovis land use model outlined in Chapter 4, early Clovis groups mapped onto particular landscapes, and planned for tool stone shortages by caching stockpiles of lithic materials in known locations of intended return. Caching of tool stone provided Clovis groups considerable flexibility when scheduling future movements. Unlike Folsom groups that geared up and transported all required toolstone in anticipation of being at considerable distance from known high quality lithic source areas for extended periods of time, Clovis groups embedded lithic source stockpiles throughout their movement sequence. Gearing up episodes for Clovis groups were structured differently than Folsom in that needs were driven in part by the anticipation of replenishing cached materials. When gearing up activities took place, they were conducted in locations that contained naturally occurring high quality lithic materials, similar to Folsom groups. These fixed positions on the landscape likely served as aggregation locations (Hofman 1994c; Holen 2001, 2014).

Stone tools have a limited use life because of resharpening and maintenance, stressing the importance of balancing costs associated with stone tool manufacture, maintenance, and transportation (Sellet 2006:225). Strategies of tool manufacture and maintenance create redundancy in technological organization and structure in Clovis and Folsom assemblages, and accounts for the high frequency of reworking observed on Clovis and Folsom points, an observation elaborated in Chapter 7. Cached stockpiles insured access to stone for Clovis groups when replacement of broken or expended tools was necessary, allowing for maintenance of the carried toolkit with little or no loss of transportable stone. If tool stone shortage occurred, conservation techniques would be implemented until another cache location or lithic source area could be visited.

Caching has not been explicitly demonstrated for Folsom groups and was not a reliable strategy as the number of bison kill episodes, the location of these events, and the distance of the kill locations from known lithic sources were not entirely predictable. A well planned and curated biface technology accounted for anticipated needs, even when the timing, magnitude, frequency, and location of those needs were uncertain. Since lithic procurement was secondary to bison acquisition and scheduled around the pursuit of the latter, Folsom lithic technology required intensive gearing up episodes at or near lithic source areas, as well as recycling and rejuvenation techniques that took place as conservation restraints and needs dictated when away from lithic source locations.

These different land use and lithic provisioning techniques resulted in separate long term and short term needs, and different techniques and strategies of tool manufacture and transportation between Clovis and Folsom groups. Particularly, fluting of preforms for Folsom groups typically occurred in bunches during retooling or gearing up episodes. These events were likely focused on times of reduced mobility during colder months of the year (Sellet 2013:394), and almost exclusively took place at campsites near lithic source locations rather than on hunting trips (Amick 1994c:22). This in part was due to the high failure rate of Folsom fluting at between 10-37% (e.g. Ingbar and Hofman 1999; Sellet 2004), to as high as 30-50% or more (e.g. Flenniken 1978), but also because gearing up and fluting takes time and often was not feasible while frequently moving on the hunt. In contrast, Clovis fluting failure rates are projected around 12% (Ellis and Payne 1995), and the assurance that stockpiles of tool stone were immediately available or anticipated in the near future mitigated the risks of Clovis fluting activities. With more flexibility in scheduling and a less structured (i.e. specialized) fluting technique than Folsom groups, Clovis preforms were fluted at the discretion of the tool carrier on an as-desired or as-needed basis, often at locations distant from lithic source locations.

These differences as well as unique tool forms discussed in Chapter 4, including the common occurrence of blades in Clovis assemblages and ultrathins (also with high production failure rates) in Folsom toolkits, contextualize how land use and separate subsistence strategies result in observable variation in chipped stone assemblages across the landscape. Diverse land use patterns were derived in part from environmental flux of the terminal Pleistocene as outlined in Chapter 3, and likely served as a stimulant for the creation of observed morphological variation between Clovis and Folsom projectile points (VanPool, O'Brien, and Lyman 2015:69). Dissimilar use of lithic materials between Clovis and Folsom groups is also noted and discussed further in Chapters 7-9.

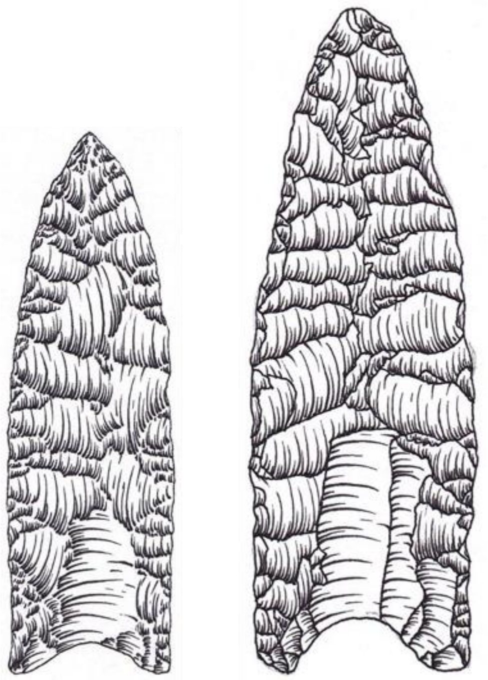

Figure 8. Example of two Clovis points from the Kansas River of northeastern Kansas. Note the dissimilar fluting treatment. Images not shown to scale. Illustrations by Kenny Resser.

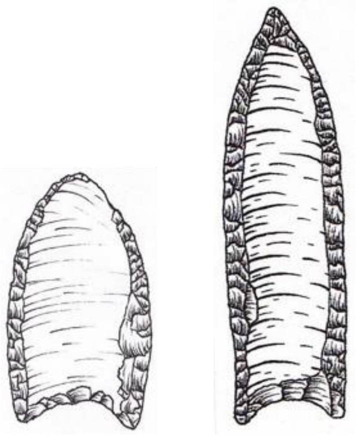

Figure 9. Example of two Folsom points displaying variability in reworking resulting in differential width and length ratios. The Folsom example on the left is from the Kansas River of northeastern Kansas. The example on the right is from north of the study area in Nebraska. Images not shown to scale. Illustrations by Kenny Resser.

Figure 10. Folsom preform from the Shifting Sands site, Texas. The preform was recovered in four fragments. The preform was fluted once on the obverse face and the channel flake was recovered in five fragments. It was fluted twice on the reverse face, with the channel flakes recovered in seven fragments. Lithic material is Edwards chert.

CHAPTER 6

METHODOLOGY

Recording Projectile Points and Preforms

Recording of Clovis and Folsom projectile points and preforms is a primary objective for distribution studies of this nature. The dataset utilized in this analysis has been compiled from previous projectile point surveys, museum records and collections, private collections, and published manuscripts. The majority of projectile points and preforms under consideration are isolated surface discoveries in private collections. A sample of projectile points and preforms from the large site assemblages of Lindenmeier and Stewart's Cattle Guard are not included in the distribution calculations, but are considered separately in comparisons.

A number of issues must be considered when recording artifacts in private and museum collections. First, movement of points since Clovis and Folsom times makes recording of projectile points logistically complicated. This movement could have happened prehistorically as demonstrated at the Los Guachimontones site, Jalisco, Mexico where at least two Folsom points were transported by later inhabitants (Canales et al. 2006). Movement can also occur in modern times when collectors pass away and their artifacts are sold or inherited by individuals whom may live very distant from the original find locations. The prevalence of bought and sold artifacts seriously hampers authenticity verification as valuable contextual information of original find location is lost, and the artifact is removed from the original find county, state, and sometimes country. Mixing becomes a concern when these artifacts, usually from many different localities, are incorporated into show-and-tell frames, sometimes with little to no provenience information. This issue is exacerbated by the influx of modern point replicas which are sometimes passed off as originals, although some replicas can be easily differentiated from authentic artifacts.

Discretion must be used when recording artifacts, and if any doubt was present in regards to authenticity or original find location, those artifacts were not included in this study.

Considerable morphological variability is often encountered in single point styles when recording projectile points. Morphological variability can be explained in many ways (Bentley et al. 2004; Buchanan and Hamilton 2009; Buchanan et al. 2014; Eren, Buchanan, and O'Brien 2015; Lassen 2013, 2015; Morrow 2015; Morrow and Morrow 1999; VanPool, O'Brien, and Lyman 2015), and should be viewed as a continuum rather than a static property (Morrow 2015). It is becoming increasingly clear that Midland (or unfluted Folsom) points are a different technological expression of the same organizational system as Folsom, as they routinely co-occur together (Hofman 1992; Hofman, Amick, and Rose 1990; Jennings 2012, 2015; Lassen 2013, 2015; Meltzer, Seebach, and Byerly 2006). Unfluted (Midland), unifacially fluted, and pseudo fluted Folsom projectile points are included in this analysis.

Recognition and assignment of projectile points into particular artifact types is often complicated through abrasion, patination, adhering carbonate, breakage, and attrition through reworking. Accounting for this variability and classifying into a typological category is admittedly subjective, although quantitative measures have been targeted at making these distinctions (Morrow 2015). If classifying a point as either Clovis or Folsom was uncertain, it was omitted from this study.

A series of metric attributes was systematically recorded for each point and preform when possible, including maximum length, width, thickness, fluted thickness, flute width, flute length, and basal width. Measurements were recorded on a standardized fluted point survey form developed by Hofman (1994b), an abbreviated version of which is included in Appendix B, and input into an excel spreadsheet. The spreadsheet and recording forms also contain descriptive information including reworking, abrasion, patina, material type, and flaking style, and contextual information including finder, find location, and discovery date. In the interest of maintaining a good rapport with collectors who have generously shared contextual find information, these details are not included here. A sketch or photograph of the artifact accompanied most survey forms.

Projectile Points as Data Sets

The advantages and disadvantages of using projectile points and preforms as datasets to reconstruct prehistoric land use patterns has received considerable inquiry (c.f. Bamforth 2002, 2009; Sellet 2006; Surovell 2003). The most often cited criticism is that projectile points represent only one aspect of much larger organizational systems, and consideration of only projectile points can skew interpretations of land use and subsistence strategies as only hunting or hunting related sites are being sampled. Similarly, lithic material types of projectile points may be different than accompanying chipped stone assemblages as projectile points are highly curated, transported, and potentially traded amongst other groups with greater propensity than more expedient flake technologies. Although limitations are recognized when considering only projectile points to reconstruct land use patterns, assemblage level data is largely lacking for most finds, and other artifact classes when recovered as isolates are often not diagnostic to time period or technology.

Assemblages of tools other than points that may inform on residential rather than hunting activities are nearly non-existent for Clovis sites within the study region (Bamforth 2009:142; Hofman 1996; Hofman and Graham 1998; Holen 2001). This is exactly why projectile points need to be considered. Projectile points in general, and fluted points specifically are easily recognizable, they are widespread in distribution across the landscape, and particular styles are restricted to specific time periods (LaBelle 2005:73). This allows for broad spatial patterning studies at known temporal ranges that other chipped stone tool forms cannot provide. Also, since projectile points are highly curated tools, they have a longer "past" than expedient tool types and can inform on the entire history of stone acquisition and provisioning (Ingbar 1994; Jones, Jones, and Hughes 2003 LaBelle, Andrews, and Seebach 2003; McDonald 1999; Meltzer 1989).

Importance of Private Collections, Surface Discoveries, and Isolates

Information derived from surface collections has traditionally received little to no attention in archaeological research, primarily because of the perception that information resulting from surface discoveries is less accurate than excavated materials (Blackmar 2001:67). However, surface-derived information should be viewed as complimentary to excavated data, and necessary especially at large regional scales when few excavated assemblages are available (Hofman 1989, 1991; Hofman and Graham 1998; Hofman and Ingbar 1988). Similarly, consideration of isolated artifact occurrences has received criticism as isolates are independently insufficient for modeling robust prehistoric mobility strategies (Odell 1994; Thacker 2006). However, once a sufficient sample of isolates and single-site occurrences has been recorded, it becomes possible to address land use patterns at many different geographic scales. This requires combined use of many collections and many sites as no one collection or site is sufficient for addressing questions of prehistoric land use and lithic procurement at large spatial scales (Hofman 1989:218). This also requires a significant amount of time investment to assemble datasets of suitable size with reliable information. Records are continuously growing with each new artifact discovery, and interpretations are constantly refining. Nevertheless, current artifact sample sizes are miniscule compared to estimates of the expected number of Clovis and Folsom artifacts that were likely produced and discarded throughout the study area (c.f. Hofman 2013).

There is much to learn from private collections and collectors as the amount of time professional archaeologist spend in the field is usually modest compared to that of interested collectors who's finds represent the culmination of years spent combing over particular landscapes. If these collections are ignored, artifact distributions and densities for any particular region are dramatically hampered, and interpretations of prehistoric behavior become severely limited by sample size.

Scales of Analysis

Several spatial scales of analysis are considered in this dissertation, including county, state, and physiographic or subphysiographic province. Spatial information is recorded minimally at the county level, and more specifically to site if that information is available. If county level provenience is not available, or discrepancies in collector information were encountered, those artifacts are not included in this analysis. Information is readily available and easily obtained at the county level (Prasciunas 2008:37), and little other provenience information is often available for surface finds (Blackmar 2001:68). Counties are useful spatial units for assessing the distribution of projectile points and preforms because they "are many in number, small in size relative to the study area, and arbitrary in location and boundaries with respect to the archaeological record" (Shott 2002:93).

Counties are easily mappable units that can further be utilized in environmental and physiographic reconstructions (Blackmar 2001; Meltzer and Bever 1995). However, several factors in county level analysis need to be addressed. First, it is sometimes difficult to know exactly from what county an artifact derived, especially if the original find location occurs in a four-corner area of multiple county convergence. This issue is mitigated somewhat when addressed at the larger scale of analysis of physiographic regions, as assignment to any of the four counties in question will often result in a single physiographic designation. However, the problem is exacerbated when the artifact in question was found in a river stream gravel context, as movement of the artifact downstream as well as laterally across the stream channel cannot be accurately accounted for. River boundaries often correspond with physiographic boundaries, and lateral movement of artifacts can result in designation within a county that may also be a different physiographic region than where the artifact originated from. Several counties are separated by major rivers within the study region (Figure 11), but the problem is most apparent for northeastern Kansas where designation in one county or another can result in assignment to the Glaciated Region or the Osage Cuestas whose boundary corresponds roughly with the Kansas River. There is currently no way to remedy this issue other than to be cognizant that it exists, and may potentially bias distribution interpretations.

Second, county borders and physiographic region boundaries not separated by major rivers are typically not congruous. To remedy this situation, counties are assigned to a particular physiographic region only if greater than 50% of the land area of that county falls within the physiographic region, as shown in Figure 12. Although this method is not entirely foolproof as demonstrated by the Lindenmeier site placement in Larimer County, Colorado, which is in the Colorado Piedmont but would be classified as the Rocky Mountains using my methodology, these issues can be mitigated by specific site location information when available. Artifacts or sites with known locations more specific than county level are assigned to physiographic regions accordingly based on the position within the county they are found, even if the majority of the county may comprise a different physiographic region. This methodology should not obscure patterning at larger geographic scales. Designation of each county to a particular physiographic region is summarized in Appendix C.

Lithic Material Identification: Strategies and Shortcomings

All lithic material identifications in this study have been conducted at the macroscopic level or with the assistance of limited magnification with a 10X loupe. Color, texture, inclusions, fossil composition, luster, burning, cortex, weathering, and patination were all considered when making material type distinctions. The lithic comparative collection at the University of Kansas Archaeological Research Center was consulted periodically when unfamiliar materials were encountered. Limited use of long and shortwave ultraviolet fluorescence proved particularly helpful when an artifact was completely patinated.

These methods of identifying lithic material type are admittedly subjective and incredible diversity in color, texture, and inclusions of some material types can complicate identification efforts. This difficulty is amplified when dealing with smaller artifact fragments, heavily patinated, abraded, or weathered items, and heat treated or burned specimens as the range of natural physical variability common in some material types is often masked by these conditions (Ray 2013:3). If particular artifacts were observed firsthand and lithic material type designation was uncertain, these artifacts are classified as *unidentified* material type, and are included in this study. Artifacts documented in previous reports that do not have accompanying material type listed are included in artifact distribution calculations, but not included in lithic procurement discussions as the material types for these particular artifacts are not necessarily *unidentified*, but are simply *unknown*. Lithic material summaries and distributions are considered further in Chapters 7-9, and physical attributes and locations of lithic material types are described in Appendix A.

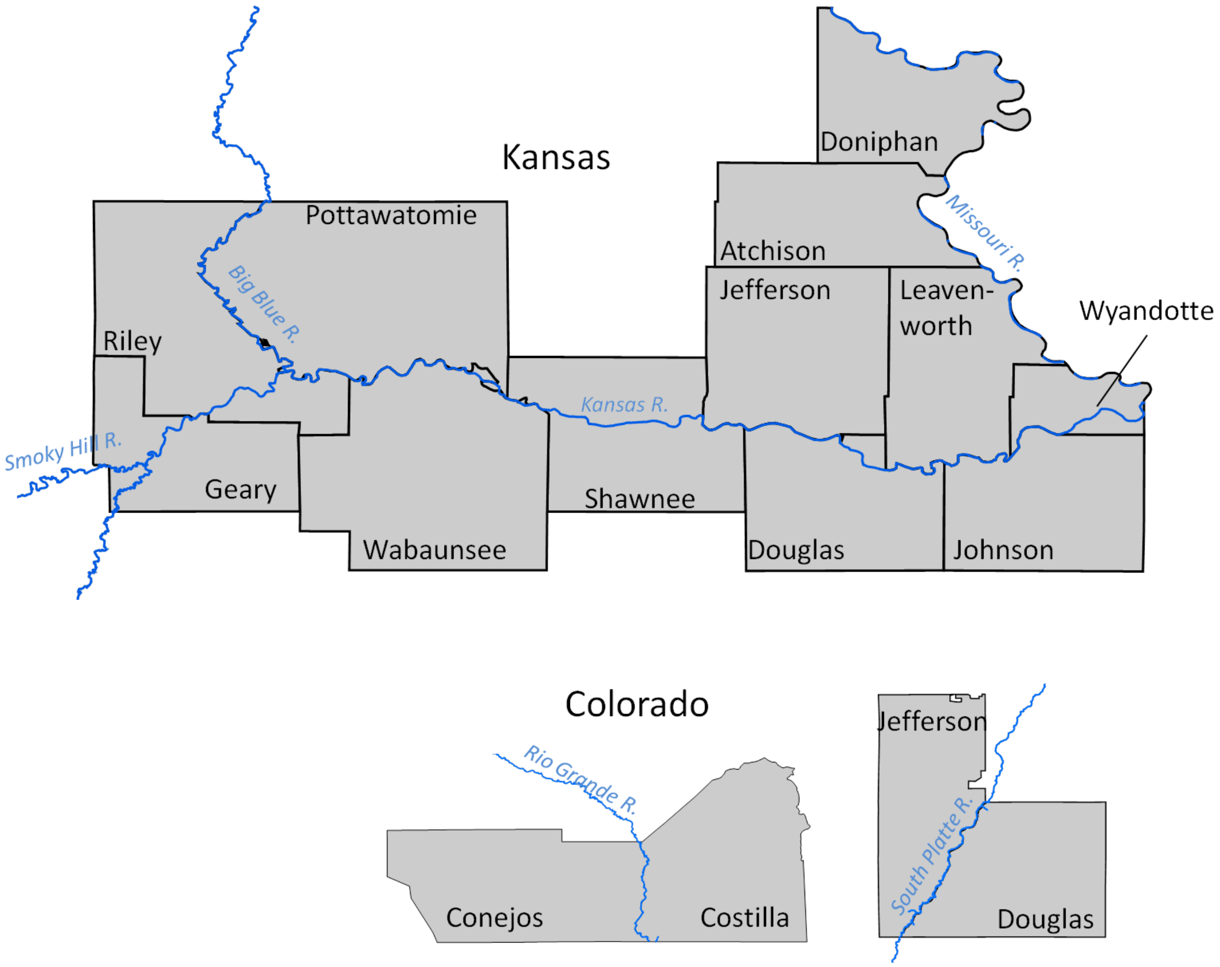

Figure 11. Counties within the study area separated by major rivers.

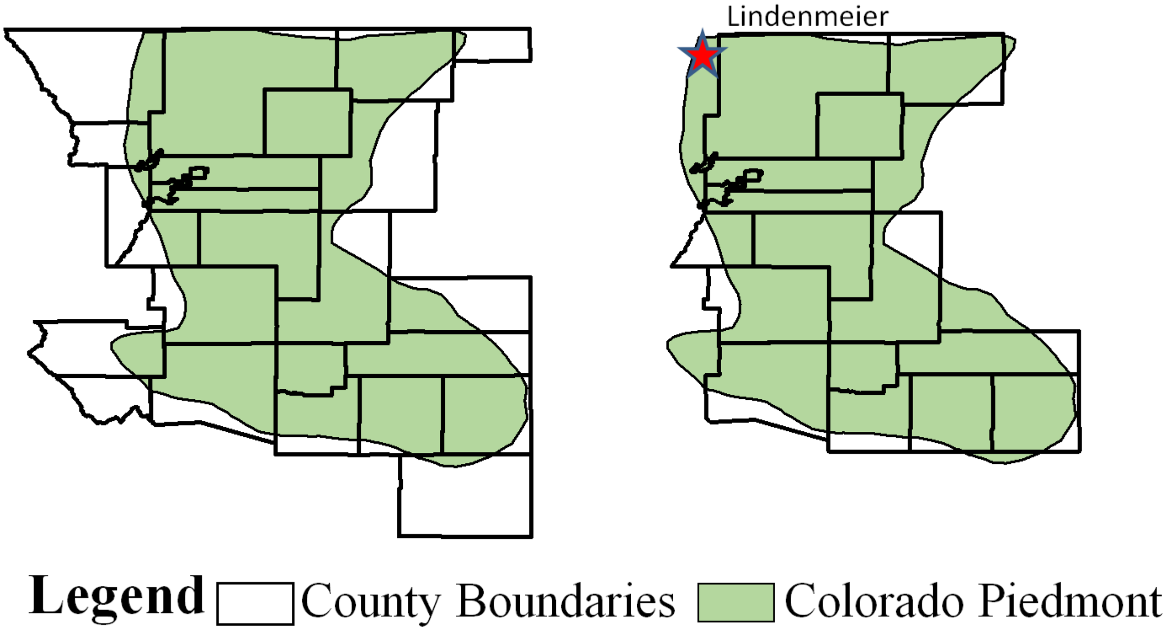

Figure 12. Method for rectifying county borders with physiographic boundaries. At left are the 26 counties that fall entirely or partially within the Colorado Piedmont. At right are the 17 counties with >50% landmass within the Colorado Piedmont. Note that the Lindenmeier site placement in Larimer County will be included in the Rocky Mountains and not the Colorado Piedmont using this method. Specific site location information is used to remedy these situations and assign sites to the proper physiographic regions.

CHAPTER 7

THE STUDY SAMPLE

The sample of artifacts included here has been compiled from previous site reports, surveys, museum collections and records, and private collections. The majority of artifacts under consideration occurred as isolated surface finds in private collections. A sample of artifacts from the large Folsom site assemblages of Cattle Guard and Lindenmeier are considered separately in comparisons in Chapter 8. A general artifact summary of the current dataset is provided in Table 4. The entire sample, as of April 1, 2015, contains 1,042 projectile points, preforms, or channel flakes. Although more collections containing Clovis or Folsom artifacts are known from within the study area, time restraints prevented recording of and incorporation of those artifacts into this analysis. The dataset for each artifact class is characterized below.

Table 4. The artifact study sample, as of April 1, 2015.

Clovis Projectile Points and Preforms			
	Colorado	**Kansas**	**Total**
Projectile Points	245	127	372
Preforms	19	8	27
Total	**264**	**135**	**399**
Folsom Projectile Points, Preforms, and Channel Flakes			
	Colorado	**Kansas**	**Total**
Projectile Points	381	68	449
Preforms	123	4	127
Channel Flakes	29	1	30
Total	**533**	**73**	**606**
Midland Projectile Points and Preforms			
Projectile Points	29	8	37
Preforms	0	0	0
Total	**29**	**8**	**37**

The Clovis Dataset

The current Clovis artifact sample contains 399 projectile points and preforms with minimum provenience information at the county level (Table 5). Of these, 372 are classified as projectile points, with the remaining 27 recorded as preforms. There are nearly twice as many Clovis occurrences in eastern Colorado compared to the entire state of Kansas, an observation that is elaborated later. No Clovis channel flakes were recognized during this analysis.

Table 5. Summary of Clovis artifacts.

Clovis Projectile Points and Preforms			
	Colorado	**Kansas**	**Total**
Projectile Points	245	127	372
Preforms	19	8	27
Total	**264**	**135**	**399**

Completeness information is available for 386, or 96.7% of the 399 Clovis artifacts. As shown in Table 6, complete and nearly complete projectile points comprise the majority of the Clovis sample, followed by basal fragments. The high number of complete Clovis artifacts in the sample can be explained in a variety of ways. First, Clovis projectile points are thicker in cross-section compared to the thinner Folsom artifacts, and likely break proportionately less. Second, there may be a sampling bias towards recording complete or nearly complete Clovis artifacts. Clovis projectile points not retaining the base can be very difficult to accurately classify as Clovis, whereas Folsom projectile points, even if the basal portion is missing, can still be readily identified through flute remnants and flaking characteristics. This is apparent when comparing the proportions of tip fragments between Clovis and Folsom artifacts in Tables 6 and 9. Third, this pattern may reflect prehistoric attitudes towards artifact recovery, stone conservation and recycling, or environmental issues including ground surface conditions and season. As outlined in Chapter 5, Clovis groups provisioned the landscape through caching behavior with stockpiles of lithic materials. The anticipation of being near cached lithic source materials, even if distant from actual stone outcrops, may have mitigated the impact of losing a complete point or preform. This behavior would result in different attitudes towards stone loss than groups limited to only the stone materials they were currently carrying, as suggested for Folsom groups. Lastly, this pattern may reflect different methods of projectile point use between Clovis and Folsom groups, as suggested by Hofman (1978). Particularly, the pattern of breakage may be linked to use of Clovis projectile points not only as weapons in conjunction with thrusting spears, but also as knives, whereas Folsom projectile points are almost exclusively used as weapon tips, and likely propelled with the atlatl rather than used as thrusting spears.

Table 6. Clovis artifacts by portion in the study sample.

Clovis Completeness Information (n:386)		
Portion	**Number**	**Percent**
Base	110	28.49
Base and Blade	8	2.07
Blade	8	2.07
Blade & Tip	8	2.07
Complete/Nearly Complete	239	61.92
Tip	2	0.52
Tip Missing	11	2.86
Total	**386**	**100**

Projectile point fragment types have traditionally been argued to occur in different contexts. Complete or nearly complete points are typically attributed to lost or unrecovered points associated with hunting events (Davis 1953), may represent ready-to-use points stored in a utilitarian cache (Huckell and Kilby 2014; Kilby 2008; Thomas 1985), or may reflect artifacts set aside for symbolic purposes in burial context (Huckell and Kilby 2014; Kilby 2008; Thomas 1985). Projectile tips are suggested to be found in kill locations whereas base fragments often reflect intentional discard and retooling of projectile points after hunting events, often at campsites rather than kill localities (Davis 1953; Haynes 1982). There are obvious exceptions to these circumstances, and no single pattern in frequency of fragments is representative of the entire organizational system (cf. Hofman 1999b). Sampling of different areas of the same site can result in considerably different interpretations of behavior (Hofman 1999b:123; Hofman, Amick, and Rose 1990; Sellet 2013).

Complete and nearly complete Clovis artifacts consist of 7 preforms and 232 points. Metric information is available for all 7 complete preforms, and 155 of the complete projectile points. Summary measurement information is provided in Table 7 for these artifacts. Note the maximum length and width of the largest projectile point in brackets. This artifact was recovered from a probable burial context, based on associated recovered materials, and may not represent an implement intended for utilitarian purposes. It is identical in size to the largest Alibates projectile point from the Drake cache. The only other reported Clovis points of comparable length or larger are all from cache context, and include two points from the Simon cache in Idaho, and four points from the East Wenatchee cache in Washington (Bradley, Collins, and Hemmings 2010:97-100).

The large range expressed in maximum and minimum size in Table 7 is not uncommon for Clovis artifacts. This is in part due to heavy reworking of artifacts, but also because some projectile points appear to be intentionally produced miniatures. Reworking of Clovis projectile points is a characteristic found throughout the entire geographic range of Clovis technological distribution (Bradley, Collins, and Hemmings 2010:101). Within the current sample considered here, 130 complete Clovis artifacts have information recorded pertaining to reworking, and 78 (60%) display evidence of reworking.

Clovis preforms on average are longer, wider, and thicker than finished Clovis projectile points. This is logical considering preforms have not yet been reduced to their final form. The larger range in size of preforms as indicated by higher standard deviation values suggests greater variability in the treatment of Clovis preforms than projectile points, particularly concerning width and thickness measurements. This suggests that finishing a Clovis preform into a point results in greater loss in width and thickness than length of that artifact, and is supportive of Callahan's (1979) and Bradley, Collins, and Hemmings (2010) analysis of Clovis biface reduction.

Table 7. Metric statistics of complete Clovis projectile points and preforms. Measurements are in centimeters.

Complete Clovis Projectile Point Summary Metrics (n:155)				
	Length	Width	Thickness	Fluted Thickness
Average	6.49	2.71	.70	.48
Maximum	[16.7] 12.69	[4.05] 3.62	.98	.75
Minimum	2.89	1.63	0.36	0.27
Standard Deviation	2.15	.46	.12	.09
Complete Clovis Preform Summary Metrics (n:7)				
Average	8.65	3.98	0.97	0.72
Maximum	11.91	4.96	1.27	1.02
Minimum	5.33	2.54	0.69	0.46
Standard Deviation	2.45	.87	.25	.25

The Folsom Dataset

A total of 606 Folsom artifacts are considered in this study, including 127 preforms, 449 projectile points, and 30 channel flakes (Table 8). Similar to the Clovis sample discussed above, more Folsom artifacts are recorded from eastern Colorado than the entire state of Kansas (this is without including the large samples from Lindenmeier and Cattle Guard). Interestingly, there are more Clovis artifacts recorded in Kansas than Folsom artifacts. This pattern is noted by Jennings

(2015:286-287) who suggests that Clovis artifacts in Kansas are overrepresented in comparison to the number of Folsom occurrences. Jennings used Blackmar's (2001) projectile point distribution information, which at the time consisted of 63 Clovis projectile points and 41 Folsom points recorded in the state of Kansas. The current study adds an additional 64 Clovis points and 27 Folsom points to the Kansas record, and strengthens the observed pattern. This observation cannot be explained through geomorphic filtering, collecting, or recording bias alone as Clovis and Folsom artifacts, at the state-level, are affected equally by these variables. This pattern is explored further in Chapter 8.

Table 8. Summary of Folsom artifacts in the study sample.

Folsom Projectile Points and Preforms			
	Colorado	**Kansas**	**Total**
Projectile Points	381	68	449
Preforms	123	4	127
Channel Flakes	29	1	30
Total	**533**	**73**	**606**

Completeness information, excluding channel flakes, is available for 568 (98.6%) of the Folsom projectile points and preforms, and is summarized in Table 9. Folsom points tend to break in more ways than Clovis points, as demonstrated by the additional portion categories included in Table 9. Particularly, Folsom points break transversely as well as parallel with the long axis, resulting in lateral edge fragments. This pattern of breakage is less commonly observed on Clovis artifacts, likely because Clovis flutes are typically shorter in length and Clovis points are generally thicker in cross-section, but also perhaps because of the differential patterns of use between Clovis and Folsom projectile points outlined by Hofman (1978). Recognition of Folsom fragments is improved by the fact that Folsom fragments are more readily identifiable through flaking characteristics and fluting treatment than Clovis fragments.

Table 9. Folsom artifacts by portion in the study sample.

Folsom Completeness Information (n:568)		
Portion	**Number**	**Percent**
Base	174	30.63
Base and Blade	31	5.46
Base Edge	18	3.17
Blade	90	15.85
Blade & Tip	19	3.35
Complete/Nearly Complete	112	19.72
Ear	7	1.23
Lateral Edge	43	7.57
Tip	69	12.15
Tip Missing	5	0.87
Total	**568**	**100**

Of the 112 complete or nearly complete Folsom artifacts in the current sample, 105 are complete projectile points, and 7 are complete preforms. The fact that only 7 (5.5%) of the 127 recorded Folsom preforms are complete (compared to 25.9%, or 7 out of 27 Clovis preforms) is reflective of the propensity of Folsom preforms to break during fluting activities. Alternatively, this may reflect different attitudes towards stone conservation and transport than Clovis groups. Particularly, the transported stone supply would be of considerable importance to Folsom groups who apparently did not provision the landscape with cached stockpiles. Under limited stone availability restraints, stone conservation, reuse, and reworking are common practices (Hofman 1991; Ingbar and Hofman 1999). The gravity of losing a complete preform likely resulted in proportionally fewer losses as greater effort and attention is devoted to maintaining the available stone supply. Also, the risky nature of fluting Folsom preforms suggests that most preforms are fluted in bunches at camp settings in areas near local stone outcrops, and may not be transported as readily or in the same quantities as finished projectile points when on the hunt. The relatively small sample (n=4) of Folsom preforms documented from Kansas where high quality stone materials are sparse may be reflective of this behavior.

When only projectile points are considered, there are proportionally fewer complete Folsom points in the study sample compared to the number of complete Clovis points. This discrepancy is highlighted in Table 10. A Fisher's exact test demonstrates that this observation is extremely statistically significant, with a P value of <.0001. This is a stronger statistical correlation than that observed by Hofman (1978), who hypothesized that the lower frequency of breakage observed in Clovis projectile points may be a product of using thrusting spears rather than propelling darts with atlatls. Projectile points used with thrusting spears are less likely to strike solid masses such as bone and break as they are more likely to hit intended targets such as the soft underside of animals as opposed to the bony broadside of an animal that is targeted with atlatls. This hunting strategy, used in conjunction with Frison's (1978:111-112) mammoth procurement model, would account for proportionally fewer broken points at kill localities than sites where atlatls were in use (Hofman 1978:4).

Table 10. Fischer's exact test of Clovis and Folsom projectile point completeness.

	Complete	Broken	Total
Clovis	232	127	359
Folsom	105	338	443
Total	337	465	802
Fisher's exact test: P<.0001 (Statistically significant)			

This observed discrepancy can be explained in a variety of other ways as well. First, as previously discussed, Folsom points tend to break more often and in more ways than the more robust Clovis projectile points. Second, Folsom projectile points are designed to be highly curated, reusable items, even if tip breakage occurs (Ahler and Geib 1999, 2000). In a technological system where projectile points are viewed as long use-life commodities, broken points, when recovered, are often retained in the active toolkit and refurbished into reusable items. This recycling behavior results in proportionally fewer complete projectile points discarded across the landscape, as they remained in the active toolkit until completely depleted or broken beyond a reusable threshold. This behavior is suggested when comparing the number of Clovis projectile point tip fragments and points missing the distal end to the comparable fragments in the Folsom sample. However, as previously mentioned, this pattern is also a product of the distal end of Folsom points being more recognizable. The lower frequency of Folsom projectile points with tips missing compared to the Clovis data set may correspond to a higher degree of stone conservation. Of the 105 complete Folsom points, 101 have information recorded pertaining to reworking, and 61, or 60.4% display reworking. This is identical to the degree of reworking observed in the Clovis sample at 60%.

Variation in spatial distributions of different portions of artifacts at the scale of analysis considered in this study can only provide cursory assumptions about behavior as complete artifact assemblages from specific site contexts are not considered, and there are no predetermined rules governing when, where, and how complete projectile points and fragments are discarded across the landscape. However, some general patterns are apparent when considering completeness information of Clovis and Folsom projectile points for each physiographic region, as highlighted in Figures 13 and 14.

Complete Clovis projectile points are ubiquitous in their occurrence throughout the study area but occur in different proportions in separate physiographic regions. Particularly, complete Clovis points outnumber all other fragment types in the San Luis Valley, Colorado Piedmont, High Plains, Arkansas Lowlands, Red Hills, Smoky Hills, Flint Hills, Glaciated Region, and Osage Cuestas. The Raton Basin is tied with one complete, and one blade fragment of Clovis points recorded. The only Physiographic region where this pattern does not hold is in the Rocky Mountains, where base fragments outnumber complete Clovis points 2-1.

In comparison, Folsom base fragments are more widespread and common than complete Folsom projectile points. Folsom base fragments outnumber complete projectile points in the San Luis Valley, Raton Basin, Colorado Piedmont, High Plains, Red Hills, Smoky Hills, and the Osage Cuestas regions. The only physiographic region where this pattern is reversed is in the Glaciated Region of northeast Kansas, where complete Folsom projectile points outnumber base fragments 9-5.

The discrepancy between Clovis and Folsom completeness is linked to the inherent difficulties associated with Clovis projectile point recognition when basal fragments are missing, and also tied to the greater propensity of Folsom projectile points to break due to thinness. It may also be linked to prehistoric attitudes concerning stone conservation and discard, as well as different hunting techniques and tool use (i.e. Clovis projectile points also serving as knives).

Of the 105 complete or nearly complete Folsom projectile points, 91 have available metric information, and 6 of the 7 preforms have known measurements summarized in Table 11. In general, average length, width, thickness, and fluted thickness measurements conform to measurements observed on Folsom artifacts outside the study area (c.f. Meltzer 2006; Morrow and Morrow 1999, 2002). Similar to Clovis projectile points, the greatest variability in dimensions, as highlighted by standard deviation values, is length. This is due to heavy reworking of some projectile points as well as the occasional occurrence of intentionally produced Folsom miniatures (Lassen 2013, 2015).

When comparing preform dimensions between the Clovis and Folsom dataset, there is much less variability expressed in the dimensions of the Folsom preforms. This suggests that

Folsom preforms are more standardized in their production and overall morphology than Clovis preforms. Folsom preforms are also longer and much wider than finished Folsom projectile points, but are only slightly thicker. This is similar to the pattern observed by Morrow and Morrow (2002:153) on a sample of Folsom preforms and projectile points from Iowa.

Table 11. Metric attributes of complete Folsom projectile points and preforms. Measurements are in centimeters.

Complete Folsom Projectile Point Summary Metrics (n:91)				
	Length	Width	Thickness	Fluted Thickness
Average	4.53	2.14	.44	.33
Maximum	7.95	2.68	.63	.47
Minimum	2.07	1.44	.31	.23
Standard Deviation	1.24	.26	.07	.06
Complete Folsom Preform Summary Metrics (n:6)				
Average	6.94	3.47	0.67	0.48
Maximum	9.15	4.77	0.84	0.59
Minimum	5.54	2.70	0.57	0.39
Standard Deviation	1.69	0.89	0.09	0.10

The Midland Dataset

The Midland dataset suffers from small sample size. This may be due to recording bias and recognition difficulties associated with points that do not exhibit a characteristic easily identifiable flute remnant. I feel Midland points are a different technological expression of the same organizational system as Folsom, but others argue that there is no such thing as an unfluted Folsom projectile point (Lassen 2015). Midland and Folsom projectile points share most morphological and technological characteristics, with the exception of the removal of channel flakes. Their temporal and spatial distribution, as well as basic economy and other chipped stone tool forms are virtually identical as well (Hofman 1996:62).

The Midland dataset is summarized in Table 12. No Midland preforms are recognized in this study, and documented Midland preforms have never been reported (Meltzer, Seebach, and Byerly 2006:172). The scarcity (or complete lack) of documented Midland preforms may be reflective of the nature of Midland preform production, and linked to inherent recognition difficulties. Particularly, if Midland preforms were produced on diminished flake blanks or recycled Folsom points or other artifacts, as suggested by Hofman (1992), then Midland preforms would be difficult to identify (Meltzer, Seebach, and Byerly 2006).

Table 12. Summary of Midland artifacts in the study sample.

Midland Projectile Points and Preforms			
	Colorado	**Kansas**	**Total**
Projectile Points	29	8	37
Preforms	0	0	0
Total	**29**	**8**	**37**

Completeness information is available for 35 of the 37 Midland projectile points, as shown in Table 13. Base fragments are the most common portion of Midland artifacts documented in the current sample, accounting for 60% of the Midland data set. Complete projectile points are the second most common occurrence at 20%. The lack of other portion categories observed in the Folsom sample, including lateral edge fragments and ear fragments, is likely due to recognition biases. Specifically, ear fragments of Midland projectile points are not necessarily diagnostic as other late Paleoindian projectile point types produce similar ear styles. Similarly, lateral edge fragments can be difficult to discern technological affiliation if no flute remnants are present.

Table 13. Midland artifacts by portion in the study sample.

Midland Completeness Information (n:35)		
Portion	**Number**	**Percent**
Base	21	60
Base and Blade	2	5.6
Blade	3	8.6
Blade & Tip	1	2.9
Complete/Nearly Complete	7	20
Tip	1	2.9
Total	**35**	**100**

Metric information is available for 6 of the 7 complete or nearly complete Midland points and provided in Table 14. On average, the Midland projectile points within the study sample are slightly longer and narrower than the Folsom points, but have identical thickness measurements. This is supportive of the often cited notion that Midland points represent Folsom preforms or flake blanks that were too thin to flute, as the fluted Folsom specimens had to have been thicker prior to the channel flake removals than the comparable Midland specimens (Agogino 1968, 1969; Rovner and Agogino 1967). However, thinner Folsom examples within the current dataset exhibit flute remnants, and thicker Midland points examined outside the study area do not portray any evidence of attempted flute removals (Judge 1970). The fact that Midland points within the current sample are narrower on average than Folsom points within the dataset is supportive of Judge’s (1970) hypothesis that point width, and perhaps not thickness, is of equal or more importance in determining if a preform was fluted. Other variables likely influenced whether a preform was fluted as well, including number of kill and retooling events since a lithic source area had been visited (Hofman 1991), anticipation of being at distance or near suitable lithic materials for gearing up (Hofman 1991; Sellet 2013), or idiosyncratic factors which may include knapper skill and situational variables (Amick 1995).

Table 14. Metric attributes of complete Midland projectile points. Measurements are in centimeters.

Complete Midland Projectile Point Summary Metrics (n:6)			
	Length	Width	Thickness
Average	4.78	1.97	.46
Maximum	5.39	2.35	0.57
Minimum	3.62	1.54	0.34
Standard Deviation	0.64	0.30	0.09

Lithic Material Summaries

Primary lithic material types for Clovis, Folsom, and Midland artifacts are provided in Table 15. Lithic material information is available for 972 out of 1042 of the recorded artifacts considered herein, or approximately 93.3% of the study sample. The remaining artifacts, as outlined in Chapter 6, are not necessarily unidentified material types but are material types that are simply unknown because firsthand observation was not conducted on those specimens. Spatial distributions of different material types is examined in Chapters 8 and 9. Summary statistics of lithic material types for Clovis, Folsom, and Midland artifacts are outlined below. Description of lithic materials and source locations is provided in Appendix A.

The most prevalent material represented by Clovis artifacts is White River Group Chalcedony, including Flattop Chalcedony (n=88, 23.09%), followed by unidentified chert varieties (n=46, 12.07%), Alibates (n=42, 11.02%), Smoky Hill Jasper (n=36, 9.45%), Hartville chert (n=30, 7.87%), fossil wood (n=29, 7.61%), and various quartzites (n=28, 7.34%). These seven lithic materials account for nearly 78% of the entire Clovis sample. All other varieties listed in Table 15 each account for less than 5% of the study sample.

Folsom lithic materials are dominated by White River Group (Flattop) Chalcedony, (n=169, 30.51%), followed by fossil woods (n=84, 15.16%), Hartville chert (n=57, 10.29%), Trout Creek chert (n=53, 9.57%), unidentified chert varieties (n=42, 7.58%), Alibates (n=32, 5.77%), and various chalcedonies (n=30, 5.43%). These seven lithic materials account for 84.3% of the entire Folsom sample. All other lithic varieties listed in Table 15 each account for less than 5% of the study sample.

Lithic material type frequencies in the current Midland sample are dominated by Alibates (n=13, 35.14%). Similar to the Folsom dataset, White River Group (n=11, 29.73%) and fossil wood (n=5, 13.51%) each occur frequently. Hartville chert (n=2, 5.41%) and Smoky Hill Jasper (n=2, 5.41%) round out the most common Midland lithic material occurrences. These five lithic material types account for over 89% of the current Midland sample. All other lithic varieties listed in Table 15 each account for less than 5% of the study sample.

Table 15. Lithic material summary for Clovis, Folsom, and Midland artifacts.

	Clovis		**Folsom**		**Midland**	
Material Type	**Count**	**%**	**Count**	**%**	**Count**	**%**
Alibates	42	11.02	32	5.77	13	35.14
Basalt	9	2.36	2	0.36	0	0
Chalcedony (Various)	19	4.99	30	5.41	1	2.7
Edwards	6	1.57	17	3.07	1	2.7
Florence (Permian)	15	3.94	13	2.35	1	2.7
Fossil Wood	29	7.62	84	15.16	5	13.51
Hartville	30	7.87	57	10.29	2	5.41
Pennsylvanian	8	2.10	1	0.18	0	0
Quartzite (Various)	28	7.35	24	4.33	1	2.7
Smoky Hill Jasper	36	9.45	19	3.43	2	5.41
Trout Creek	4	1.05	52	9.57	0	0
White River Group	88	23.10	169	30.51	11	29.73
Other*	21	5.51	11	1.99	0	0
Unidentified	46	12.07	42	7.58	0	0
Total	**381**	**100**	**554**	**100**	**37**	**100**
* Other includes Burlington, Knife River, Kremmling/Troublesome, moss agate, Obsidian, Phosphoria, Porcellanite, Quartz Crystal, Reeds Spring, and Tongue River Silicified Sediment						

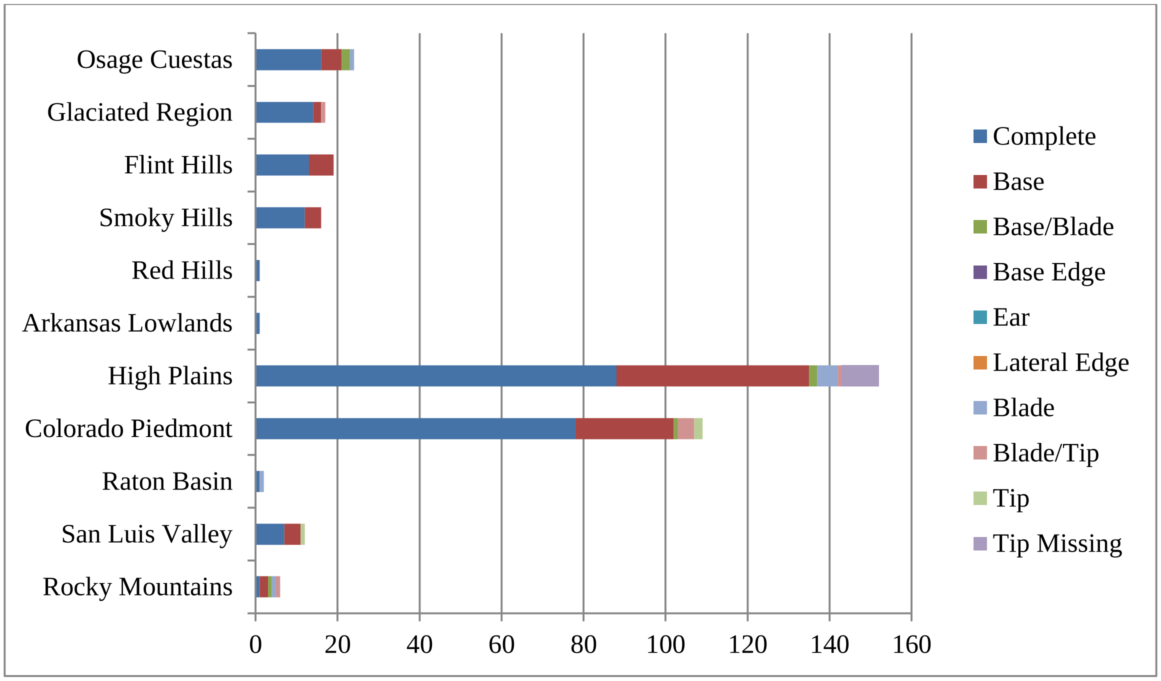

Figure 13. Distribution of Clovis projectile point fragments per physiographic region.

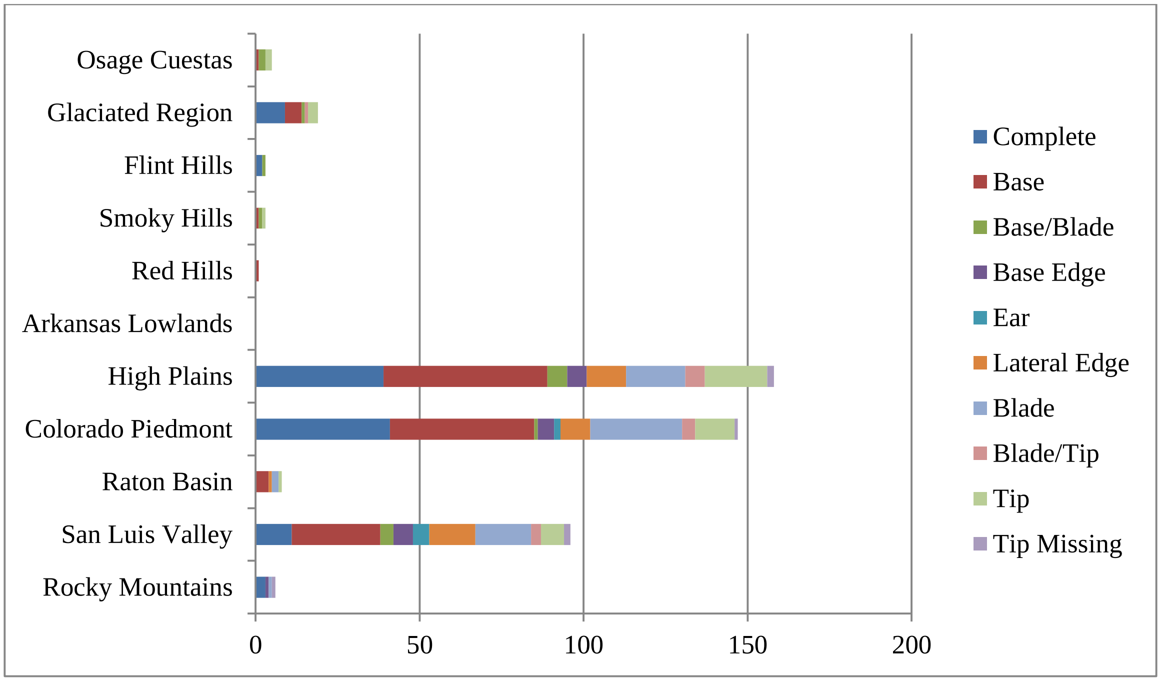

Figure 14. Distribution of Folsom projectile point fragments per physiographic region.

CHAPTER 8

TESTS AND RESULTS

This chapter explores distributions of Clovis, Folsom, and Midland artifacts at a variety of different analytical and spatial scales. Tests include frequency, ubiquity, and density analysis conducted at the county and state level, and by physiographic or subphysiographic region. The goal is to determine if Clovis, Folsom, and Midland artifacts are evenly distributed across the landscape, and whether they are similar in their distributions. Potential factors contributing to observed spatial patterning are addressed, including recording or collecting bias as well as site visibility and geomorphic filtering. The chapter closes with a discussion of lithic material distributions observed in the Clovis, Folsom, and Midland artifacts, and draws comparisons to artifact samples from the Cattle Guard and Lindenmeier sites.

FREQUENCY ANALYSIS

Frequency analysis refers to the actual number of recorded artifacts that occur within each county or area within the study region. Although Clovis and Folsom/Midland projectile points are often found in the same county, Clovis and Folsom artifacts are typically not found at the same site locations within counties, as demonstrated in Table 2. In fact, there are only four sites that contain buried Clovis and Folsom/Midland artifacts that are stratigraphically distinct, including Blackwater Draw, NM (Hester 1972), Jake Bluff, OK (Bement and Carter 2010), Gault, TX (Collins 2002, 2007, Waters et al. 2011), and Friedkin, TX (Jennings 2012; Waters et al. 2011), all of which are located to the south of the study area. This indicates different landscape use for particular regions between Clovis and Folsom groups. It is expected, based on the proposed land use models outlined in Chapter 4, that spatial distributions of Clovis and

Folsom artifacts will be patchy and uneven across the landscape as separate areas were presumably targeted with varying intensities and for different purposes.

When considered at the state level, Clovis, Folsom, and Midland artifacts all occur in greater numbers in Colorado than in Kansas (Figure 15). As discussed in Chapter 7, geomorphic filtering, collecting, and recording bias are eliminated at the state level as these variables affect each point style equally at this scale of analysis within each state (Jennings 2015). In Colorado, Folsom artifacts are recorded more than twice as often as Clovis artifacts. This is suspected to be a real occurrence as potential biases affect each projectile point style with equal vigor. This is also an expected pattern when viewed from the perspective of increasing population through time, as well as the longer duration of the Folsom period, resulting in increased tool production and discard, and subsequent recovery and incorporation into the archaeological record. However, this pattern is reversed within Kansas where Clovis artifacts are recovered and documented nearly twice as often as Folsom finds. This also is suspected to be a real pattern as bias alone cannot account for the observed discrepancy in Clovis and Folsom occurrences in Kansas. These observations are reflective, at least cursorily, of differential prehistoric land use.

To better visualize how Clovis, Folsom, and Midland artifacts are distributed across the landscape, it is necessary to look at spatial distributions at the county level and to correlate those counties to known physiographic or subphysiographic regions. Figures 16, 17, and 18 provide county-level distribution maps for Clovis, Folsom, and Midland projectile points and preforms. Figure 19 provides raw counts of recorded artifacts per each physiographic region for Clovis Folsom and Midland projectile points and preforms.

A number of noteworthy observations are apparent when viewing these distributions. First, Clovis projectile point and preform distributions are uneven and patchy throughout the study region with heavy concentrations clustered in a few specific counties. The heaviest concentrations of recorded Clovis artifacts within the study region are found in Logan, Saguache, Washington, Weld, and Yuma Counties, Colorado. These particular regions correspond to landscapes characterized by heavy erosion and deflation, little surface vegetation, and remarkable surface visibility. Specifically, Saguache County is located within the San Luis Valley, an area that has experienced thousands of years of aeolian deflation exacerbated in the northern portion of the valley by the incorporation of center pivot irrigation in the 1960's and the Closed Basin Project, started in the 1980's. The Closed Basin Project consists of a series of 170 wells within the northern portion of the valley that pump water out of the closed basin and into the Rio Grande River to the south for use of the water further downstream. According to local ranchers and artifact collectors I visited in this area, this has resulted in loss of surface vegetation on non-irrigated land in the northern portion of the valley, and increased erosion and deflation in the last 30 years.

In northeastern Colorado, Logan, Weld, and Washington Counties are intersected by the South Platte River, and most artifacts recorded from these counties have been recovered from stream gravel deposits within the South Platte and its tributaries. Yuma County is characterized by heavy surface erosion and blowout features as it is part of the Wray dune field. Collectors have long known the advantage of searching for artifacts in these particular locations and have specifically targeted these areas since at least the 1920's. The seemingly heavy artifact concentrations for these particular counties, therefore, are in part a product of collector intensity and subsequent artifact recording efforts, as well as geomorphic processes and modern ground surface conditions within these areas.

Geomorphic filtering also affects artifact distributions in Kansas. Particularly, there is an apparent gap in the Clovis record for central Kansas. This gap corresponds with the eastern Smoky Hills and western Flint Hills physiographic regions. As outlined in Chapter 2, these regions are characterized by heavy erosion on upland surfaces, often down to bedrock materials. Streams in this region are typically deeply incised and distinguished by the common occurrence of strath terraces. Soils of the correct age for containing Clovis artifacts are rare in this location, and typically deeply buried if present (Mandel 2008).

Folsom artifact distributions at the county level are similar to those observed for the Clovis sample with a few notable exceptions. In general, there are more recorded Folsom occurrences throughout Colorado than Kansas, with more Folsom artifacts recorded from Saguache and Logan counties alone than the entire state of Kansas. The distributions depicted in Figure 17 do not include the large artifact assemblages from the Lindenmeier and Cattle Guard sites, each of which contains more Folsom preforms and projectile points than the entire Kansas sample.

Similar to the Clovis dataset, the heaviest concentrations of Folsom artifacts are found in Saguache County in the San Luis Valley, and in northeastern Colorado within the Wray dune field (Yuma County) and South Platt River (Logan, Sedgwick, Washington, and Weld Counties). Most of Kansas, with the exception of extreme western Kansas and northeastern Kansas, is lacking in recorded Folsom points and preforms. This pattern in part is explained by the same geomorphic factors affecting the Clovis sample in central Kansas, but is expanded to include the southeastern third of the state where recorded Clovis discoveries are relatively common but Folsom occurrences are rare. Hofman (1994b) noted a similar pattern and suggested the lower frequency of Folsom artifacts documented from central and southeastern Kansas was likely a reflection of uneven research and reporting from these regions. However, the observed discrepancy has only been strengthened in the 20+ years since. This discrepancy cannot be explained by geomorphic filtering alone and suggests that Folsom people did not utilize these areas, particularly the Osage Cuestas physiographic region, with the same intensity as Clovis groups.

Midland projectile point distributions are confined to eastern Colorado and western Kansas, with a single occurrence recorded further east from Geary County in the Flint Hills (Figure 18). The heaviest concentrations of Midland projectile points are found in Yuma County, Colorado in the Wray dune field, in Logan County, Colorado from the South Platt River, and in Kearny County in southwestern Kansas where a series of four Midland base fragments are recorded. The artifacts included in the Kearny County sample are derived from dune fields associated with the Arkansas River, and may be from either Prowers County, Colorado, or Hamilton, Kearny, or Finney County Kansas. Due to the small sample size of the Midland data set, it is not possible to determine if geomorphic filtering is affecting the observed distributions.

Figure 19 displays the actual number of occurrences of Clovis, Folsom, or Midland projectile points, preforms, or channel flakes per each physiographic region. The majority of artifacts under consideration here were recorded from the Colorado Piedmont and the High Plains. From the High Plains and west to the Rocky Mountains, Folsom artifacts are more frequently encountered than Clovis or Midland artifacts. East of the High Plains, Clovis artifacts are more common, with the only exception found in northeastern Kansas. This corresponds with the Glaciated Region, and is the only physiographic region east of the High Plains where Folsom artifacts are more common in occurrence than Clovis projectile points or preforms. Two possible reasons for this observed pattern are noted here. First, this trend may reflect difficulties inherent in recognizing Clovis artifact fragments, as discussed in Chapter 7. Particularly, Dalton projectile points are a relatively common occurrence in eastern Kansas, and Clovis and Dalton projectile points can be difficult to differentiate morphologically when only the proximal portion of the projectile point is present (Goodyear 1982; Wetherhill 1995:29). This situation is exacerbated when the artifacts are recovered as isolates from secondary context in stream gravels, as is true for most of the documented artifacts in the study sample from the Glaciated Region. The Clovis sample may be underrepresented in this region because of reservations in classifying morphologically similar projectile point base fragments, which are not included here if they were not confidently assigned to Clovis. However, this reasoning applies to the Osage Cuestas region of eastern Kansas as well, and a very different pattern of Clovis and Folsom occurrences is found in this region, with Clovis artifacts recorded more often and in more locations. Alternatively, the pattern observed for the Glaciated Region may reflect targeted prehistoric utilization of an area rich in floral and faunal as well as chipped stone resources. If the latter is the case, it represents a unique circumstance for Folsom land use not observed elsewhere in Kansas. This pattern is addressed further when considering lithic material composition of the Clovis and Folsom datasets below.

UBIQUITY ANALYSIS

Ubiquity analysis is used to determine if each point style is evenly distributed throughout each physiographic region. Ubiquity analysis allows systematic standardized comparisons between counties and physiographic regions by allowing independent evaluation of each point style without heavy concentrations of one style affecting the results (Blackmar 2001:69; Popper 1988:60-61). Standardization is achieved by applying the same weight to occurrences of Clovis and Folsom artifacts by scoring each as present or absent per county or physiographic region regardless of the number of times each appears within a county or region. This eliminates heavy concentrations in single counties as is expected with an excavated site with high numbers of projectile points or the documentation of a single private collection obtained within the boundaries of a single county. A frequency score is then derived by calculating the number of counties in which a Clovis or Folsom projectile point or preform is present expressed as a percentage of the total number of counties within each physiographic region (Popper 1988:60-61).

Ubiquity analysis is conducted at a series of spatial scales here. At the state level, Folsom artifacts are the most widespread throughout Colorado, with nearly 60% of the 46 counties of Colorado included in this study containing at least one Folsom projectile point or preform (Figure 20). Clovis projectile points and preforms are documented from 50% of the Colorado counties included here, and Midland artifacts are recorded from fewer than 20%. In contrast, Clovis projectile points and preforms are more ubiquitous throughout Kansas than the documented Folsom artifacts. Clovis artifacts are recorded from 40% of the 105 counties in Kansas, and Folsom occurrences are documented from less than 30% of the Kansas counties. Midland artifacts are recorded from fewer than 4% of the counties in Kansas.

Ubiquity analysis at the state level does not provide much meaningful information regarding differential prehistoric land use intensity or potential biases affecting the observed distributions. However, it is supportive of the general trends observed in the frequency analysis where more artifacts are recorded in Colorado than Kansas, and are more ubiquitous in their overall distributions within Colorado. Folsom artifacts are the most widespread in Colorado, but Clovis artifacts are recorded more frequently throughout Kansas than Folsom points.

Several trends emerge when considering how widespread or ubiquitous Clovis and Folsom artifact occurrences are for each physiographic region. Figure 21 displays the percent of counties within each physiographic region that contain a Clovis or Folsom projectile point or preform. Midland artifacts are not considered in this analysis as the Midland artifact sample is very small. All Midland artifacts, with the exception of one projectile point from the Flint Hills and one projectile point from the Raton Basin are from the High Plains or Colorado Piedmont. Four Midland artifacts from the High Plains were found in dune fields associated with the Arkansas River.

In general, Folsom projectile points and preforms are more widespread to the west of the High Plains. This includes the Colorado Piedmont, the Raton Basin, the Rocky Mountains, and the San Luis Valley. Moving east of these regions, Clovis projectile points and preforms are more ubiquitous in occurrence. Even though Folsom artifacts are documented in greater numbers from the High Plains, they are restricted to fewer locations and are less widespread in their distribution within the High Plains. Clovis artifacts are more ubiquitous throughout the High Plains, the Smoky Hills, the Arkansas River Lowlands, the Flint Hills, and the Osage Cuestas. The only exception is found in the Glaciated Region of northeastern Kansas where Folsom occurrences are more frequent and more ubiquitous. It must be noted, however, that the number of counties within each region can influence these results.

DENSITY ANALYSIS

Frequency and ubiquity analysis do not standardize projectile point and preform occurrences to land mass area. This is important to consider as there are significant differences in size of counties and physiographic regions, as well as number of counties in regions within the study area. For example, when using frequency analysis, a very large county with 20 recorded artifacts will appear the same as a very small county with the same artifact count even though the artifacts are actually more common per land mass area within the smaller county. Calculations made here use densities per landmass rather than raw counts to control for county and physiographic region size and to standardize calculations. The total number of projectile points per county was converted to a projectile point density per county by dividing the number of points within a county by the total landmass. These numbers are expectedly small, so multiplying by 1000 arrives at a measure of projectile point occurrence per 1000 km^2 for each county (Prasciunas 2008:37). Densities are calculated in a similar fashion for each physiographic region as county designation and size is known. Clovis and Folsom artifact densities for each physiographic region are displayed in Figure 22.

Several trends emerge when examining Clovis and Folsom artifact densities within the study area. Most striking is that Folsom artifacts are abundant within the San Luis Valley, with 6.5 occurrences per 1000 km^2. This is over 6 times the occurrence of Clovis points documented for the same region. This discrepancy cannot be explained by collecting, recording, or geomorphic filtering bias, and suggests that the Folsom presence in the San Luis Valley was more intense than the Clovis utilization of this same area. Alternatively, if Clovis utilization *intensity* of the San Luis Valley was similar to that of Folsom groups, landscape *use* must have been different between the two. Clovis groups were not leaving behind as many projectile points and preforms as Folsom groups, suggesting separate perceived needs and agendas, if landscape utilization intensity is held constant.

Folsom points and preforms are also more common in the Colorado Piedmont, Raton Basin, and High Plains. Although Clovis projectile points and preforms are more widespread throughout the High Plains, as demonstrated through ubiquity analysis, they occur in fewer numbers than Folsom points and preforms, as shown through density and frequency analysis. Clovis artifacts are more abundant in the Smoky Hills, Flint Hills, and Osage Cuestas. Densities within the Rocky Mountains, Arkansas Lowlands, Red Hills, and Glaciated Region are relatively similar between the Clovis and Folsom sample.

LITHIC MATERIAL COMPOSITION AND DISTRIBUTION

This section briefly explores patterns in the lithic material composition and distribution of each lithic material type for Clovis, Folsom, and Midland artifacts. The primary lithic material types are summarized for the Clovis, Folsom, and Midland datasets in Chapter 7. Distributions of those lithic material are explored spatially here at the county level and by physiographic region. Comparisons are drawn between the observed patterns in the Folsom dataset to the artifact assemblages from the Lindenmeier and Cattle Guard sites. All calculations are represented as percentages. General patterns in lithic material distributions noted here are elaborated in Chapter 9.

Clovis Lithic Material Distributions

Figure 23 displays the percentage of lithic material types found in each county within the Clovis dataset. Several general patterns are apparent at this scale of analysis, and are sequentially addressed moving from west to east. First, Clovis artifacts from the San Luis Valley and immediately north (Rio Grande, Saguache, and Chaffee Counties) are typically produced of various chalcedonies, quartzites, and Trout Creek chert. Clovis artifacts recorded from central Colorado are mostly produced of White River Group Chalcedony, primarily from the Flattop source area. Hartville chert is most common in extreme northern Colorado, but extends, in small quantity, as far south as Crowley County, Colorado. Southeastern Colorado exhibits a mixture of fossil woods including Black Forest, Alibates, Edwards, and various quartzites. Alibates and various quartzites become more prevalent in the Clovis sample in western Kansas. East of the central Kansas data gap, Clovis lithic material types change markedly. Smoky Hill Jasper and Florence cherts from the Flint Hills become predominant lithic materials in several counties. However, this pattern changes quickly immediately to the east where unidentified varieties of chert, Mississippian-age cherts from the Ozarks, and Pennsylvanian-age cherts are more common.

Figure 24 displays the Clovis percentage of lithic materials found within each physiographic region. The purpose is to elucidate if the general patterns observed at the county level change when those counties are incorporated into associated physiographic regions. As county boundaries are arbitrary and irrelevant reflections of prehistoric behavior and land use, it is argued that distributions observed within physiographic regions may better represent landscape characteristics that influenced prehistoric use of those regions. Analysis at this scale also serves to enhance or mask particular patterns observed at the county level by increasing artifact sample size for each region.

Interpretation of lithic material patterning does not change at this larger scale of analysis for the San Luis Valley and the Rocky Mountains. Trout Creek chert, various chalcedonies and quartzites, and unidentified materials comprise the majority of those samples. East of the Rocky Mountains, some differences are noted that were not immediately apparent at the county level. First, the Colorado Piedmont sample is predominantly composed of White River Group chalcedony, followed by Hartville chert and Alibates. The relatively common occurrence of Alibates in the Colorado Piedmont was masked in the county level analysis. Further east, the predominance of White River Group chalcedony in the High Plains is more evident at this scale of analysis. Also, the presence of Smoky Hill Jasper as well as Alibates are better expressed. One of the most striking differences is the abundance of White River Group in the Smoky Hills sample, which was not apparent in the county level analysis. Smoky Hill Jasper is also the primary material Clovis artifacts are produced of from this region. Smoky Hill Jasper is common in the Flint Hills Clovis dataset, but does not move east of this region into the Osage Cuestas or north into the Glaciated Region. Instead, these areas contain more Permian (Florence) and Pennsylvanian age cherts, Mississippian-age cherts from the Ozarks, as well as unidentified materials. White River Group, although expressed minimally, is found in the eastern Kansas Clovis sample as well.

Folsom Lithic Material Distributions

Figure 25 displays the percentage of lithic material types found in each county within the Folsom dataset. Observed patterns are sequentially addressed moving from west to east. Folsom artifacts from counties within the San Luis Valley are predominantly produced of Trout Creek chert. Alibates has a greater expression within these counties than observed for the Clovis sample. White River Group, primarily Flattop Chalcedony, and Hartville chert are the most common materials from counties in northern Colorado. This pattern is similar to that noted for the Clovis sample, but is better expressed and more homogenous within the Folsom dataset. Counties from central Colorado are dominated by fossil woods, primarily Black Forest wood which is local to this region. This pattern was not observed in the Clovis sample.

The western Kansas Folsom dataset is primarily comprised of Alibates, Smoky Hill Jasper, Edwards chert, and quartzite. Unlike the Clovis dataset where White River Group is found in extreme eastern Kansas, the same material in the Folsom sample is not found east of Decatur County in northwestern Kansas. Also, the expression of Smoky Hill Jasper observed in east central Kansas in the Clovis sample is not represented in the Folsom dataset. Instead, this material is primarily found further west in the Folsom sample. Florence and unidentified cherts dominate the sample from northeastern Kansas, and the presence of Pennsylvanian cherts common in the Clovis dataset is not noted.

Figure 26 displays the Folsom lithic material composition for each physiographic region. Similar to the pattern noted at the county level, the San Luis Valley sample is dominated by Trout Creek chert. Alibates, quartzites, fossil wood, and unidentified materials are also common in the San Luis Valley sample. The Colorado Piedmont sample is predominantly White River Group chalcedony, fossil wood, and Hartville chert. On the High Plains, White River Group chalcedony is also the predominant material, followed by fossil wood. Other materials, including Alibates, Hartville, and Smoky Hill Jasper appear in similar quantities in the High Plains. East of the High Plains, the lithic composition of the Folsom dataset changes drastically. Primarily, the Smoky Hills, Flint Hills, Osage Cuestas, and Glaciated Region are dominated by Florence cherts and unidentified materials. White River Group Chalcedony does not occur in any of these areas, and Pennsylvanian cherts common in the Clovis sample are absent as well.

Lindenmeier Site Comparison

In a sample of 197 projectile points and preforms analyzed by Lassen (2013:226) from the Lindenmeier site, the most predominant lithic materials noted are chalcedonies, including Flattop chalcedony, and Hartville chert. This corroborates Robert’s (1935:18) observation that the most predominant chipped stone lithic material from the Lindenmeier site is chalcedony, followed by chert and jasper. The lithic composition observed in the Lindenmeier assemblage compares favorably to the recorded Folsom projectile points and preforms from private collections recovered in the same physiographic region, if the identification of White River Group/Flattop is correct (Holen suggests the material identified as Flattop from Lindenmeier may be Kremmling/Troublesome, personal communication 2015). Specifically, Folsom artifacts in the study sample from the Colorado Piedmont, within which the Lindenmeier site is situated on the extreme western fringe, are dominated by White River Group chalcedony, primarily from the Flattop source, followed by Hartville chert. This pattern is most apparent in the northern Colorado counties of Larimer, Weld, Morgan, Logan, and Sedgwick. With the exception of the Larimer County artifacts, most other Folsom finds considered here are derived from stream gravel contexts in the South Platte River. Interestingly, the South Platte River appears to serve as a boundary to southern movement of Hartville chert as only three recorded Folsom artifacts produced of Hartville chert are found below this drainage: two projectile points from Elbert County, and one projectile point from Prowers County. South of the South Platte River, fossil wood, primarily Black Forest Wood, and White River Group, primarily Flattop chalcedony, dominate the Folsom artifacts recorded from the Colorado Piedmont.

Cattle Guard Site Comparison

The two most abundant tool stones within the chipped stone assemblage from the Cattle Guard site in the San Luis Valley are Black Forest wood and Trout Creek chert (Jodry 1999:86). Of the 211 projectile points, 49 preforms, and 276 channel flakes analyzed by Jodry (1999:103), 37.1% were produced of Back Forest wood, and 12.1% were produced of Trout Creek chert. For a detailed summary of all material types for projectile points, preforms, and channel flakes from the Cattle Guard site, see Table 22 in Jodry 1999:175.

Trout Creek chert dominates the Folsom artifacts recorded in private collections included in this analysis from the San Luis Valley. Trout Creek chert is prevalent at the Cattle Guard site, but Black Forest wood is the most common lithic material for production of projectile points, preforms, and channel flakes at this locality. Although Folsom artifacts produced of Black Forest wood are commonly noted in the private collections from the San Luis Valley analyzed here, it does not occur as frequently as Trout Creek chert. The relatively high proportion of unidentified materials in my sample from the San Luis Valley likely represent other lithic materials commonly found at the Cattle Guard site with which I was not familiar enough to confidently classify, including Cumbres chert, Chuska chalcedony, and Mosca chert.

An interesting pattern of lithic procurement is found throughout the San Luis Valley in the Folsom sample. Southern lithic materials, including Alibates and Edwards move into the valley, and materials found to the north and east, including Trout Creek chert and Black Forest wood move south into the San Luis Valley. Movement is almost exclusively north and south with the exception of Black Forest wood from the Palmer Divide area of Colorado, and a few Trout Creek artifacts that have been transported to the east of the Rocky Mountains. The Trout Creek source area is near the headwaters of the Arkansas River, suggesting movements along this drainage as a possible route of travel linking the San Luis Valley to the Colorado Piedmont. Artifacts produced of Alibates and Edwards could have traveled north along the Front Range of the Rocky Mountains, then west through the Arkansas River corridor into the San Luis Valley. It is possible these groups would be carrying Black Forest wood as well as Trout Creek chert as both source locations would be in proximity to such movements. Alternatively, Folsom groups may have traveled from the Alibates or Edwards source locations, north through the San Luis Valley, then east through the Arkansas River corridor out onto the Colorado Piedmont. Either of these movement patterns would represent a much longer distance of stone transport than if those materials were moved directly from the source areas to the locations they were discarded on the Colorado Piedmont or San Luis Valley.

Midland Lithic Material Distributions

Figure 27 displays the lithic composition and distribution of the Midland projectile points in the study sample. The sample size is small, but an apparent trend is noted. Alibates dominates the artifact sample except for in extreme northeastern Colorado where White River Group, Fossil Wood, Hartville, and Smoky Hill Jasper are present. The Midland projectile point recorded from eastern Kansas is produced of Florence, which is similar to the Folsom sample from this area.

Figure 28 shows the Midland lithic material composition for each physiographic region. At this larger scale of analysis, the distribution of Alibates, although still the dominant material, is somewhat masked by White River Group and fossil wood in the Colorado Piedmont and High Plains. This trend is similar to that observed for the Folsom sample. The single projectile point from the Flint Hills is produced of local Florence chert. Folsom artifacts from this area are characterized by Florence chert as well.

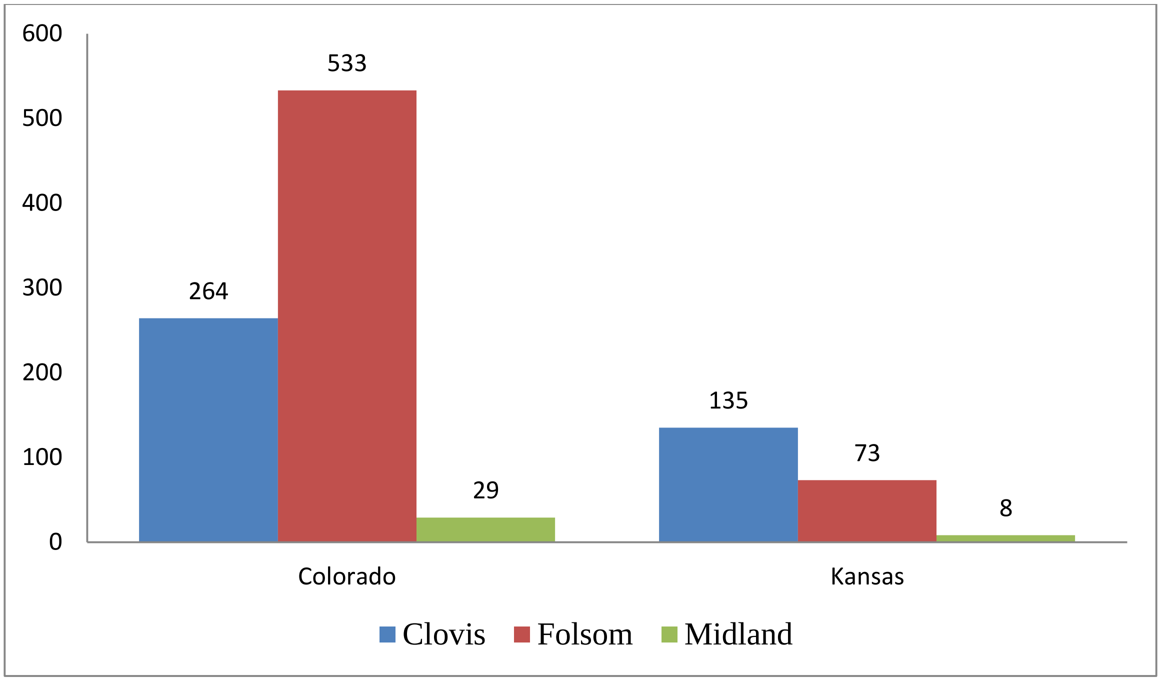

Figure 15. Numbers of Clovis, Folsom, and Midland artifacts from Colorado and Kansas.

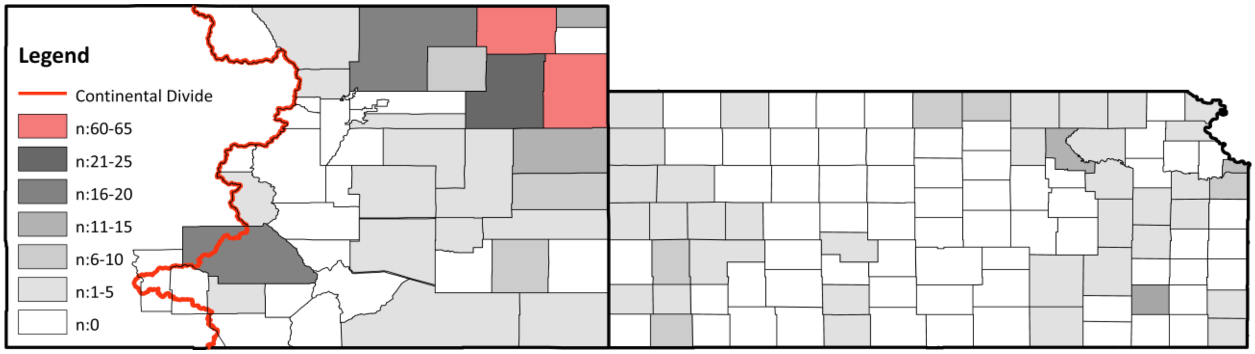

Figure 16. Clovis projectile point and preform distribution by county. Total sample consists of 399 artifacts.

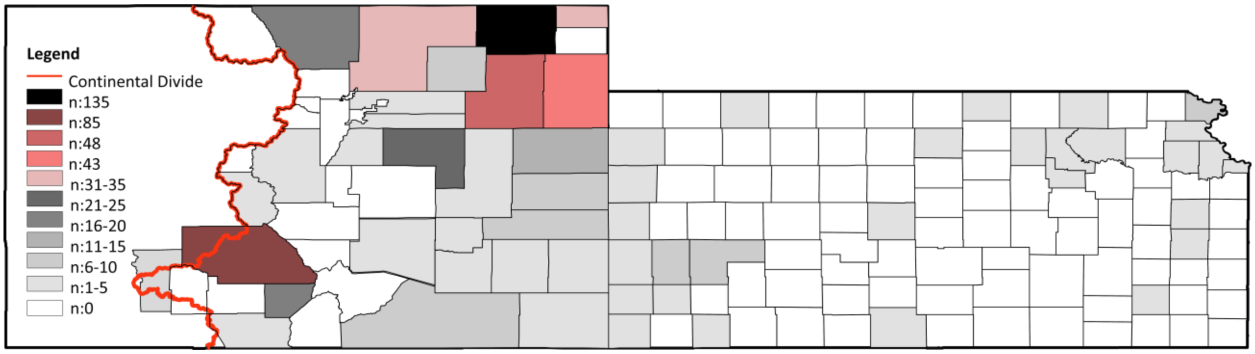

Figure 17. Folsom projectile point and preform distribution by county. Total sample consists of 606 artifacts.

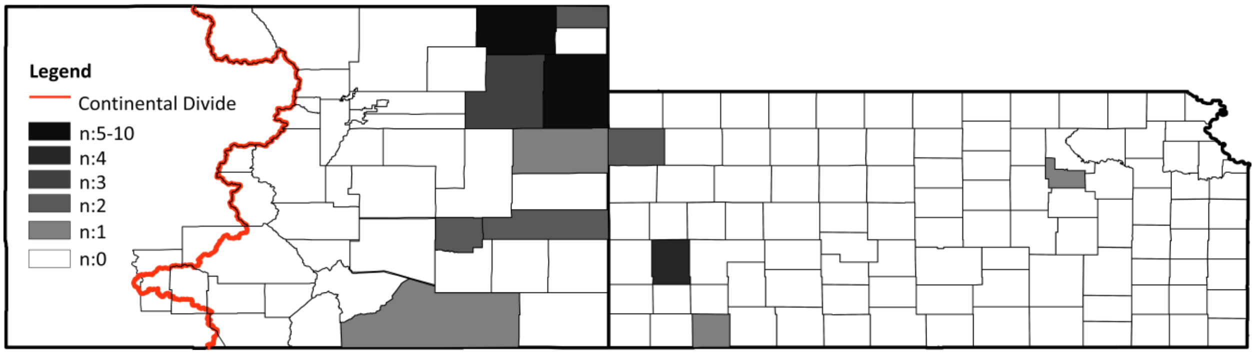

Figure 18. Midland projectile point distribution by county. Total sample consists of 37 artifacts.

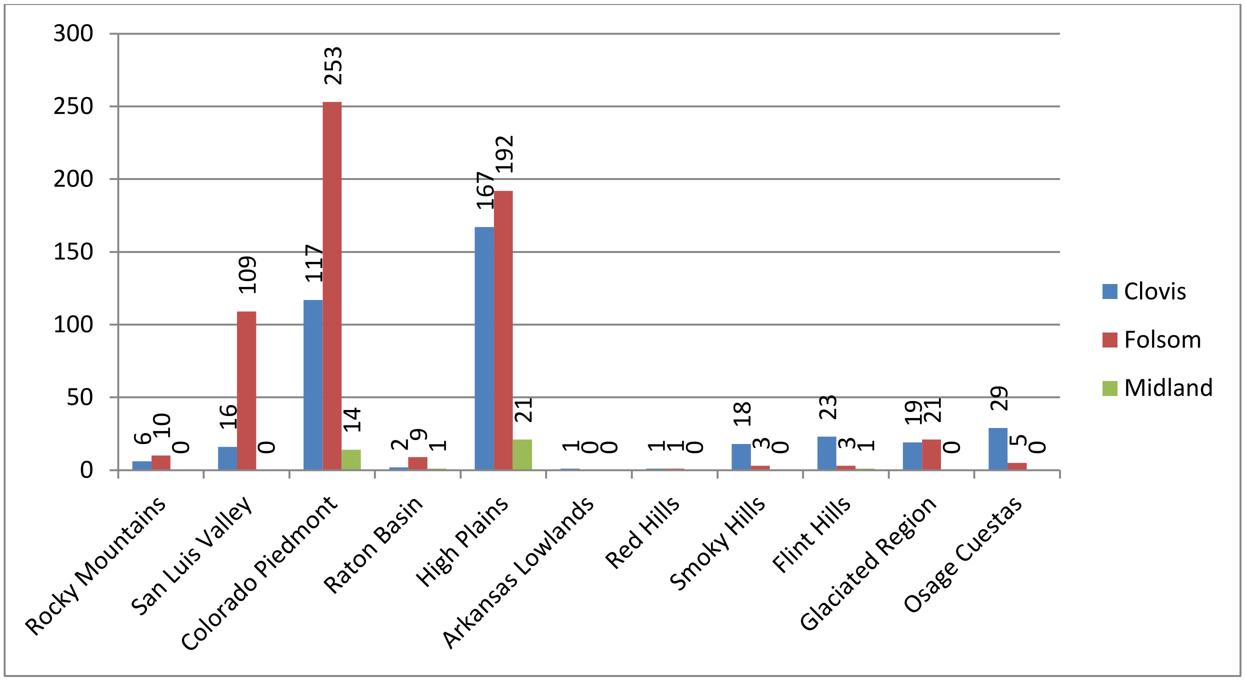

Figure 19. Number of projectile points, preforms, and channel flakes recorded for each physiographic region.

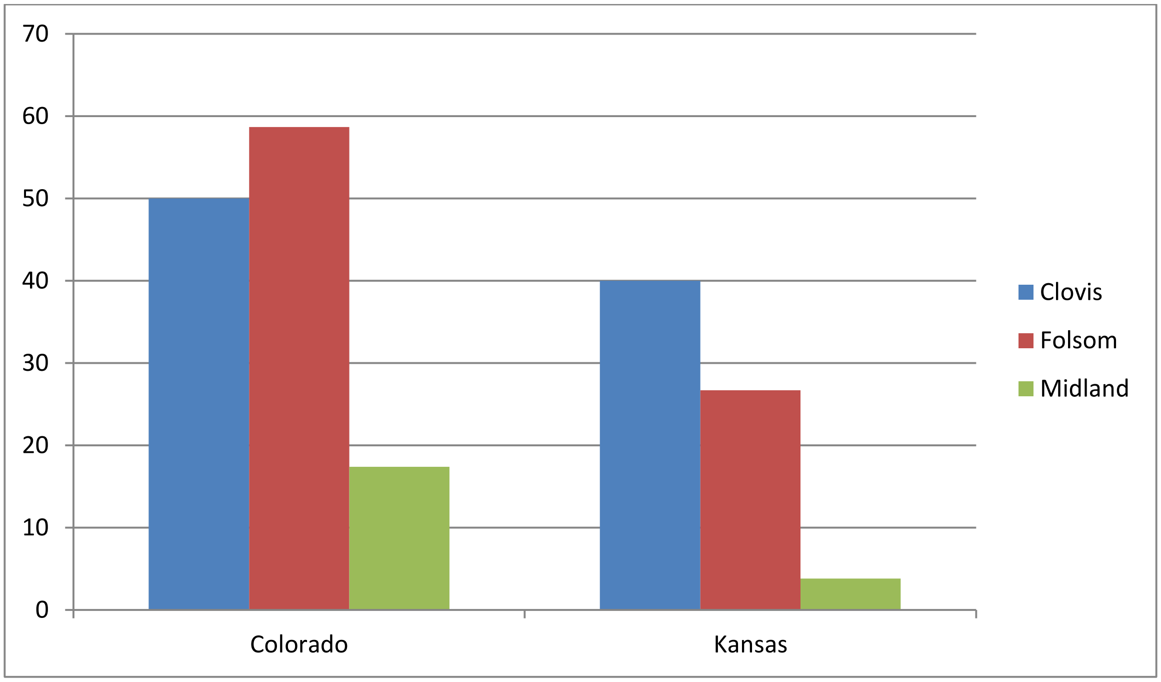

Figure 20. State level ubiquity. Figure depicts percentage of counties within each state within the study area that contain a Clovis, Folsom, or Midland projectile point or preform.

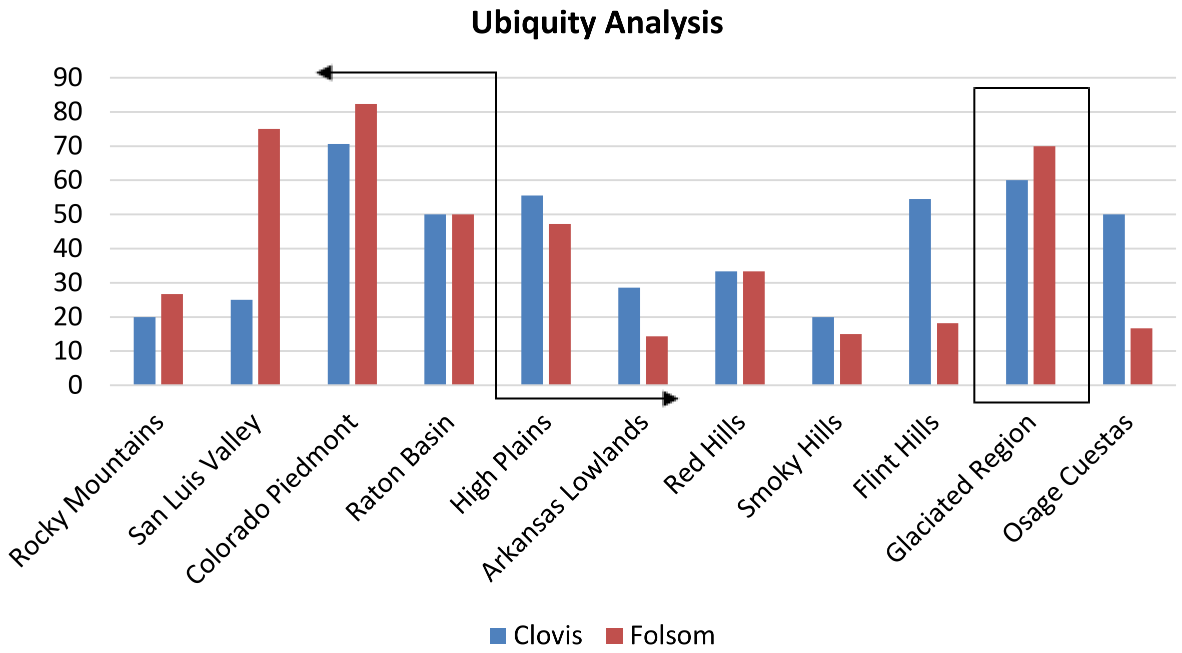

Figure 21. Ubiquity analysis for each physiographic region containing a Clovis or Folsom projectile point or preform. Figure depicts the percentage of counties within each region where at least one Clovis or Folsom projectile point or preform is recorded. Folsom artifacts are more widespread west of the High Plains whereas Clovis artifacts, with the exception of the Glaciated Region, are more ubiquitous east of this region.

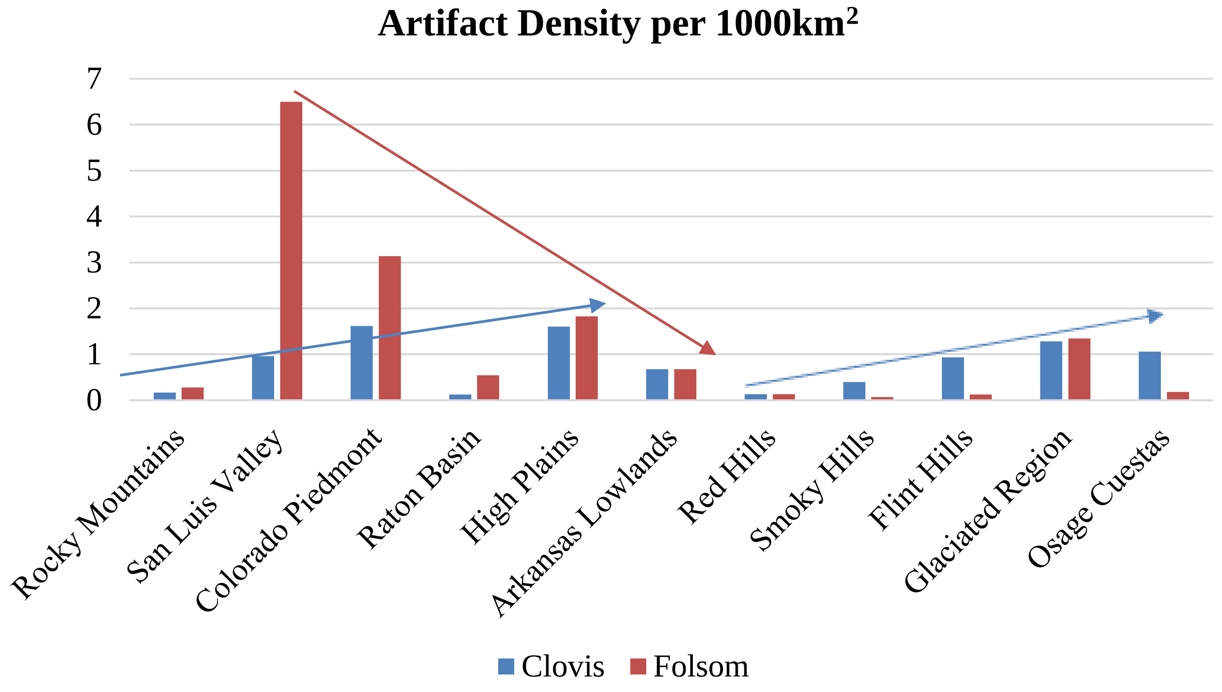

Figure 22. Artifact density per $1000km^2$ for each physiographic region. In general, Folsom artifact density decreases from west to east and dramatically falls off east of the High Plains with the exception of the Glaciated Region. Clovis densities are bimodal in that they increase from west to east until hitting the central Kansas gap discussed in the frequency analysis. They then increase again east of this gap.

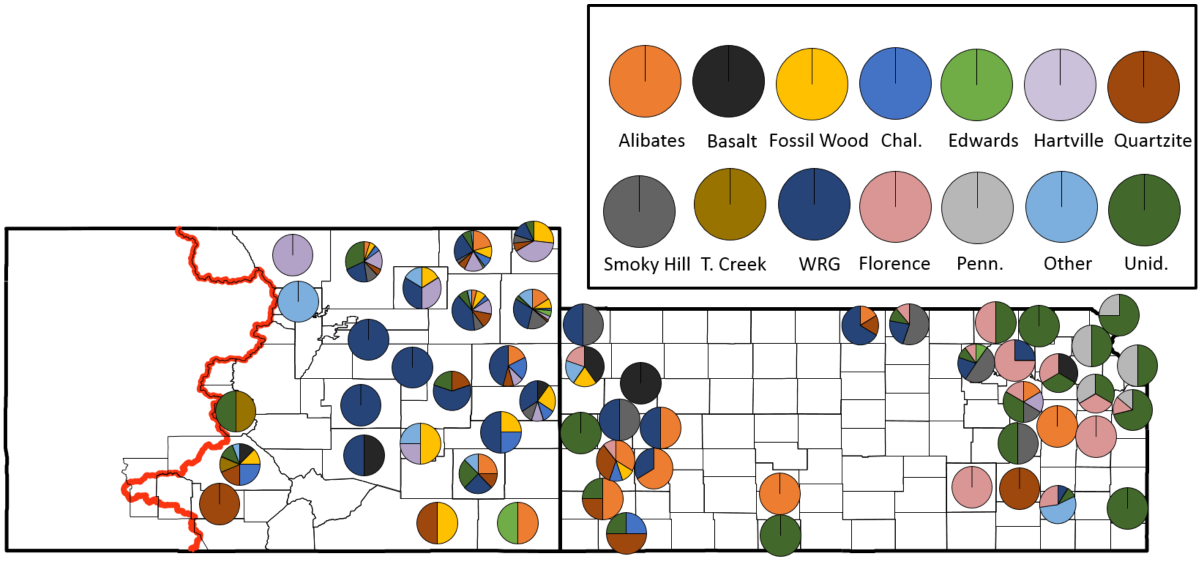

Figure 23. Percentage of Clovis lithic material types by county of occurrence.

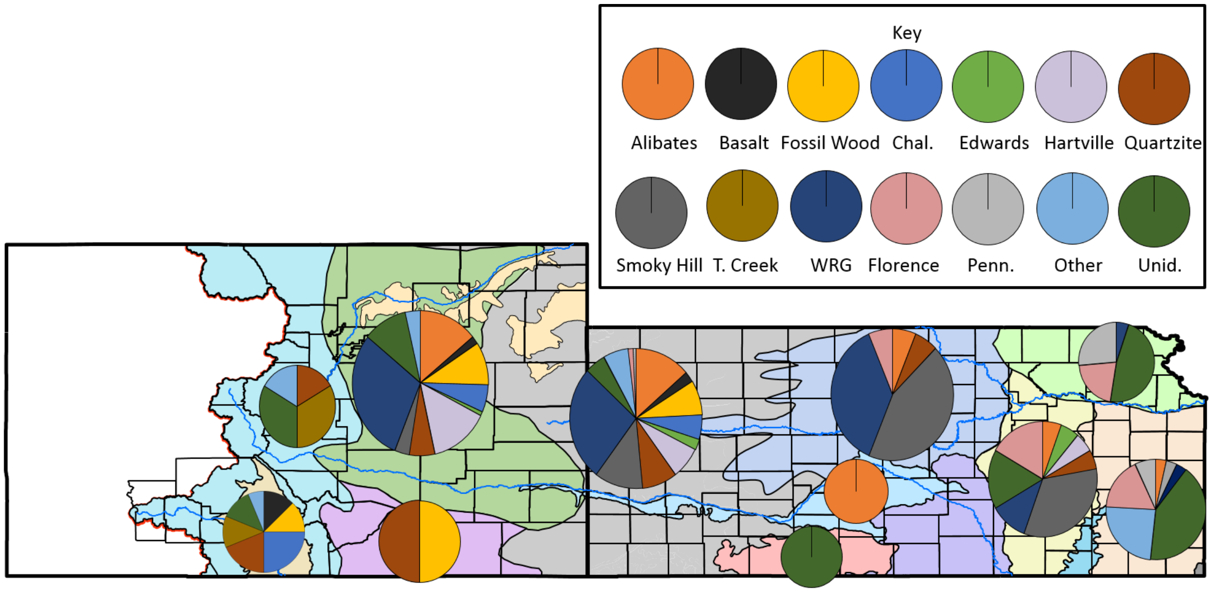

Figure 24. Clovis lithic material distribution by physiographic region.

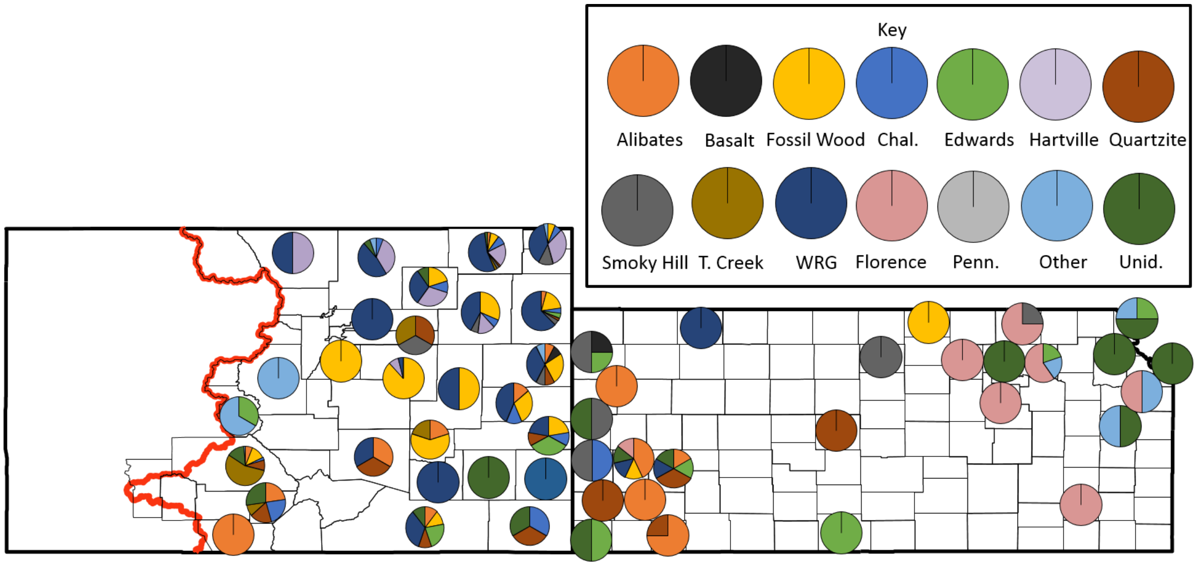

Figure 25. Percentage of Folsom lithic material types by county of occurrence.

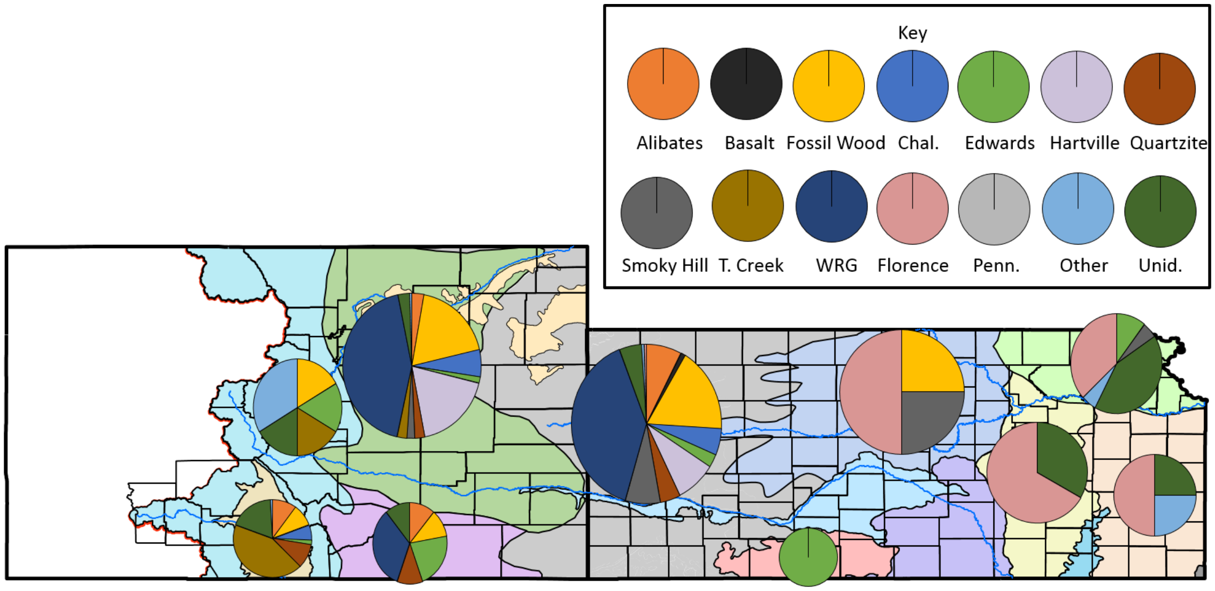

Figure 26. Folsom lithic material distribution by physiographic region.

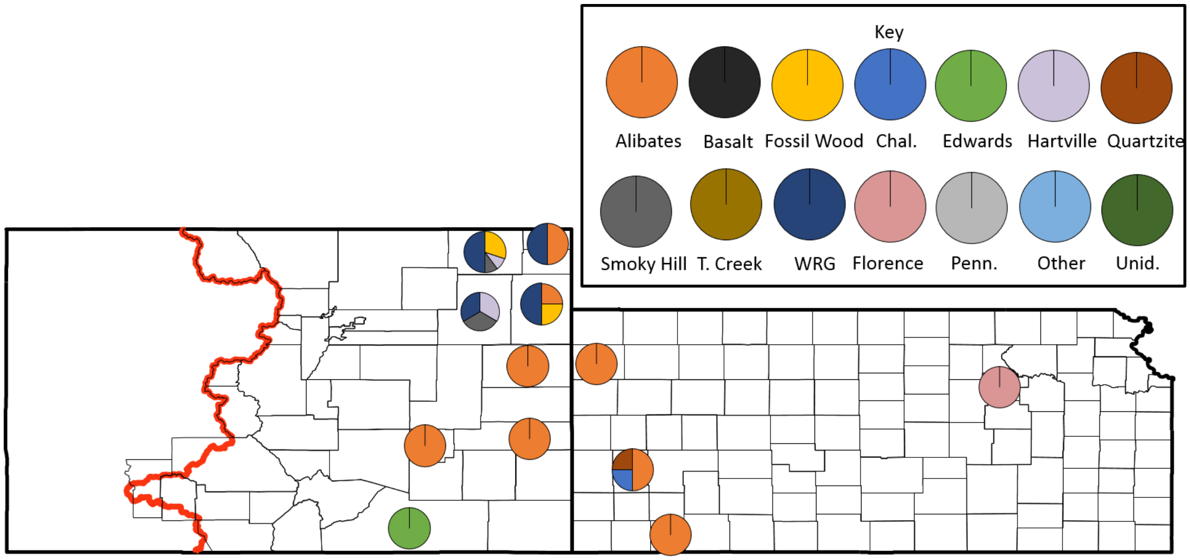

Figure 27. Midland projectile point lithic material distribution by county.

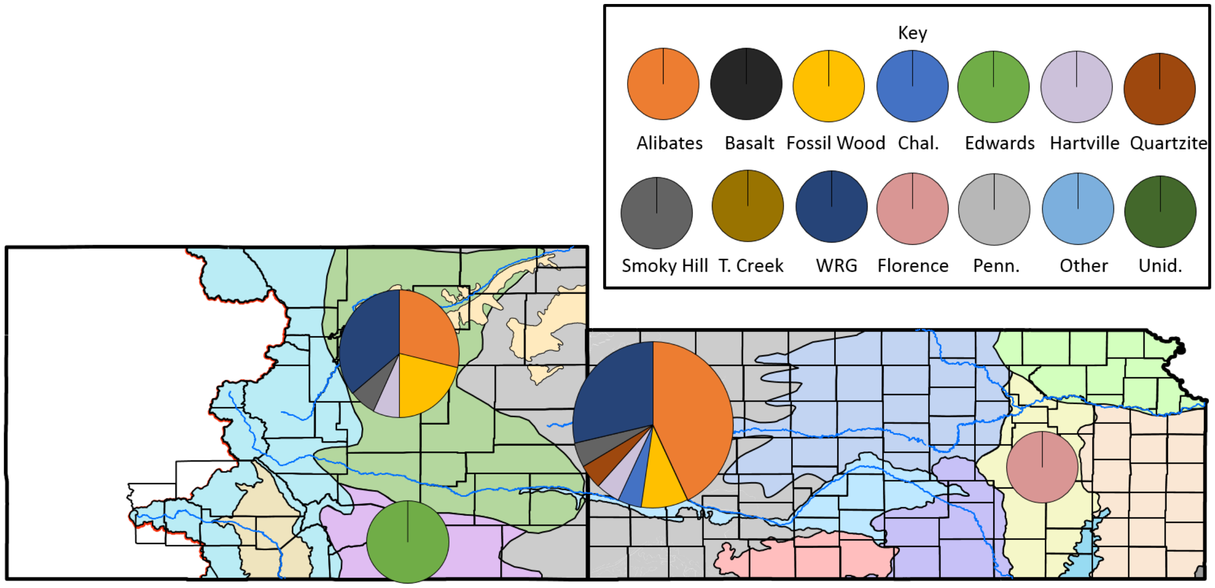

Figure 28. Midland lithic material distribution by physiographic region.

CHAPTER 9

EXPLORATION AND INTERPRETATION OF ARTIFACT DISTRIBUTION PATTERNS

This chapter explores potential factors driving the uneven distributions of Clovis, Folsom, and Midland artifacts across the study area as outlined in Chapter 8. Factors influencing differential land use are addressed in terms of distinct prehistoric use of landscapes between Clovis and Folsom/Midland groups, and modern biases that may be affecting the observed distributions are considered. Each physiographic region is sequentially addressed moving from west to east. Differential use of lithic materials between Clovis, Folsom, and Midland groups is discussed and correlated with the proposed Clovis and Folsom land use models.

The Southern Rocky Mountains

As discussed in Chapter 2, a wide variety of mobile and stationary resources would have been available to prehistoric occupants in the Rocky Mountains. However, Clovis and Folsom artifact occurrences are rare in high elevation settings (2,400 m or higher), and no Midland points are recorded in the sample from the study area. It is likely that the lower frequency of sites recorded in the high elevation mountain settings is a product of site visibility, archaeological research intensity, and differential exposure of sites through erosional factors that have more readily uncovered artifacts in the Colorado Piedmont and High Plains to the east. The alternative scenario is that these regions may have only been passed over or utilized for specialized purposes during Clovis and Folsom times, leaving only a cursory archaeological signature. Shortly after the Folsom interval, there appears to be a mountain-based Paleoindian tradition (Benedict 1992; Brunswig 2001; Husted 1969, 1974; Pitblado 2003; Pitblado and Brunswig 2007:64). By 10,000 RCYBP, a hunting and gathering adaptation to mountain environments was flourishing in the

Rocky Mountains, with deer, antelope, bighorn sheep, rodents, rabbits, reptiles, fish, and to a lesser degree bison being utilized (Benedict 1992; Black 1991; Pitblado 2003:9). Soon after, house pits, extensive drive lines, and game blinds are found in high elevation settings. Evidence for Folsom habitation structures at the Mountaineer site in the Gunnison Basin (Andrews 2010; Morgan 2015; Stiger 2006) to the west of the study area is supportive of extensive use of intermontane basins by Folsom groups, as well as the heavy concentration of Folsom materials from the Middle Park area, including Barger Gulch and Upper Twin Mountain (Kornfeld 1998, 2002; Kornfeld and Frison 2000; Kornfeld et al. 1999; Naze 1986, 1994; Surovell and Waguespack 2007; Surovell et al. 2001; Surovell et al. 2005). However, sites recorded outside of basins and valleys are rather ephemeral, as suggested by the modest artifact assemblages from the high elevation Black Mountain and Black Dump sites (Jodry 1993; Jodry et al. 1996; Prasciunas and Denoyer 2005).

Of the six Clovis projectile points recorded from high elevation mountain settings, two are produced of Trout Creek chert from the Sawatch Range near Buena Vista, Colorado (Black 2000, 2011), two are produced of unknown materials, one is produced of Troublesome, or Kremmling chert from the Middle Park area of the Rocky Mountains (Black 2000:134; Kornfeld, Frison, and White 2001; Surovell et al. 2001), and one is manufactured from a red quartzite, the source of which is unknown, but possibly local (Figure 29). In essence, all recorded Clovis artifacts from high elevation mountain settings considered here are produced of materials that have been transported less than 100 km or are locally available. However, the presence of lithic materials from west of the Rocky Mountains in the Mahaffy Clovis cache from Boulder County, Colorado is evidence of prehistoric movement of these materials considerable distance over high elevation settings during Clovis times (Bamforth 2014).

Of the ten Folsom artifacts from high elevation mountain settings, four are produced of unknown materials, two are produced of Troublesome chert, and one each are manufactured from Trout Creek, Black Forest wood, Edwards chert, and a clear dendritic chalcedony colloquially termed moss agate (Figure 30). A wider range of lithic materials is found in the Folsom sample from this region, with local and nonlocal materials represented. This is in contrast with the Clovis sample from this region where primarily local materials are present. Of the nonlocal materials present in the Folsom sample, all originate east of the Rocky Mountains, specifically from east-central Wyoming, east-central Colorado, and central Texas. Surprisingly, no Folsom quartzite artifacts are recorded for this region as quartzite is the most prevalent lithic material at the Mountaineer site west of the study area in the Gunnison Basin (Andrews 2010; Morgan 2015).

Intermontane Basins

Intermontane basins and parklands are unique in that environmental conditions are reflective of those found on the Colorado Piedmont and High Plains to the east, yet most intermontane basins contain sufficient resources to support year-long occupation and despite high elevations possibly served as wintering-over locations for prehistoric groups. The high frequency of Clovis and Folsom sites within these regions attests to intensive utilization, as exemplified by the San Luis Valley, raising the possibility that a mountain adapted way of life may have flourished within these valleys concurrent with the Plains adaptation further to the east. However, the higher frequency of artifact discoveries within these valleys must also be considered from a geomorphic standpoint. Site visibility is considerably increased within the San Luis Valley where wind deflation and erosion characterize the landscape. The higher frequency of recorded artifacts from this region is in part a product of site visibility, collector activity, and subsequent artifact recording efforts within these areas. These issues affect Clovis, Folsom, and Midland occurrences equally, and yet there is considerable variation in the frequency of these artifact types found within the San Luis Valley, as demonstrated in Figure 20. Particularly, as discussed in Chapter 8, Folsom artifacts are well represented within this region, suggesting differential land use between Clovis and Folsom groups for this particular region.

Lithic materials are also represented in different proportions between the Clovis and Folsom datasets within the study sample. Clovis artifacts are primarily produced of local materials within the San Luis Valley, reflective of the general pattern noted for the surrounding high elevation mountain settings. Specifically, the Clovis artifacts considered here are produced of various quartzites, chalcedonies, and basalts that are local to the San Luis Valley area, as well as Trout Creek chert found around 100-120 km to the north of the San Luis Valley (Figure 31). The fossil wood artifacts within the Clovis sample do not definitively resemble Black Forest wood, and are possibly produced from local cobbles which are common in glaciofluvial gravels in the northwestern portion of the San Luis Valley (Jodry 1999:88). A single Clovis projectile point produced of quartz crystal is also noted in the San Luis Valley sample.

In contrast, the Folsom artifacts from the same region are predominately produced of Trout Creek chert (n=47; 43.1%), but also contain various fossil woods, two of which are identified as Black Forest wood from the Colorado Piedmont. Alibates (n=9; 8.3%) and Edwards chert (n=2; 1.8%) from Texas are also present in the San Luis Valley Folsom sample (Figure 32). Folsom tool stone movement within the San Luis Valley appears to be oriented primarily north/south as discussed in Chapter 8, but incorporation of lithic materials from the northeast, east, and southeast is noted. Using Black Forest, Colorado as a proxy for the source area of Black Forest wood, these materials have been transported in excess of 170 km into the northern portion of the San Luis Valley. Alibates and Edwards chert have moved in excess of 425 km and 750 km respectively from the southeast (Jodry 1999:88-98). Jodry (1999) also notes the presence of Chuska chert at the Cattle Guard site. Chuska is found approximately 400 km to the southwest of the site in volcanic flows of the Chuska Mountains of the San Juan Basin near the New Mexico-Arizona border (Cameron 2001:83; LeTourneau 2000:459). This material was not identified in the current analysis because of unfamiliarity with the source. A single Folsom projectile point fragment produced of obsidian is also noted in the San Luis Valley sample, the source location of which is unknown.

In summary, Clovis artifacts from within the Rocky Mountains and intermontane basins are primarily produced of local or near local sources, with evidence for transportation of materials originating from the west moving across the Rocky Mountains. Folsom artifacts in the study sample are primarily produced of Trout Creek chert, but also exhibit material movements in excess of 750 km straight line distance from the southeast, and 170 km distance from the northeast. This suggests interaction and/or direct movement and lithic procurement between the open Plains to the east by Folsom groups, possibly on a seasonal basis as dictated by bison availability and the need for sheltered overwintering locations. The possibility of lithic material exchange with other Folsom groups occupying different regions cannot be ruled out. This pattern of lithic movement is not indicated by the locally derived Clovis sample.

The Foothill Belt

Similar to intermontane basins, the foothill belt offers a rich refugia that has been proposed as a seasonal habitation area during winter months by Folsom groups (Amick 1996). Amick’s work has focused on the southern Plains and Southwest, and suggests seasonal occupation of the foothills during cooler months when wood for fuel, bison for sustenance, and shelter from the more inhospitable High Plains winter conditions to the east would have been needed. Recorded Clovis and Folsom sites, however, are rare within the foothills of the study area, with only the Folsom-age Johnson site (Galloway 1961) and the Mahaffy Clovis cache (Bamforth 2014) located in or adjacent to the foothills of the Colorado Piedmont. The Johnson site artifacts are included as part of the Colorado Piedmont in this analysis rather than assignment to the Rocky Mountains. The current location of the chipped stone artifacts from the Johnson locality is unknown, and lithic material information is lacking. The site location suggests utilization of natural topographic features of the foothills to provide protection from the wind (Galloway 1961), and may be supportive of Amick's model.

The Mahaffy cache contains Clovis artifacts that have been moved considerable distance across the mountains from western sources. Specifically, artifacts in the Mahaffy cache are produced of Kremmling chert and quartzites from Middle Park, Colorado, Tiger or Bridger Basin chert from northwest Colorado or southwest Wyoming, and quartzite from the Uinta Mountains of northeastern Utah (Bamforth 2014:42-3). This last material has traveled in excess of 350 km straight line. This is a minimum distance due to difficulties associated with traversing the extreme topography of the Rocky Mountains. This is in contrast to the lithic material composition of the small Clovis sample from high elevation mountain settings which is comprised exclusively of local or near local materials.

The Raton Basin

The rugged landscape of the Raton section limits site visibility and has suppressed archaeological research efforts in this region (Meltzer 2006). The relatively small sample of Clovis and Folsom/Midland artifacts from this region is undoubtedly a reflection of geomorphic processes and modern surface conditions. However, Meltzer (2006:81-28) suggests the region held little appeal to prehistoric hunters during winter months when conditions were severe and inhospitable even to bison populations which likely did not overwinter in the area. Successful hunting for Folsom groups in the area was probably restricted between late Spring and early Fall when animal abundance and foraging opportunities were greater (Meltzer 2006:82). Meltzer (2006:82) suggests the region may have been "merely a way station en route to someplace else". This is an opposite pattern of land use than that modeled for the foothills by Amick (1996), in which the foothills were specifically targeted as overwintering locations.

Only two Clovis projectile points are recorded for the Raton Basin. One of these is produced of Black Forest wood from about 170 km to the north. Interestingly, this material is observed in the Clovis study sample east of the foothills of the Rocky Mountains, but is not definitively identified west of this boundary. The other Clovis point from this region is produced of a gray quartzite, the source of which is uncertain.

Nine Folsom artifacts, all projectile points, are recorded from the Raton Basin (Figure 33). Of these, three are produced of White River Group chalcedony, likely from the Flattop, Colorado source. Using Flattop Butte, Colorado as a source location proxy, this material has traveled around 400 km from the north. Two Folsom points are produced of Edwards chert from at least 630 km to the southeast. A single Midland point fragment is also identified as Edwards chert. One Folsom projectile point is produced of Alibates from some 295 km to the southeast. One projectile point is produced of Black Forest wood from ca. 190 km to the north, and one is produced of quartzite identified as Dakota Quartzite from southeastern Colorado, primarily Baca County where extensive outcrops of this material are found (Banks 1990:94). The remaining Folsom projectile point from the Raton basin is produced of an unidentified chert. All materials in the Folsom/Midland study sample from this region originate from the north, northeast, south, or southeast. No western lithic sources are identified, a pattern also observed for the Rocky Mountains. The wide variety in lithic materials in the Folsom sample, equally split between northern and southern sources, may be reflective of separate groups, possibly separated by many generations, and possibly representing separate Folsom territories or home ranges. Distinct Folsom groups may have passed through the area on seasonal bison hunting trips. Similar models of seasonal land use by Folsom groups have been proposed by Bement and Carter (2015) and Carlson and Bement (2013) on the Southern Plains to account for the presence of lithic materials from both northern and southern sources at a series of Folsom sites in northwestern Oklahoma. Importantly, various basalts and some quartzites are locally abundant from this region and yet Clovis and Folsom groups generally did not utilize these materials. All lithic materials observed, with the possible exception of the unidentified Folsom projectile point, derive from outside of the region, and cursorily support Meltzer's (2006:82) notion of the region as merely a passing through area on the way to some other intended target.

The Colorado Piedmont

Clovis and Folsom artifact samples from the Colorado Piedmont are considerably larger than those observed for the Rocky Mountains to the west and the Raton Basin to the south. There are more Folsom artifacts by raw count from the Colorado Piedmont than from any other physiographic region considered. The large number is driven by artifact collections from the South Platte River. Geomorphic factors, collector intensity and artifact recording efforts in this region all influence the observed distributions.

117 Clovis projectile points and preforms are recorded for the Colorado Piedmont (Figure 34). Of these, the most common lithic material is White River Group chalcedony (n=34; 29.1%), found ubiquitously throughout the region, but Clovis points of this material are more common

with proximity to the Flattop chalcedony source area in Logan County. This is in agreement with Clovis lithic procurement patterns observed by Holen (2001:136) for this region. The longest distance movement of this material within the Colorado Piedmont is recorded at around 330 km in Otero, County. No Clovis artifacts produced of White River Group chalcedony are documented further south within the Colorado sample, but a Clovis projectile point produced of this material is reported from the panhandle of Oklahoma, about 475 km from the source area (Hofman and Wyckoff 1991), and one Clovis projectile point from southeastern Kansas, a distance of ca. 750 km may be produced of a White River Group material, indicating it occasionally was transported well to the south and east of the source location (Hofman 2014). The rare documentation of this material so far south in the Clovis sample may be reflective of exchange rather than direct procurement.

Hartville cherts (n=17; 14.5%) are the second most common Clovis artifact material within the Colorado Piedmont. The longest distance movement of this material south from its source area in east-central Wyoming is also recorded in Otero, County, about 500 km from the source area. Most Clovis artifacts produced of this material are found in close proximity to the South Platte River of northeastern Colorado and north of this location, including one of the Clovis projectile points from the Dent site.

The relatively high occurrence of Alibates (n=16; 13.7%) within the Colorado Piedmont Clovis sample is in part a product of the Drake cache in Logan County where n=11 Clovis projectile points produced of this material were found around 590 km from the source location (Stanford and Jodry 1988; Stanford 1997). When these cache artifacts are not considered, the remaining sample consists of one projectile point from Weld County, two projectile points from Logan County, and two projectile points from the extreme southern edge of the Colorado

Piedmont in Bent County. The Bent County specimens have traveled about 275 km from the source area in the Texas panhandle. The only Clovis artifact produced of Edwards chert from the Colorado Piedmont region is also from the Drake cache, and has moved 975 km from the source area (Stanford and Jodry 1988; Stanford 1997). Holen (2001:138) questioned the anomalous nature of the Drake cache and determined it fits a broader pattern of Alibates movement into northeastern Colorado and surrounding areas. The cache contents, if not a burial offering, may be viewed as a stockpile of tool stone intended for retrieval but never recovered prehistorically. The four other Alibates examples from the region support the fact that Clovis groups were transporting and losing or discarding projectile points produced of Alibates within the Colorado Piedmont area, and transportation of this material by Clovis groups to locations far north of the source area is well documented (Holen 2001; Meltzer 1995). The lone Edwards occurrence is more perplexing. At about 975 km from the source location in central Texas, this artifact represents one of the longest documented movements of a lithic material in the Clovis study sample. If the Drake cache contents are reflective of common Clovis behaviors regarding stone procurement and transport, more artifacts produced of this material should be expected throughout the region.

Only six Clovis projectile points (5.1%) are produced of Black Forest or Elizabethan wood in the Colorado Piedmont sample. This number is seemingly low considering the source area for Black Forest wood is located on the Palmer Divide area of the Colorado Piedmont. Clovis groups apparently did not actively target this source as a primary material to produce projectile points. It is possible that the nature of the material, occurring primarily as lag deposits and secondarily redeposited alluvial gravels, was not preferred for manufacturing Clovis points, or the material may not have been widely accessible in Clovis time.

Four Clovis artifacts (3.4%), all from the South Platte River, have been identified as Smoky Hill Jasper. The farthest west movement of this material is found in Weld County, where two Clovis artifacts, a projectile point and preform are documented at about 300 km west of the source location in western Kansas and southwest Nebraska. The remaining two Smoky Hill Jasper Clovis artifacts are both from Logan County. Smoky Hill Jasper is more common in the Clovis sample from regions to the east, including the High Plains, Smoky Hills, and Flint Hills, but is rarely found in excess of 150 km from source locations (Holen 2001:137). This suggests that Smoky Hill Jasper use by Clovis groups was relatively localized, but examples from Oklahoma are noted (Hofman 1990).

Three Clovis artifacts, all from the South Platte River, and all from Logan County are produced of a clear chalcedony known as Holiday Springs chalcedony. The source location of this material is unknown but may be near Pawnee Buttes in Logan County (Kornfeld et al. 2007:261). If the source location is in Logan County as suggested, these artifacts are produced of local materials.

Also of note in the Clovis sample from the Colorado Piedmont are two projectile points produced of basalt, both from Pueblo County. Basalts occur in Tertiary-age gravels of eastern Colorado and western Kansas, and are common in the Raton Basin. It is uncertain from which source these particular artifacts are manufactured. A single Clovis point from Bent County is produced of obsidian. The source of this material is currently unknown. A single Clovis point produced of quartz crystal, also from an unknown source, is documented from Crowley County. One Clovis point each are produced of moss agate from east-central Wyoming, and phosphoria from the Big Horn Mountains of northern Wyoming. This material was also present at the Klein site in Weld County (Holen 2001:145-146; Zier et al. 1993). All other Clovis artifacts from the

Colorado Piedmont are produced of various chalcedonies, silicified woods, quartzites, and unidentified or unknown cherts whose source areas are not identified. Although some quartzites in the sample are identified to source locations, these classifications are subjective and problematic. I make no attempt here to differentiate between quartzite varieties as considerable variability and overlap is often encountered in these materials.

Folsom artifacts are common throughout the Colorado Piedmont, but most abundant in northern Colorado from the South Platte River. The Folsom Colorado Piedmont sample contains 253 artifacts (Figure 35). Of these, White River Group silicates dominate the sample (n=93; 36.8%). This material is found as Folsom artifacts throughout the Colorado Piedmont and south into the Raton Basin, further south in Colorado than observed for the Clovis sample. Most Folsom artifacts produced of White River Group chalcedony, however, are recorded from the South Platte River of northern Colorado. The farthest west Folsom artifact occurrence of this material is found on the western edge of the Colorado Piedmont in eastern Larimer County. It is not represented in the Rocky Mountains or San Luis Valley in the study sample.

The second most prevalent lithic material within the Folsom sample from the Colorado Piedmont is Hartville chert (n=39; 15.4%). This is similar to the observed Clovis lithic material composition. However, the restriction of this material to the South Platte River and areas to the north of this boundary is even more striking, with only two artifacts found below this line in Elbert County, approximately 340 km south of the source area. It is possible that Hartville chert was transported southeast down the North Platte River, then west up the South Platte River as Folsom artifacts produced of this material are common from these regions of Nebraska (Williams 2015).

The greatest discrepancy in lithic composition between the Clovis and Folsom datasets is found in Black Forest wood. There are n=32 (12.6%) Folsom artifacts produced of this material in the sample, making it the third most common material recorded in the Colorado Piedmont Folsom sample. This material is primarily confined in its distribution to the Palmer Divide area, but is also found in small portions to the west in the San Luis Valley, to the south in the Raton Basin, to the east in the High Plains, and north of the South Platte River. It is possible this discrepancy is related to the nature of the lithic material, and that secondary cobbles of this material in alluvial context are suitable for production of smaller Folsom points, but not suitable for production of the larger Clovis artifacts. Alternatively, Clovis and Folsom groups may have experienced differential access to this material due to different land use patterns and environmental circumstances.

Six Folsom artifacts (2.4%) are produced of Alibates flint. Of these, one channel flake, one preform, and two points have been reported from Logan County, about 600 km distant from the source location, indicating that this material was occasionally transported as preforms and fluted at considerable distances from the source by Folsom knappers. The remaining two Alibates artifacts are a preform documented from Pueblo County, and a projectile point from Crowley County. Only three Edwards chert Folsom artifacts are noted, all from Kiowa County, and about 775 km from the central Texas source area. This is a surprisingly low number considering the prevalence of this material used by Folsom people on the Southern Plains, and is likely a reflection of the extreme distance required for this material to travel from the source area. Utilization of this material by Folsom people on the Southern Plains drops off dramatically after ca. 400 km (c.f. Hofman 1992; 1999a).

Holiday Springs, the clear chalcedony whose source location is currently unknown but possibly in Logan County, Colorado, was also used by Folsom groups. Six artifacts (2.4%), representing three preforms, one of which is a snap tip, and three projectile points are recorded, all from Logan County. This is a similar pattern noted in the Clovis sample, suggesting that both Clovis and Folsom groups occasionally used this material, but did not transport it considerable distance from the source area.

The presence of five Folsom artifacts (2.0%) produced of Trout Creek chert is the only definitive evidence within the Folsom sample of a lithic material moving considerable distance east from a mountain source location. Interestingly, three of these artifacts are preforms. One preform is recorded from Arapaho County, a distance of about 130 km from the source location to the southwest. The South Platte River exits the mountains within 25 km from this find location, and likely would have served as an entry location and route of travel through the mountains. The second Trout Creek artifact from the Colorado Piedmont is a projectile point from Crowley County. This artifact has traveled about 210 km southeast from the source location. It is likely that the Arkansas River, located about 20 km south of this find location, served as a corridor of travel through the mountains as the headwaters of this river flow by the source area. The remaining Trout Creek artifacts, two preforms and one projectile point are from Logan County, a distance of about 340 km northeast of the source location. This is the longest recorded movement of this lithic material within the sample. The South Platte River can be followed from these find locations to South Park, Colorado within 40 km of the source location of Trout Creek chert. As discussed in Chapter 8, this material is the most common lithic source utilized in the San Luis Valley by Folsom groups, and along with Black Forest wood provides a link between Folsom groups using the Colorado Piedmont and high elevation valleys within the

Rocky Mountains. River corridors, whether traversing the South Platte or the Arkansas River, likely served as routes of travel between the source location of this material and the Colorado Piedmont.

Four Folsom artifacts (1.6%) produced of Smoky Hill Jasper are documented for the Colorado Piedmont. Of these, two projectile points and one channel flake are recorded for Logan County, and one projectile point is recorded in Arapaho County, at a distance of about 340 km west of the primary source areas of western Kansas and southwestern Nebraska. Hofman (1992) has noted the rare occurrence of Smoky Hill Jasper in Southern Plains Folsom sites, and it is apparent from this analysis that Smoky Hill Jasper was transported west in only small quantities by Folsom people. A similar pattern is noted in Nebraska where Folsom artifacts produced of Smoky Hill Jasper are rarely transported west of source locations (Williams 2015; Williams and Hofman 2010). However, the presence of one channel flake made of Smoky Hill Jasper in Logan County, Colorado indicates that this material may have been occasionally transported as preforms and fluted at distance from the source location. This supports the staging model of Folsom lithic reduction (Hofman 1992; Ingbar 1992) in which reduction is staged when distant from lithic source locations so that the carried tool stone supply has a relatively “controlled and anticipated life cycle within the mobility and activity strategy” (Ingbar 1992:187). Alternatively, it must be questioned if preforms are being transported and fluted at distance, or if fluting occurred elsewhere and channel flakes were occasionally being transported and discarded considerable distances from where the fluting activity took place. This question cannot be answered without a larger sample of artifacts and analysis at the assemblage level of specific sites. The remaining Folsom artifacts from the Colorado Piedmont are produced of various chalcedonies, quartzites and unidentified or unknown cherts, the sources of which cannot be adequately accounted for.

Midland projectile points are primarily documented from the High Plains and the Colorado Piedmont, with fourteen occurrences recorded for the Piedmont region. Of these, only three are complete projectile points. The remaining eleven are proximal fragments. Similar to the Folsom sample, the most prevalent material for Midland projectile points in the Colorado Piedmont is White River Group chalcedony (n=5; 35.7%). All five of these specimens are from Logan County near the source location of Flattop Chalcedony.

Interestingly, the next most common material Midland projectile points are produced of from this region is Alibates (n=4; 28.6%), all base fragments, and all documented from the southeastern portion of the Colorado Piedmont in Crowley and Kiowa Counties. This material has been transported about 340 km and 320 km respectively from the source area located to the southeast in the Texas panhandle. The prevalence of Midland projectile points in the Southern Plains is well documented (Hofman, Amick, and Rose 1990; Hofman and Graham 1998; Jennings 2012; Lassen 2013; Meltzer, Seebach, and Byerly 2006). The relative abundance of southern lithic materials present in the Midland sample may reflect a continuity between the Southern Plains adaptation and that observed in the southeastern portion of the Colorado Piedmont.

Black Forest wood is the next most common lithic material from which Midland projectile points in the Colorado Piedmont are produced (n=2; 14.3%), including a base fragment and a complete point from Logan County. An additional complete point, also from Logan County, is produced of an unidentified fossil wood. The use of Black Forest wood is in line with the observed materials used by Folsom groups within this region, but less reflective of Clovis behavior. This material has been transported about 230 km to the northeast from the source location. Interestingly, the complete Midland point produced of Black Forest wood may be manufactured on a channel flake, and would provide a supportive link between Folsom and Midland technology.

The remaining Midland artifacts from the Colorado Piedmont are a base and blade fragment from Logan County produced of Hartville chert, about 225 km southeast of the source area, and a base fragment produced of Smoky Hill Jasper, also from Logan County, about 200 km west of the source location. These two examples are somewhat anomalous in that Midland artifacts produced of these materials are rare within the sample, and the transportation direction of these materials, namely south and west respectively, is opposite that observed for the other Midland artifacts in the sample, which have primarily moved north and east from the lithic source locations.

The High Plains

As demonstrated in Chapter 8, Folsom artifacts are more numerous but less widespread than Clovis projectile points in the High Plains. 158 Clovis projectile points are considered in this study from the High Plains region (Figure 36), an area that is often characterized as a "region best passed through or used for specialized functions" (LaBelle 2005:24; Wheat 1972). This is the most recorded Clovis projectile points per physiographic region for all areas considered in this study. Of these, 43 (27.2%) are produced of White River Group silicates, the most prevalent material in the High Plains Clovis sample. White River Group is most abundantly expressed near the Flattop source area of northeastern Colorado, particularly in Washington and Yuma counties, but is also found in small quantities (n=5) in southwestern Kansas within the High Plains region.

Alibates is the second most common lithic material in the High Plains Clovis sample, with 22 (13.9%) occurrences. Spatially, Alibates is ubiquitous throughout southwestern Kansas, but is also well represented from upland settings in Yuma County, Colorado. This observation is in line with that observed for the Drake cache to the west in the Colorado Piedmont, and supports the notion that the cache may be a utilitarian stockpile. The Alibates Clovis distribution suggests a recurrent Clovis lithic procurement and transportation pattern rather than an anomalous occurrence for the Drake cache (Holen 2001). Alibates is also well represented in the Sailor-Helton cache from southwestern Kansas, but no projectile points or preforms are present in that assemblage (Mallouf 1994).

Smoky Hill Jasper is the next most common material by number of occurrence in the High Plains Clovis sample (n=19; 12.0%). This pattern is very different than that observed for the Colorado Piedmont to the west, where only four Smoky Hill Jasper Clovis artifacts are recorded. This is likely a reflection of proximity to source areas of Smoky Hill Jasper in northwestern Kansas and southwestern Nebraska. Caching of large bifaces and blades of this material during Clovis time has been documented in the Busse cache from northwestern Kansas (Hofman 1995a). Interestingly, Smoky Hill Jasper is not represented in southwestern Kansas and is not recorded south of Wichita County, Kansas in the sample, but Clovis artifacts produced of Smoky Hill Jasper have been reported from Oklahoma (Hofman 1990).

Hartville chert is relatively common in the High Plains Clovis sample (n=13; 8.2%), but is not as prevalent as noted for the Colorado Piedmont to the west. All Hartville occurrences are restricted to northeastern Colorado in the study sample, with no Clovis artifacts produced of Hartville chert documented from the High Plains of Kansas. These artifacts are split between upland and stream bed finds, with seven found in upland settings south of the South Platte River.

This is distinct from that observed for the Folsom sample to the west in the Colorado Piedmont where Folsom artifacts of this material are only rarely found south of the South Platte River.

Four Clovis artifacts each are produced of basalt, Black Forest wood, and Edwards chert. Basalts occur locally in tertiary-age gravels of eastern Colorado and western Kansas, and it is possible that these materials were locally derived. Black Forest wood is restricted to upland finds in Yuma County, Colorado (n=3), and a single projectile point from the South Platte River in Sedgwick County, Colorado. These artifacts have been transported 200 and 275 km respectively northeast from the source location. The distribution of Edwards chert is also restricted to Colorado, with three projectile points recorded from Yuma County, and a single projectile point recorded in Baca County in extreme southeastern Colorado. The Yuma County artifacts have been transported about 850 km from the source location in Texas.

Knife River Flint from west-central North Dakota is only present in the Clovis sample from the High Plains region, and consists of three Clovis artifacts (1.9%). Two of these artifacts from upland settings in Yuma County have been transported 800-825 km from the source location. The third artifact, a Clovis preform from Sherman County, Kansas, has moved in excess of 875 km to the south from the source area. Knife River Flint has been documented in excess of 1,500 km from the source location at the Bostrom Site in St. Clair County, Illinois, where this material was possibly transported south and east via the Missouri River (Tankersley 1995; Tankersley and Morrow 1993). No Folsom artifacts in the sample are produced of this material, although it was intensively utilized near the source location by Folsom groups (Root 1994, 2000; Root et al. 1999; William 2000). The few occurrences of long distance transportation of this material in the sample may be a product of trade or exchange rather than direct procurement (Holen 2001).

All other lithic materials in the Clovis sample from the High Plains that are identified to specific source locations include three or fewer projectile points, but some notable materials are present. Two projectile points are produced of Permian-age Florence chert from the Flint Hills region of east-central Kansas. This material, along with a single projectile point produced of Pennsylvanian chert from nearest source areas in extreme southeastern Nebraska or northeastern Kansas represent the rare long distance movement of materials that originate well to the east of the High Plains. The Pennsylvanian artifact has been transported in excess of 500 km from the nearest source area to Yuma County, Colorado, and is not reflective of the general trend for Clovis artifacts produced of this material to rarely move greater than 40 km from the source locations (Holen 2001:138).

Two Clovis projectile points from the High Plains are produced of phosphoria, and one each are produced of Holiday Springs chalcedony and porcellanite. The Holiday Springs example is the only occurrence of this material outside of the South Platte River and east of the Colorado Piedmont. The porcellanite source is unknown, but likely originated to the north and west of the Yuma County find location, perhaps in the Fort Union Formation of the Powder River Basin in Wyoming (Francis 1991:310; Francis and Larson 1996:87; Fredlund 1976:207-208; Miller 1991:466). Two Clovis artifacts produced of Tongue River Silicified Sediment from this formation are also present in the High Plains sample. However, this material is also found in secondary gravel deposits in the Pawnee Grassland area of northeastern Colorado (Holen 2001:145) and elsewhere (Ahler 1977), and may be confused with Dawson Formation welded tuff from the Colorado Springs area (c.f. Stielow and Lindsey 2014). It is uncertain what source is represented in the Clovis artifacts considered here.

There are 192 Folsom artifacts from the High Plains in the sample (Figure 37). In general, there is less variability in the Folsom artifact lithic materials from this region compared to the Clovis sample. White River Group silicates comprise the majority of the High Plains Folsom sample, with 73 (38.0%) occurrences of this material. This material, although most abundant in the Colorado Piedmont and High Plains, does not occur east of Decatur and Finney Counties, Kansas. These counties are about 370 km southeast of the source location. East of these counties, the Folsom lithic composition is markedly different and no chalcedonies of any variety are noted.

Hartville chert (n=16; 8.3%), Alibates (n=14; 7.3%), and Smoky Hill Jasper (n=13; 6.8%) are all proportionally similar in number of occurrences. However, the distribution of Hartville chert is restricted to Sedgwick and Washington Counties, Colorado, with no examples recorded south or east of these counties. Although Alibates is recorded as far north as Yuma County, Colorado, its primary distribution is confined to southwestern Kansas, and may reflect a regional pattern of use of this material for this region (Hofman 1994b). Smoky Hill Jasper is not found south of Hamilton County, Kansas in the study area, but a projectile point from the Cooper Folsom site in northwestern Oklahoma (Bement 1994), and a flake blank Folsom preform and endscraper from the Waugh site in northwestern Oklahoma (Hofman 2006) indicate this material was occasionally transported further south by Folsom people.

Various silicified woods (n=22; 11.5%), and 10 (5.2%) specifically identified to the Black Forest wood source location, reflects more intensive use of these materials by Folsom groups than Clovis people in the High Plains. These materials are mostly restricted to Colorado counties, the only exceptions being two Folsom projectile points, one each from Kearny County and Sherman County, Kansas. This indicates that although fossil wood use was common by

Folsom groups, these materials, and Black Forest wood in particular, were rarely moved considerable distances east of the source location.

Edwards chert is represented by 5 (2.6%) Folsom artifacts in the High Plains, all from upland settings. Unlike the fossil wood distributions in the High Plains Folsom sample, the majority of Edwards chert is documented from Kansas counties, including one each from Finney, Morton, and Sherman Counties. The remaining two Folsom projectile points are from Yuma County, Colorado.

All other Folsom artifact materials from the High Plains with known lithic sources include only one or two artifacts. These are two projectile points produced of basalt, likely from the locally derived Tertiary-age gravels of eastern Colorado and western Kansas. This is proportionally fewer artifacts produced of this material than observed for the Clovis sample from the same region. One Folsom projectile point is produced of Florence chert from the Flint Hills and one preform is manufactured from Holiday Springs chalcedony, the source of which is likely in Logan County, Colorado. This is a similar general pattern to that noted in the Clovis sample, with very few eastern sources moving west into the High Plains, and Holiday Springs rarely moving considerable distance east out of the Colorado Piedmont. A single Folsom projectile point from the South Platte River in Sedgwick County, Colorado is identified as Tongue River Silicified Sediment, which may derive from the secondary deposits of this material in the Pawnee Grassland area of northeastern Colorado. This material was also noted in the Clovis sample from this region. A final material worthy of mention is a single Folsom projectile point base produced of quartz crystal from Kit Carson County, Colorado. This material is more commonly observed in Clovis assemblages, and was rarely used by Folsom groups (c.f. Reher and Frison 1991).

The most Midland projectile points per physiographic region are also found in the High Plains (n=21). Although the sample is small, some very striking patterns emerge when examining the Midland sample lithic materials (Figure 38). Alibates is the predominant Midland projectile point material in the High Plains region (n=9; 42.9%). This is a similar trend to that noted for the Colorado Piedmont to the west where Alibates is well represented in the Midland sample. The proportionally high occurrence of Alibates in the Folsom and Midland study samples from southwestern Kansas is interesting from a regional perspective (Hofman 1994b). If Midland technology is a late Folsom expression, as is occasionally suggested based on relative stratigraphic relationships at sites such as Gault and Friedkin in Texas (Jennings 2012; Waters et al. 2011), then perhaps the seeming abundance of Midland projectile points produced of Alibates from the panhandle of Texas can be explained from a behavioral and environmental perspective. Particularly, Carlson and Bement (2013) suggest that bison migration patterns on the Southern Plains expand during the Folsom period. This idea is supported by stable isotope analysis and trace elements from the Beaver River Complex of Oklahoma, which suggest that bison herd movements increased from 100 km during Clovis time to over a 600 km migration diameter by the end of Folsom times (Graves 2010). Migrations of this diameter stretched into southwestern Kansas (Carlson and Bement 2013). If Midland projectile points are in fact a late Folsom development, then perhaps this regional pattern is a reflection of Folsom/Midland groups from the Southern Plains targeting these highly mobile bison populations on a seasonal basis towards the end of the Folsom interval.

The remaining Midland artifacts from the High Plains are similar to that observed in the Folsom sample. Particularly, White River Group chalcedonies account for six of the total sample, followed by silicified woods at two. The remaining Midland artifacts from known source locations are produced one each of Smoky Hill Jasper and Hartville chert.

Within the High Plains, Yuma and Sedgwick Counties, Colorado offer a unique opportunity to assess differential land use within the same physiographic region between upland settings and stream gravel context. Several patterns emerge when considering the Clovis and Folsom artifacts from these two counties. First, Folsom occurrences outnumber Clovis finds 35-15 from the South Platte River in Sedgwick County, Colorado. However, in the Wray dune field of Yuma County, Colorado, Clovis projectile points outnumber Folsom finds 61-48. A chi-square test demonstrates that this difference is statistically significant (Table 16). This is likely a reflection of different landscape use prehistorically, and supports the different land use models between Clovis and Folsom groups proposed in Chapter 4. Namely, Clovis groups targeted specific areas on the landscape, particularly playa lakes in upland settings. In contrast, Folsom groups primarily targeted a single mobile prey species that may have more readily congregated in river valley settings rather than upland settings as playa lakes were reduced in number by this time and water sources were isolated and restricted on upland surfaces. The different densities of artifacts from these two counties may also reflect targeting of riparian environments as camp localities and overwintering locations for Folsom groups. Between these two counties, there are no Clovis or Folsom/Midland artifacts recorded from Phillips County. This is a good example of the effects of geomorphic filtering, site visibility, and collector intensity on observed artifact distributions within the study area as Phillips County lacks suitable streambed gravels targeted by artifact collectors, and only has a small area of the Wray dune field that is better expressed to the south in Yuma County where blowouts and deflation are more prevalent. Phillips County is also a smaller county than neighboring Yuma and Sedgwick Counties.

Table 16. Chi-Square Test of Clovis and Folsom Artifact Occurrences in the South Platte River and Wray Dune Field. Values shown are actual number, (expected number), and [Chi-Square Statistic] for each cell. The result is significant at P<0.01.

	South Platte River	**Wray Dune Field**	**Marginal Row Totals**
Clovis	15 (23.9) [3.31]	61 (52.1) [1.5]	76
Folsom	35 (26.1) [3.03]	48 (56.9) [1.39]	83
Marginal Column Totals	50	109	159 (Grand Total)
Chi-Square Statistic 9.2602 **P Value .00234**			

The Arkansas Lowlands

Few Clovis and Folsom artifacts are reported from the Arkansas Lowlands. This low number of occurrences does not reflect the fact that several Clovis and Folsom/Midland artifacts have been found in dune formations associated with the Arkansas River in eastern Colorado and western Kansas. These specimens are included as High Plains artifacts in this analysis as they were found in upland settings rather than in stream gravel contexts. Only one artifact, a Clovis projectile point from Kiowa County, Kansas, is attributed to the Arkansas Lowlands in this analysis. This artifact is produced of Alibates and has been transported ca. 300 km from the source area in the Texas panhandle to the southwest.

The Red Hills

East of the High Plains, recorded Clovis and Folsom/Midland artifacts drop off dramatically. This corresponds with the “central Kansas gap” discussed in Chapter 8. Only two artifacts are recorded from the Red Hills region of southern Kansas. These include a single Clovis projectile point produced of an unknown material from Comanche County, Kansas, and a single Folsom projectile point base fragment produced of Edwards chert from the Vincent-Donovan site in Barber County (Ryan, Bruner, and Hofman 2004). It is likely that site visibility and the highly dissected nature of the terrain from this area as outlined in Chapter 2, as well as limited systematic archaeological fieldwork in this region contribute to the seemingly low number of recorded artifacts from the Red Hills.

The Smoky Hills

The Smoky Hills are the first physiographic region moving from the west within the study area where Clovis artifacts outnumber Folsom finds. Seventeen Clovis projectile points and a single preform are recorded from this region compared to only three Folsom projectile points. The predominant material of the Clovis artifacts is Smoky Hill Jasper (n=7; 41.2%) (Figure 39), and is locally available in several counties throughout the western Smoky Hills region. Six artifacts (35.3%) are produced of White River Group silicate, four of which are from the Eckles site area in Jewell County (Holen 1989, 2001, 2010), and have been transported about 450 km from the source area near Flattop Butte, Colorado. These two materials support the general observation that lithic materials in the Clovis sample from this region move primarily from the west to the east. The remaining materials observed in the Clovis sample are Alibates (n=1) which has moved about 570 km from the southwest, quartzite (n=1), likely from the Cretaceous-age Dakota formation, and unknown materials (n=2). A single projectile point produced of Permian-age Florence chert from the Flint Hills of Kansas is the only documented movement of a Clovis artifact produced of lithic materials originating from the east within this region.

The three Folsom artifacts from the Smoky Hills are all projectile points, and produced of fossil wood, Smoky Hill Jasper, and Florence chert respectively. The production of a Folsom artifact produced of fossil wood in this region supports the trend noted to the west in the High Plains and Colorado Piedmont for Folsom artifacts to commonly be produced of this material.

Unlike the Clovis artifacts from this region that are produced primarily of lithic materials with source areas to the west, the Folsom sample, although small, contains materials that are locally available or originate from the Flint Hills to the east. The disparity between recorded Clovis artifacts and Folsom artifacts for this region cannot be attributed to geomorphic processes alone, and suggests that Folsom utilization of the area was not as intense as that of Clovis groups. No Midland projectile points are reported from the Smoky Hills region.

The Flint Hills

There is a general trend for Clovis artifacts from the Flint Hills and regions to the east to be produced of lithic materials that are unidentified (Figure 40). This is possibly a reflection of lithic materials moving into the area from the east in the Ozarks, where many lithic sources are available that are not as readily identifiable to me as the more familiar Plains sources. It is also possible that at least some of the materials being utilized originate as secondarily redeposited glacial cobbles in northeastern Kansas. Twenty-three Clovis artifacts are documented for the Flint Hills, and of these eight (34.8%) are produced of unidentified or unknown lithic materials. Of the identified lithic material types, Smoky Hill Jasper is the predominant material (n=6; 26.1%) suggesting relatively common movement of this material to the east from western sources. Interestingly, Smoky Hill Jasper outnumbers the locally available Florence chert (n=3; 13.0%) from this region. These numbers are in part driven by the artifact assemblage from the Diskau site in Riley County where Smoky Hill Jasper is common (Schmits 1987; Schmits and Kost 1985). White River Group chalcedony is also represented in the Diskau site Clovis assemblage (n=2). This material has moved about 580 km from the source area to the northwest and is not found this far east in the Folsom data set. A single projectile point produced of Hartville chert from the Kansas River in Wabaunsee County, about 740 km from the source location, is also noted. Hartville chert is also present in limited quantities in the Diskau chipped stone assemblage (Holen 2001:140). The remaining Clovis artifacts from this region are produced of Alibates (n=1), from about 600 km to the southwest, Edwards chert (n=1), from about 875 km to the south, and Dakota quartzite (n=1), which is available in southwestern Kansas and southeastern Colorado. Transportation of Edwards chert in excess of 850 km, along with the Knife River Flint Clovis artifacts from the High Plains, represent the greatest distance lithic materials have been transported in this Clovis sample.

The three Folsom projectile points from this region are all from the extreme northern Flint Hills, and produced of Florence (n=2) which is locally available, and an unidentified chert (n=1) which may be Edwards. The smaller sample size of Folsom compared to Clovis artifacts from this region cannot be explained by geomorphic filtering alone and as suggested for the Smoky Hills to the west appears to reflect differential land use intensity. A single Midland projectile point is also recorded for this region, and is also produced of locally available Permian-age chert. This is the farthest east recorded Midland projectile point within the study sample.

The Glaciated Region

The Glaciated Region of northeastern Kansas is the only physiographic region east of the High Plains where Folsom artifacts (n=21) outnumber Clovis occurrences (n=19) if only slightly. This pattern is somewhat perplexing as Folsom occurrences to the east in Iowa, Missouri, and Illinois are relatively sparse but recorded Clovis artifacts are common from these states (Chapman 1975; Morrow and Morrow 1999; Munson 1990). This pattern may in part be due to recognition problems associated with distinguishing Clovis projectile points from Dalton artifacts (Hofman and Wyckoff 1991), which are also common from this region (Wetherill

1995). This issue is exacerbated when the artifacts are found secondarily redeposited in stream gravel context, as is true for most Paleoindian artifact discoveries from this region. It is possible that geomorphic filtering, particularly the presence of several major tributaries with suitable gravel deposits, including the Kansas and Delaware Rivers, along with collector intensity in this area and the previously noted recognition bias may be driving these numbers. The alternative, as mentioned in Chapter 2, is that the area is replete with floral and faunal resources, including wood for fuel, and possibly could have served as overwintering locations in riparian environments for at least some Folsom groups. It is also likely that some locations represent significant river crossings for bison herds and people (c.f. Wetherill 1995).

Clovis artifacts recorded for this region (Figure 41) are primarily unidentified or unknown lithic materials (n=9; 47.4%), followed by Pennsylvanian-age cherts (n=5; 26.3%) which are locally available in the region, and Permian-age Florence cherts (n=4; 21.1%) from the Flint Hills immediately to the west. A single projectile point base fragment from Pottawatomie County is produced of White River Group chalcedony, and has been transported in excess of 590 km from the Flattop Butte source area in Logan County, Colorado. Interestingly, Smoky Hill Jasper which is the primary lithic material documented in the Clovis sample from the Flint Hills immediately to the south and west is not present in the Clovis sample from the Glaciated Region.

The Folsom lithic materials from the Glaciated Region is predominantly Florence cherts (n=7; 33.3%) from the Flint Hills region to the south and west (Figure 42). Similar to the Clovis sample from this region, there is a relatively high number (n=6; 28.6%) of unidentified or unknown materials from this area. Interestingly, four artifacts are identified as possibly being made from Burlington Crescent chert which originates in Mississippian-age deposits of west-central Illinois, southeastern Iowa, east-central and southwestern Missouri, and the extreme southeastern corner of Kansas (DeRegnaucort and Georgiady 1998; Ray 2007). These artifacts represent the rare occurrence of lithic materials moving from source areas to the east as most other materials observed in the Folsom sample have an opposite source area direction. The remaining Folsom artifacts are produced of Edwards (n=2), one of which was found in Doniphan County and represents the longest observed movement of any artifact in the Folsom sample at ca. 1,000 km. One Folsom projectile point each are produced of Pennsylvanian-age chert, which is local to the region, and Smoky Hill Jasper (n=1) which has moved ca. 200 km from sources to the west.

The Osage Cuestas

South of the Glaciated Region of northeastern Kansas, Clovis projectile points and preforms outnumber Folsom artifacts 29:5. This discrepancy is in part driven by the Cutsinger-Bailey Clovis cache that contains seven projectile points in Wilson County (Hofman 2013, 2014; Smith 2002). Hofman (2013, 2014) suggests that river corridors were preferred routes of travel through this region for Clovis groups, and can help account for the presence of lithic materials from eastern and southeastern source areas. Of the Clovis artifacts from this region produced of identified materials (Figure 43), Reeds Spring chert, with nearest outcrops in Delaware County, Oklahoma, about 112 km to the southeast is the most common (n=7; 24.1%). Five artifacts (17.2%) are manufactured of Permian-age Florence chert from the Flint Hills to the west, followed by unidentified or unknown varieties of chert (n=12; 41.4%). All other materials present account for two or fewer artifacts, including two Clovis preforms from the Kansas River of locally available Pennsylvanian-age chert, one basalt projectile point from the Kansas River, the source of which is unknown, and one Alibates projectile point from about 650 km northeast of the source area in the Texas panhandle. A single projectile point is also identified as possible

White River Group chalcedony, and represents the longest distance movement of this material in the study sample at ca. 750 km from the source area to the northwest.

The small sample of Folsom artifacts from this region cannot be explained by geomorphic filtering, collector and research intensity, or recognition bias alone. The region would have offered an abundance of floral and faunal resources prehistorically, and yet documented Folsom artifacts from the area are few. Of the five Folsom artifacts from the region, two projectile points are produced of Florence chert from the Flint Hills to the west, two artifacts, including a projectile point and preform are produced of unknown or unidentified materials, and one projectile point is produced of Burlington Crescent chert, suggesting interaction with areas to the east of this region.

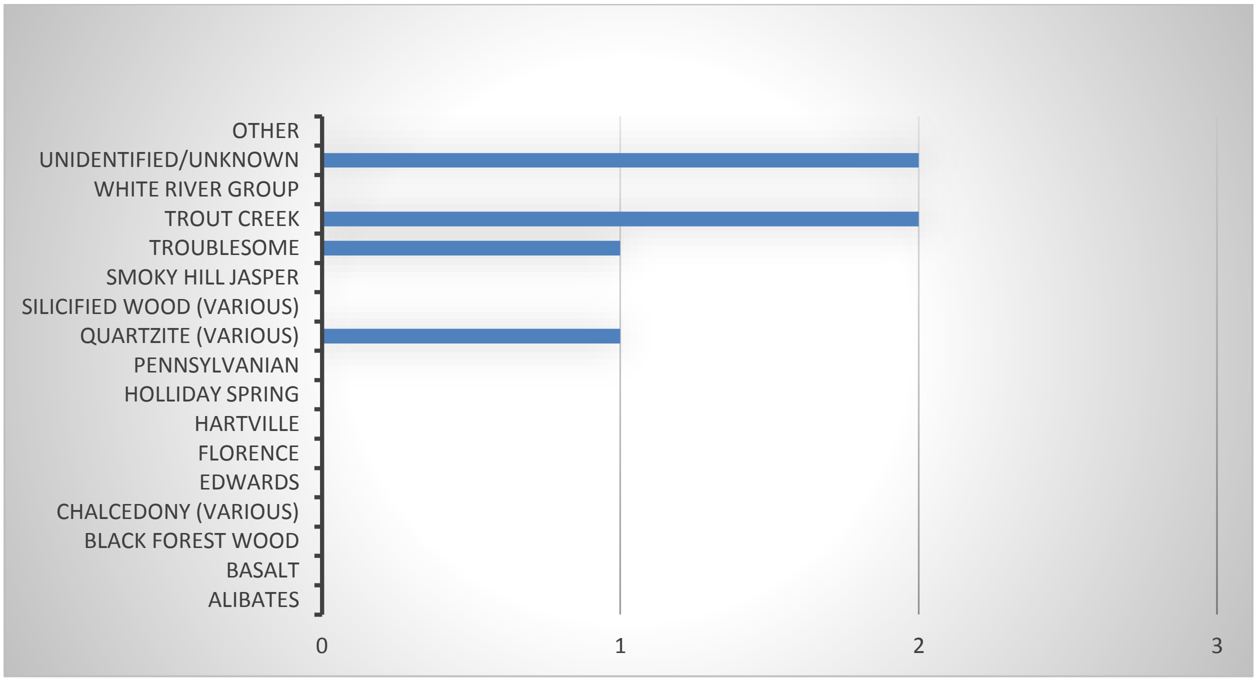

Figure 29. Clovis lithic materials in the Rocky Mountain sample. Total=6.

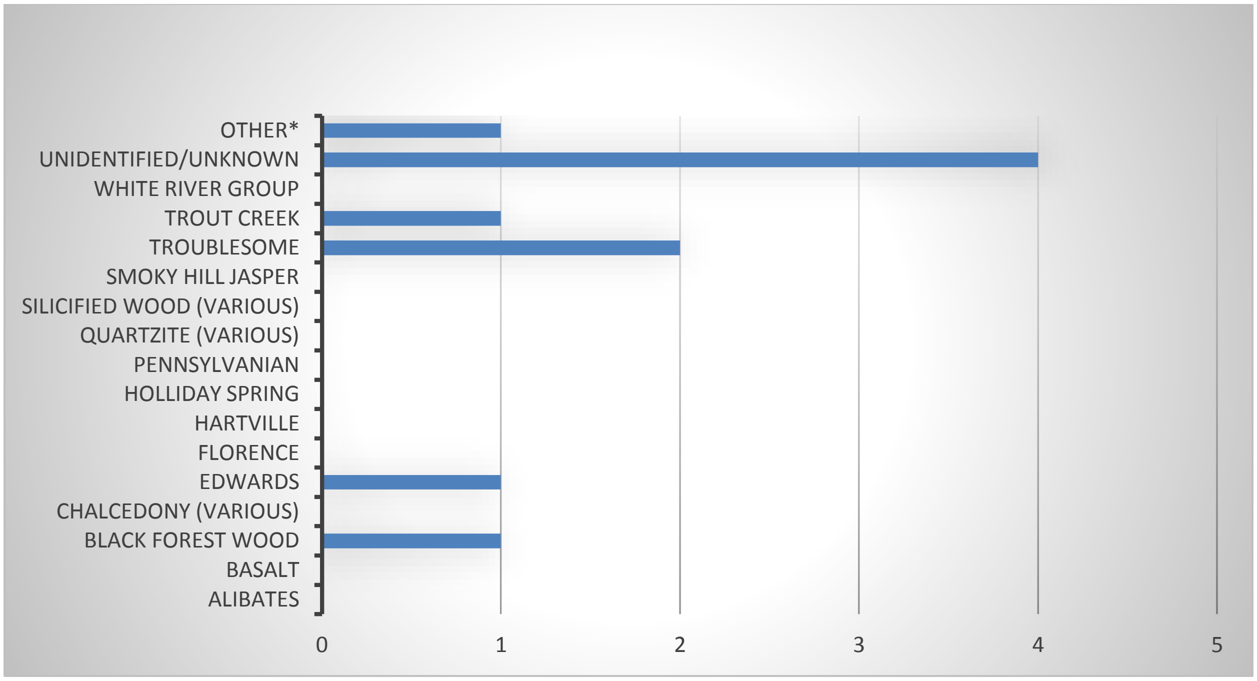

Figure 30. Folsom lithic materials in the Rocky Mountain sample. Other includes moss agate. Total=10.

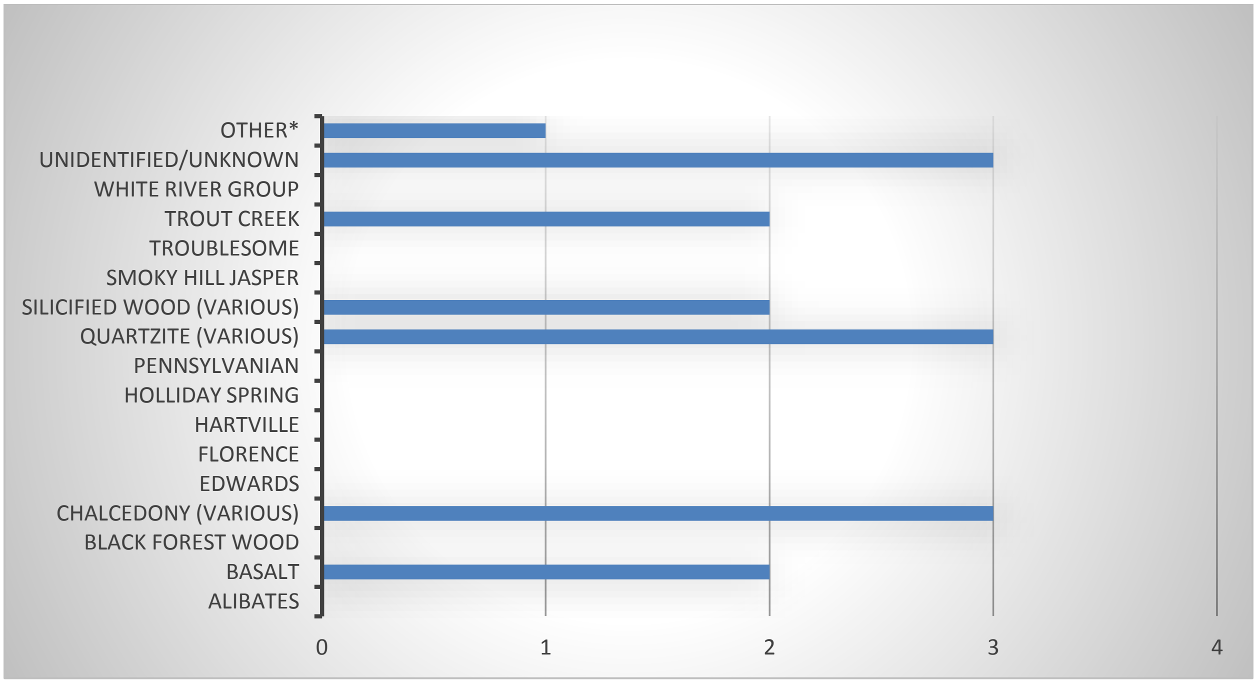

Figure 31. Clovis lithic materials in the San Luis Valley sample. Other includes quartz crystal. Total=16.

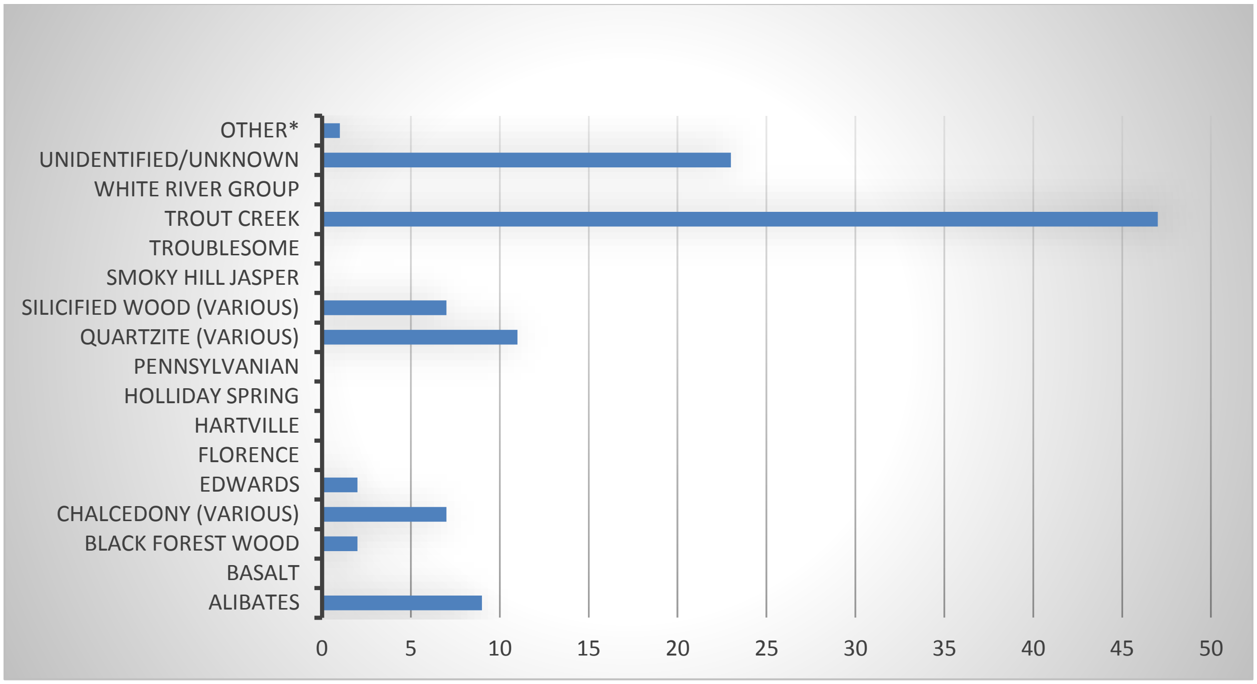

Figure 32. Folsom lithic materials in the San Luis Valley sample. Other includes obsidian. Total=109.

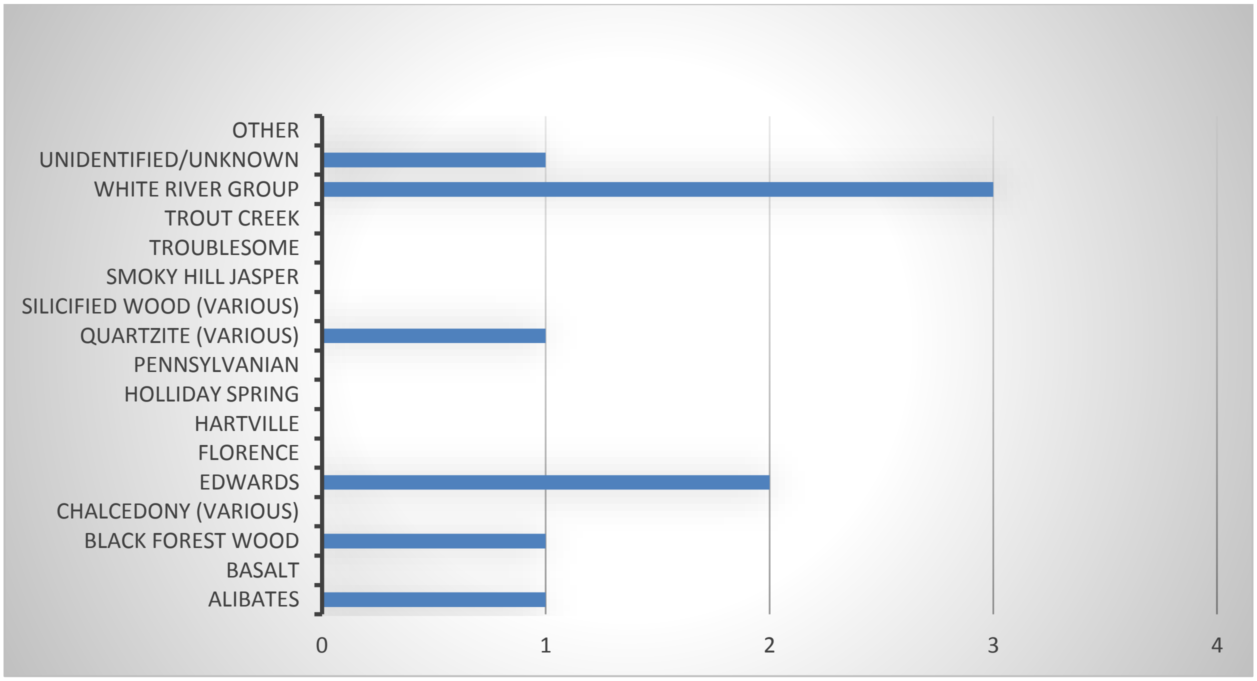

Figure 33. Folsom lithic materials in the Raton Basin sample. Total=9.

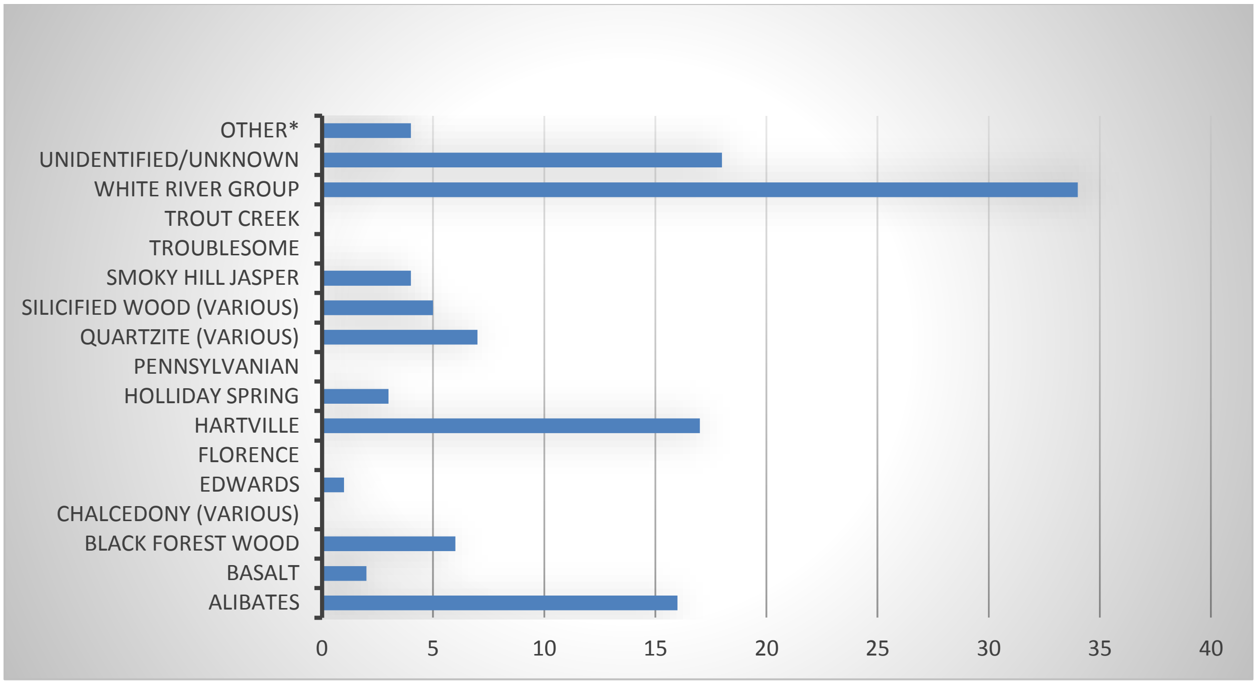

Figure 34. Clovis lithic materials in the Colorado Piedmont sample. Other includes obsidian, quartz crystal, moss agate, and phosphoria. Total=117.

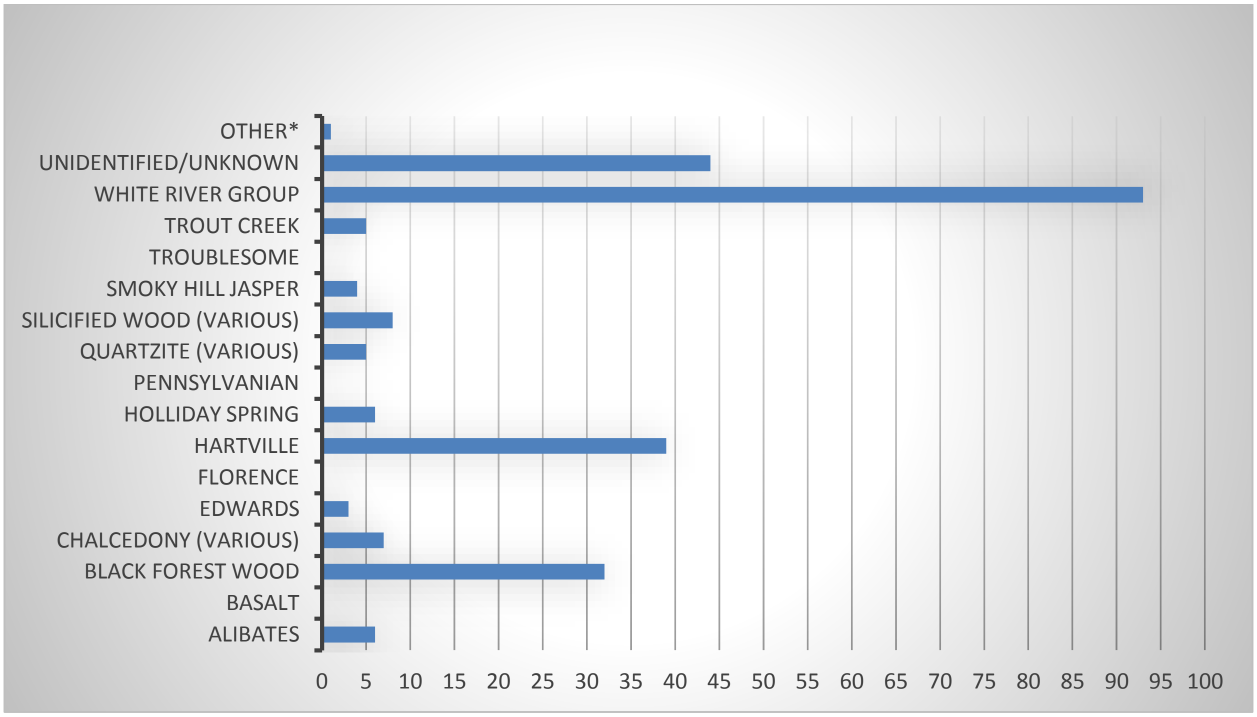

Figure 35. Folsom lithic materials in the Colorado Piedmont sample. Other includes moss agate. The high frequency of unknown material types is a product of Johnson and Fowler Parrish sites. Total=253.

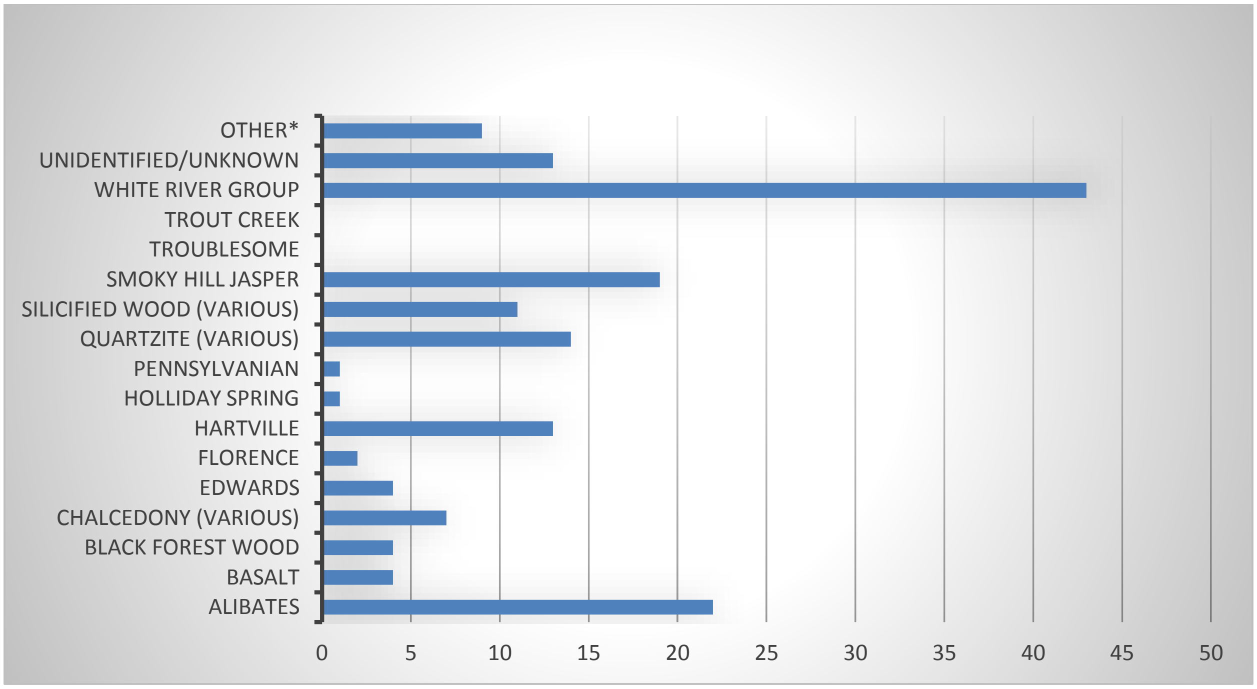

Figure 36. Clovis lithic materials in the High Plains sample. Other includes Knife River Flint (n=3), phosphoria (n=2), moss agate (n=1), porcellanite (n=1), and Tongue River Silicified Sediment (n=2). Total=167.

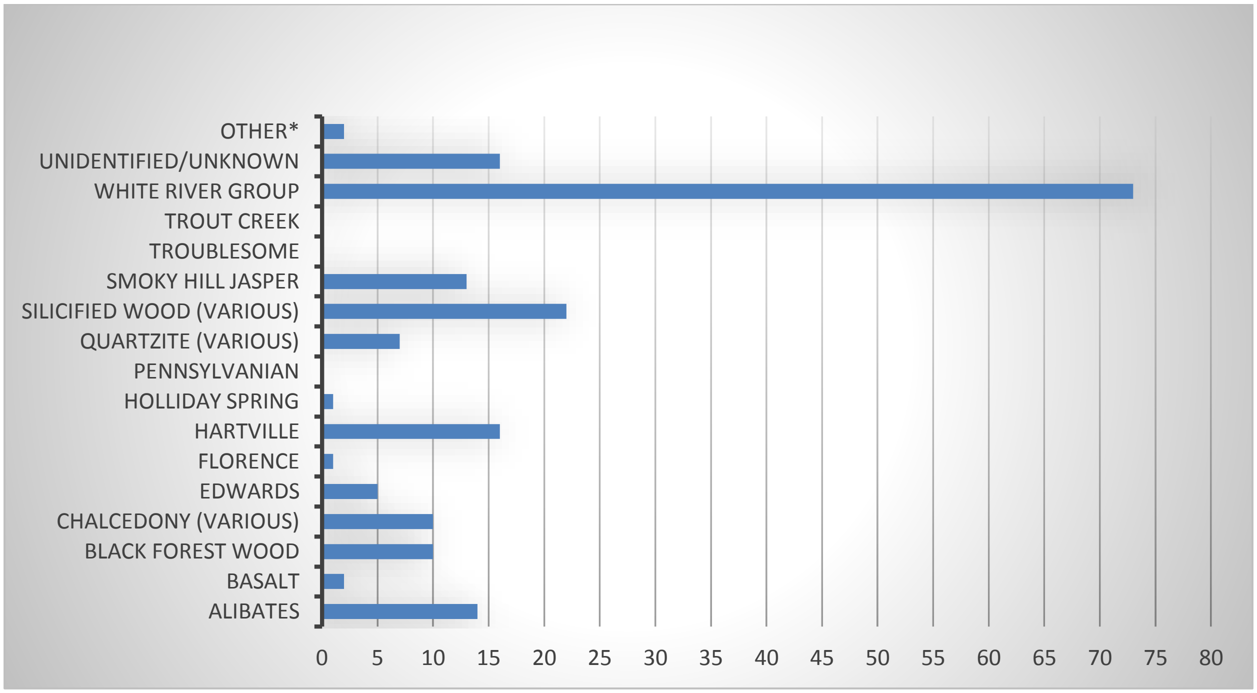

Figure 37. Folsom lithic materials in the High Plains sample. Other includes quartz crystal and Tongue River Silicified Sediment. Total=192.

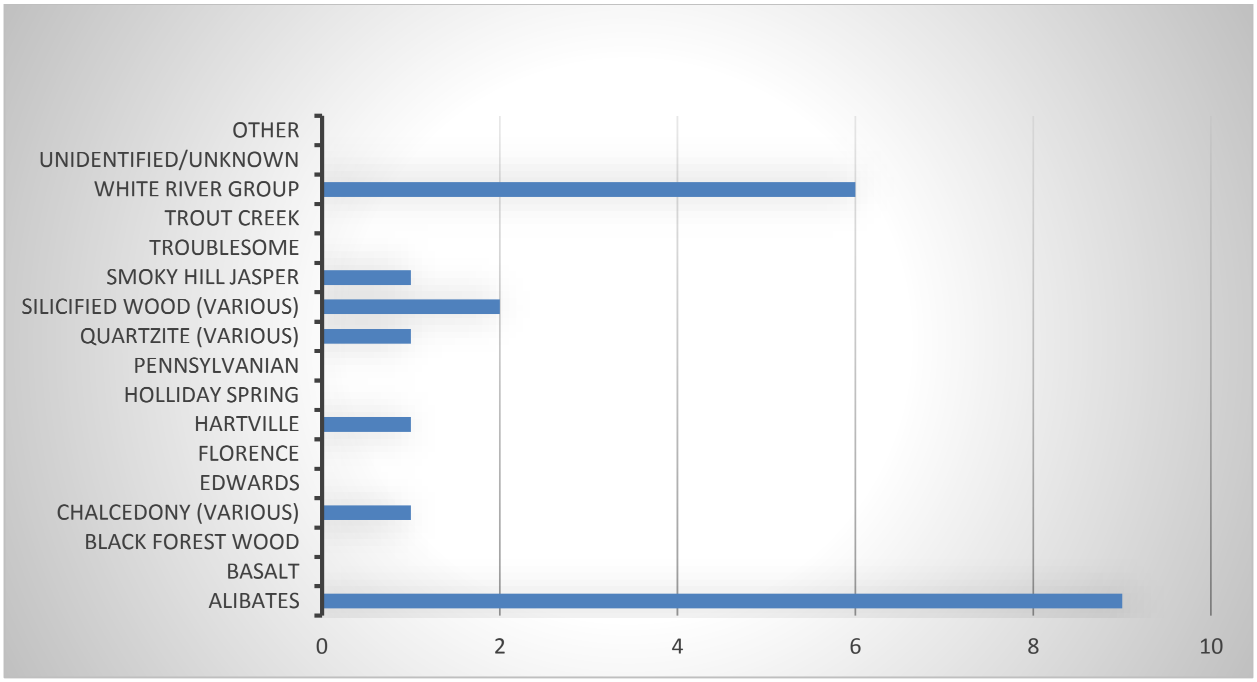

Figure 38. Midland lithic materials in the High Plains sample. Total=21.

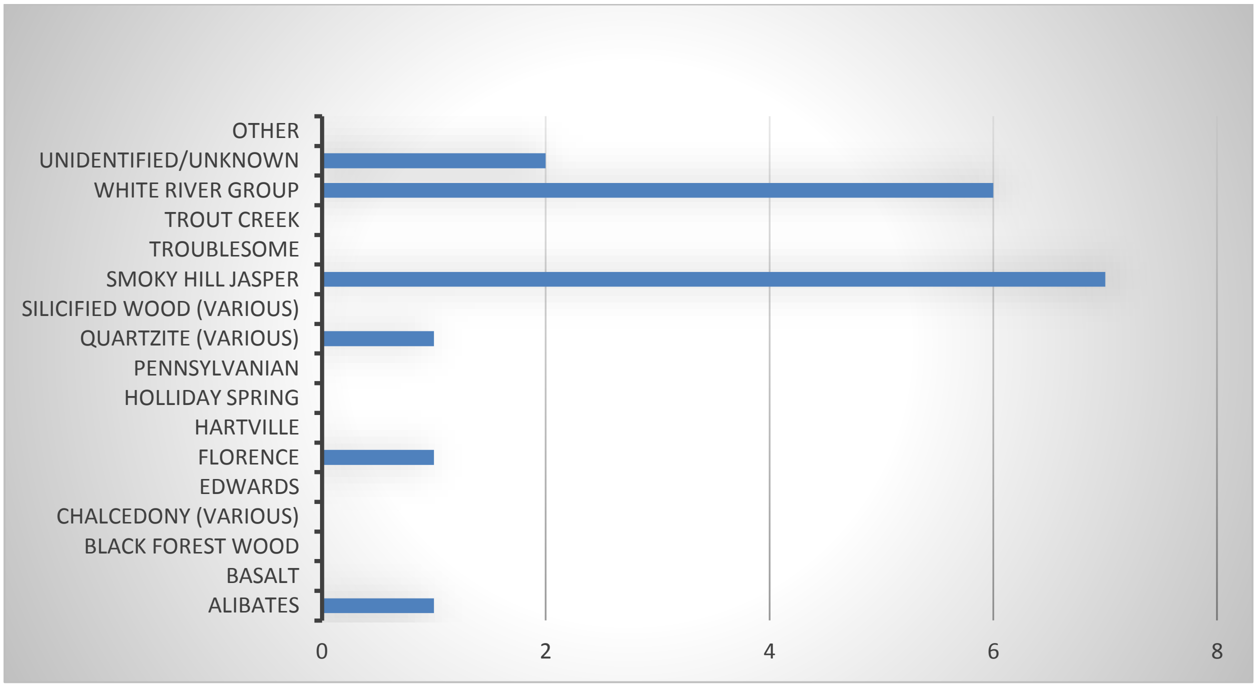

Figure 39. Clovis lithic materials in the Smoky Hills sample. Total=18.

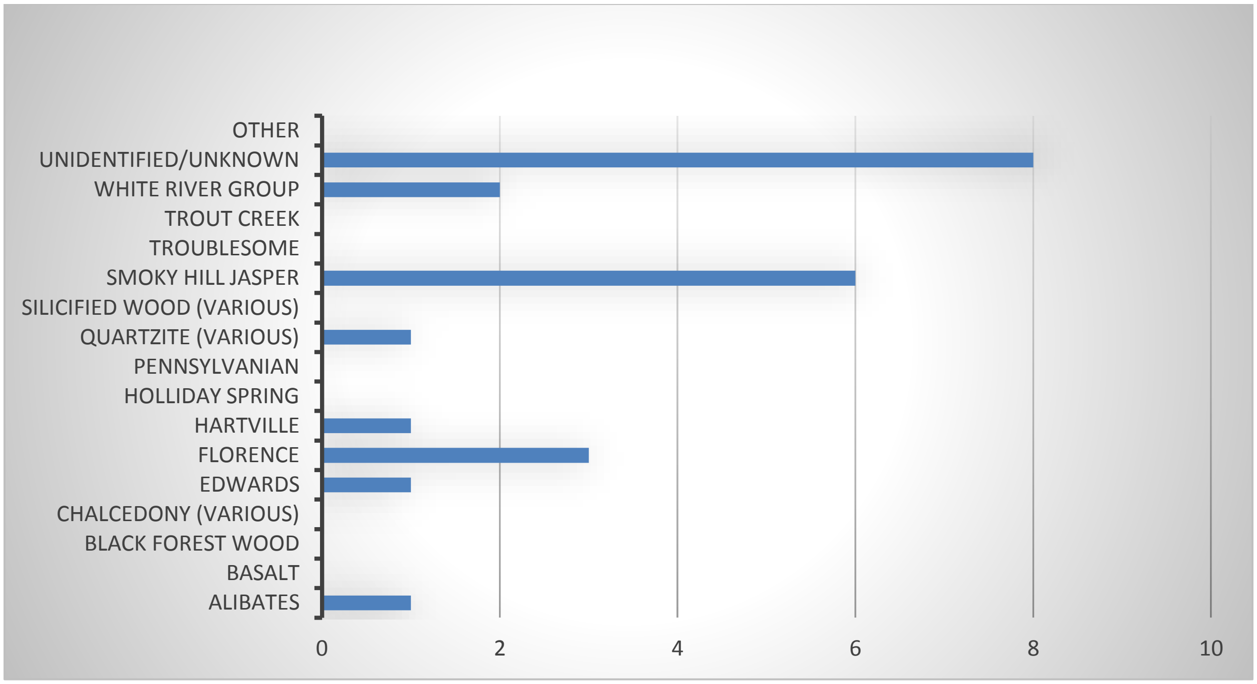

Figure 40. Clovis lithic materials in the Flint Hills sample. Total=23.

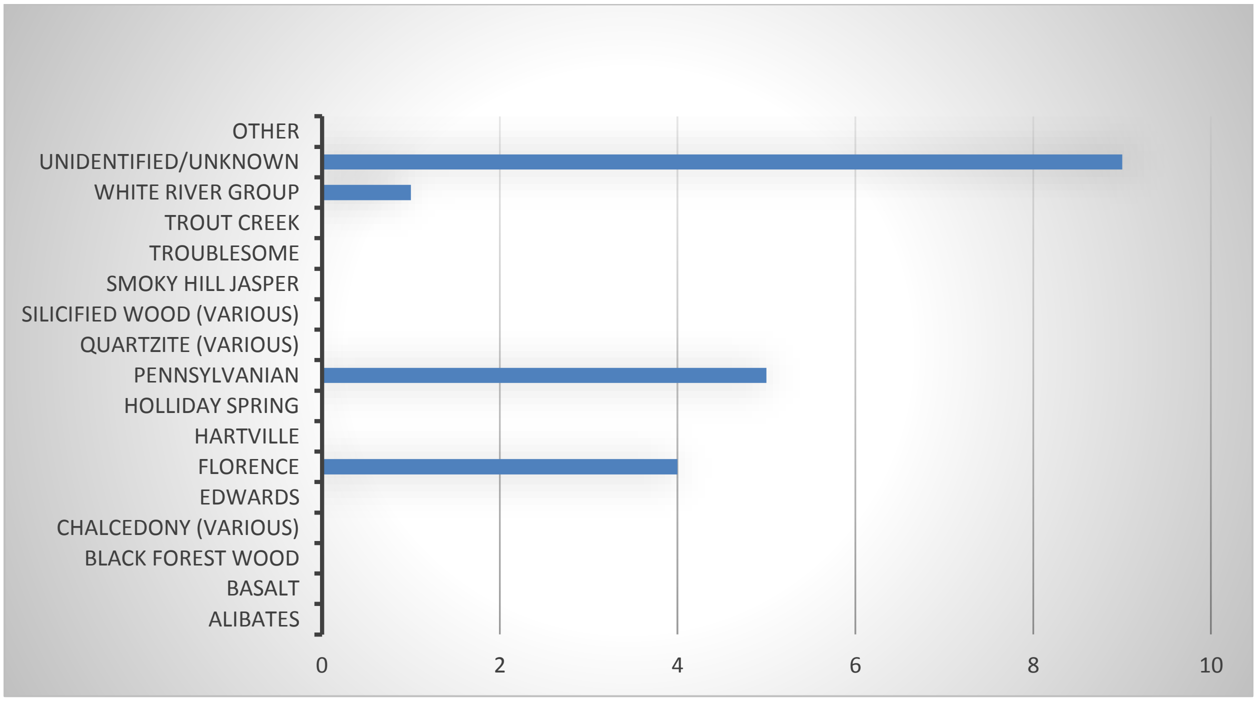

Figure 41. Clovis lithic materials in the Glaciated Region sample. Total=19.

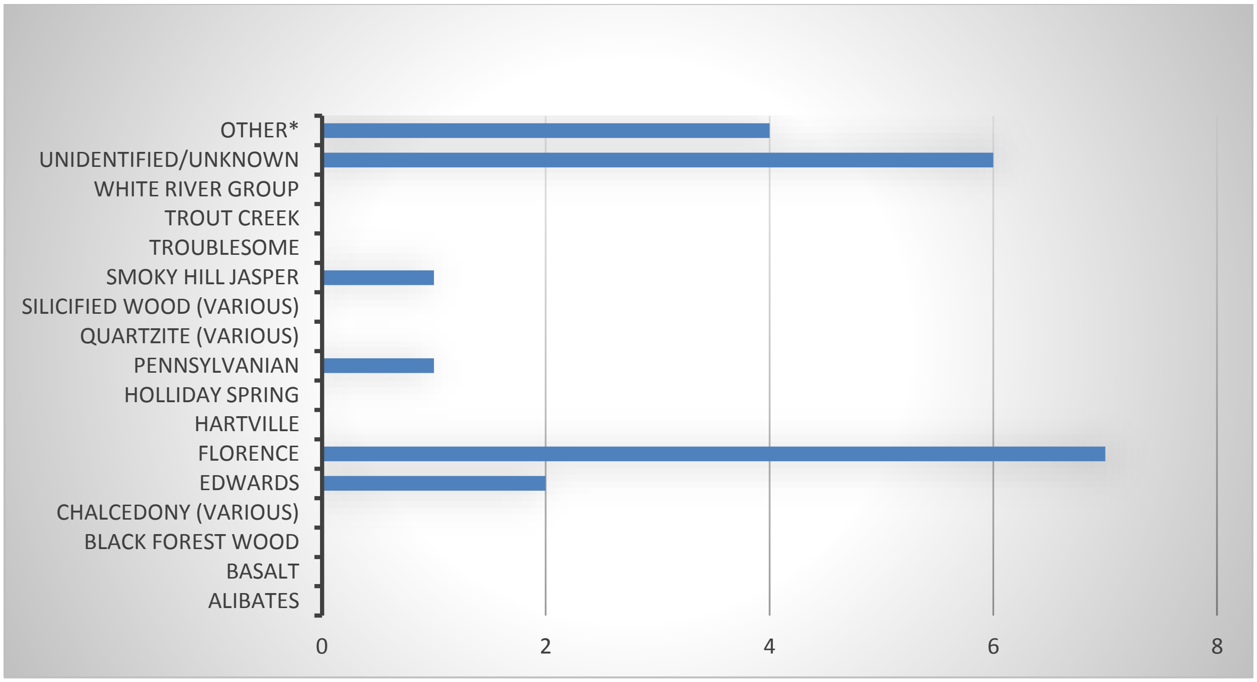

Figure 42. Folsom lithic materials in the Glaciated Region sample. Other includes Burlington Crescent chert. Total=21.

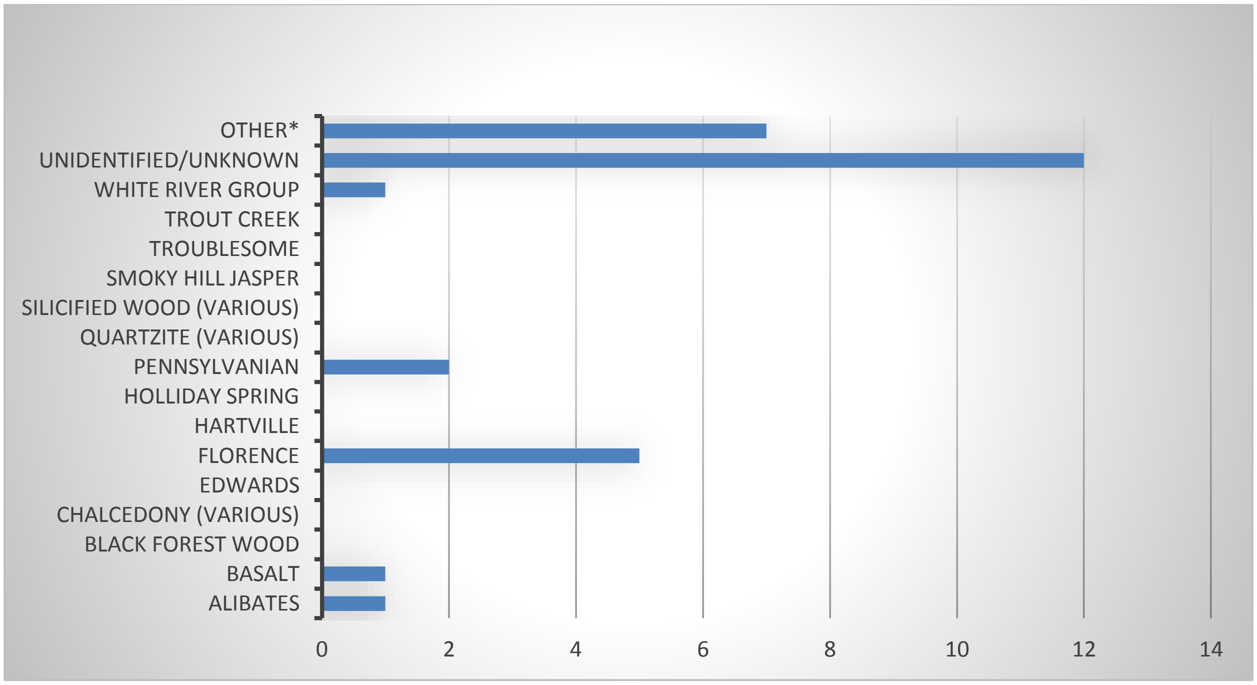

Figure 43. Clovis lithic materials in the Osage Cuestas sample. Other includes Reeds Spring chert. Total=29.

CHAPTER 10

CONCLUSIONS AND FUTURE DIRECTIONS

This study began as an effort to understand why Clovis and Folsom artifacts are unevenly represented on the landscape throughout Colorado and Kansas. It evolved into a multifaceted research project considering landscapes and physiographic features, environmental conditions and changing climates, biotic communities, mobile and stationary resource availability, land use and resource procurement strategies, chipped stone technology, different expressions of those technologies, differential breakage of chipped stone artifacts, spatial distributions of artifacts and factors affecting observed distributions, and use of lithic materials as well as the nature and location of source areas for those materials.

This dissertation views changing environmental conditions of the terminal Pleistocene as a catalyst that stimulates changes in hunting adaptations, land use patterns, and technological variation in chipped stone tool kits between Clovis and Folsom/Midland groups. These differences, whether behavioral, technological, or distributional, must be viewed as fluid, dynamic properties on a continuum of change and adaptation. Although it is not implied that Folsom developed from Clovis in this dissertation, artifact distributions must be interpreted as palimpsests, and considerable overlap is expected between Clovis and Folsom behaviors and observed artifact distributions within physiographic regions. However, significant differences in lithic material composition and spatial distribution are also noted in this study.

A relatively small change in the emphasis or focus of one aspect of an adaptive system can result in noticeable differences in the archaeological record when compounded through redundant activity and time. Such alteration in behavior was taking place by the end of the

Clovis period and was fully expressed in Folsom groups by 10,800 RCYBP. Particularly, this change was a simple shift in resource procurement strategies from a focus on specific ecological areas to an emphasis on a specific animal species for at least parts of most years. This adaptation developed in response to changing climatic and environmental conditions of the terminal Pleistocene, and dramatic restructuring of floral and faunal communities during this time throughout the study area.

These two adaptive systems result in fundamentally different strategies towards chipped stone technologies and lithic procurement and provisioning. Clovis groups with a place-oriented adaptive system could provision landscapes with stockpiles of cached chipped stone materials as intended returns to specific locations could be anticipated. This behavior is not observed in subsequent Folsom adaptations that did not provision the landscape with cached lithic materials and were fully dependent on a maintainable, transportable toolkit while on hunting excursions. Other chipped stone tool differences linked to these adaptive systems include the production and use of blades in Clovis toolkits, a behavior not commonly attributed to Folsom groups, and the use of ultrathins by Folsom people.

This dissertation uses projectile points, preforms, and channel flakes primarily from non-site contexts to address patterns in spatial distributions and lithic composition between Clovis and Folsom/Midland artifacts. Isolated surface finds from private collections comprise the bulk of the study sample. These collections are valuable research tools and must be used when addressing differences in artifact distributions at large geographic scales.

The study area assessed here fills a crucial niche between the Southern and Northern Plains for addressing differences in land use patterns between Clovis and Folsom groups. At the same time, the study area allows for critical examination in differences between Clovis and

Folsom artifact distributions from the Continental Divide of the Rocky Mountains to the Plains-Woodland interface of eastern Kansas. Assessment of artifact distributions at a variety of different spatial scales is critical, and state-level characterizations are no longer adequate for accounting for the observed variability in Clovis and Folsom/Midland lithic composition and artifact distribution (e.g. Blackmar 2001).

Condition and breakage of Clovis and Folsom/Midland artifacts are diverse and distinctive. Statistically significant differences in patterns of breakage may be in part related to different hunting techniques between Clovis and Folsom/Midland groups. Particularly, the lower number of documented broken Clovis projectile points compared to the much higher proportion of Folsom/Midland fragments may correlate to the use of thrusting spears by Clovis groups and atlatl darts by Folsom/Midland hunters (Hofman 1978). This discrepancy is also likely driven by artifact thickness (i.e. Folsom points are thinner), prehistoric strategies regarding recovery, recycling, and discard of lithic materials, and recognition bias associated with projectile point types and fragments.

Several regional patterns of diverse lithic material use between Clovis and Folsom groups explored in this study are noteworthy. First, lithic materials observed in the Clovis sample from the Rocky Mountains and San Luis Valley are primarily locally available or transported less than 100 km from source locations. In contrast, Folsom lithic materials from the Rocky Mountains and San Luis Valley contain a greater diversity of lithic materials and include lithics that have moved considerable distance from source locations east and southeast of the Rocky Mountains. The lithic assemblage of the Cattle Guard site compares favorably with the chipped stone materials observed in private collections from the San Luis Valley. The Mahaffy Clovis cache near the foothills of Boulder, Colorado contradicts the observed movement direction in the

Folsom sample from these regions, with Clovis artifacts produced of lithic materials obtained as far as 350 km distant to the west and northwest of the find location.

East of the Rocky Mountains, White River Group chalcedony is the most common material for both Clovis and Folsom artifacts in the Colorado Piedmont and High Plains regions. However, Clovis and Folsom distributions of this material are markedly different. Particularly, Folsom artifacts produced of White River Group specifically, or any chalcedony in general, are not found east of Finney and Decatur Counties in western Kansas. In contrast, Clovis artifacts produced of these materials are documented from extreme eastern Kansas. Although the greatest concentration of both Clovis and Folsom artifacts produced of this material is found with proximity to the Flattop source area in Logan County, Colorado, Folsom use of this material appears to be more localized and restricted compared to the Clovis distribution.

Similarly, the use of Hartville chert by Folsom groups, although intensive, is spatially restricted primarily to the South Platte River or areas north of this drainage (c.f. Williams 2015). Clovis artifacts produced of Hartville chert are observed much further south of this drainage than are Folsom artifacts within the sample considered here. The composition of Folsom artifacts from northeastern Colorado observed in private collections compares favorably with the predominant lithic materials reported for the Lindenmeier site in Larimer County (if the identification of White River Group/Flattop is correct). South of the South Platte River, intensive use of Black Forest wood is common in the Folsom sample but not as prevalent in the Clovis sample from this same region. It is possible the nature of this material, found primarily as lag gravels, was not preferred for production of Clovis projectile points, or that this material was differentially available to Clovis and Folsom groups. Although the greatest use of Black Forest wood is centered on the Palmer Divide area of the Colorado Piedmont where the material outcrops, it is also noted moving in limited quantities to the west into the San Luis Valley and east onto the High Plains in the Folsom sample.

An interesting regional pattern of lithic material use is found in the Folsom/Midland sample from southwestern Kansas and southeastern Colorado where southern stone sources including Alibates and Edwards chert are commonly reported. Use of some quartzite varieties by Folsom groups is also more intense in this region, a pattern not commonly noted elsewhere in the study area. Quartzites are locally abundant in southeastern Colorado, particularly in Baca County. Although Clovis use of Alibates and quartzites in this region is well represented, including the Sailor-Helton cache of Alibates tool, the distribution of these materials throughout the study area is less regionalized and more ubiquitous in the Clovis sample. It is possible that the Folsom/Midland use of these materials in this region may be reflective of separate Folsom territories and attendant stone use, or may be chronological in nature and reflect Southern Plains bison hunting adaptations towards the end of the Folsom interval when the migration diameter of bison herds is argued to have been large and routinely cycled through this area (c.f. Carlson and Bement 2013a).

In general, there is greater diversity in lithic material types used by Clovis groups compared to those observed in the Folsom sample. The greatest diversity in lithic material use is observed in the Clovis sample from the High Plains, where at least 19 different varieties of stone are reported. This pattern is expected as the High Plains region contains the fewest naturally occurring lithic source locations within the study area, and the majority of artifacts found here have been transported from other locations.

Different use between upland and riparian settings between Clovis and Folsom groups is inferred from available artifact samples within the High Plains region, and compares favorably with the proposed Clovis and Folsom/Midland land use models. Particularly, Clovis artifacts are more abundant from upland settings where they are commonly found in deflated blowout features. Folsom artifacts, although also common in blowouts, are more regularly found in stream gravel contexts. This may reflect targeting of specific landscapes by Clovis groups, namely playa lakes in upland settings. The proportionally greater occurrence of Folsom artifacts from riparian settings may reflect bison more readily congregating in river valley settings rather than upland settings where water sources were isolated and restricted, or may be indicative of fords where bison commonly crossed the rivers (c.f. Wetherill 1995). It is also possible Folsom groups targeted these regions as campsites and overwintering locations where wood for fuel was available.

East of the High Plains, documented Clovis and Folsom/Midland finds drastically diminishes. This trend is in part attributed to geomorphic filtering as severe erosion on upland settings and deep burial in alluvial context characterize this area (Mandel 2008). However, ubiquity and density analysis indicate this may represent the eastern extent of the primary Folsom territory. It is also important to note that Folsom lithic materials from east of the High Plains are markedly different than those in the High Plains and regions to the west. Folsom artifacts produced of Smoky Hill Jasper in eastern Kansas are rare, and most Folsom artifacts produced of this material have been recovered from the High Plains region to the west. Alibates is also absent from the eastern Kansas Folsom sample. This may be indicative of a distinct Folsom adaptation to the Plains-Woodland interface, where locally derived lithic materials, primarily Permian-age cherts, and materials with Ozark sources to the east were targeted. The only western link in the Folsom sample from eastern Kansas are two artifacts produced of

Edwards chert, the most common lithic material for Folsom artifacts from the Southern Plains (Amick 1994b; Hofman 1991, 1992, 1999a; Hofman Amick, and Rose 1990; LeTourneau 2000).

Clovis artifacts from the eastern third of Kansas display greater variability in lithic material types than the Folsom sample. Local Permian and Pennsylvanian-age cherts are well represented, but other materials including Reeds Spring and other Mississippian-age materials from the Ozarks, Alibates, quartzite, basalt, and White River Group chalcedony are present.

The Glaciated Region of northeastern Kansas is the only area east of the High Plains where Folsom artifacts are as common as documented Clovis occurrences. This difference may be in part a result of recognition bias associated with Clovis projectile point fragments, an issue that is exacerbated by the common occurrence of the similar Dalton projectile point style in the area. However, this recognition bias equally affects the Osage Cuestas region to the south, and Clovis finds outnumber Folsom occurrences in this region 29:5. The possibility that the Folsom adaptation to the Glaciated Region of Kansas represents a broader adaptive strategy cannot be ruled out, and use of the area as a seasonal refuge similar to Amick's (1994a) model for the foothills or Sundstrom's (1989) model for seasonal prehistoric use of the Black Hills is possible.

Regional variability in lithic material composition and distribution, and projectile point condition and fragment types between Clovis and Folsom/Midland artifacts is demonstrated in this study, and in part reflective of separate land use strategies and hunting techniques between Clovis and Folsom groups within the study area. Continued documentation of Clovis and Folsom/Midland artifacts from within and outside of the study region are needed to evaluate the observed patterns. Comparisons and integration with research conducted outside the study region is now possible as updated and revised Clovis and Folsom/Midland artifact distributions and lithic composition are characterized for the study area.

Future studies would benefit from refined assessment of unknown and unidentified lithic material types. Unfortunately, this information is not available in many circumstances as the current locations of some artifacts considered here is unknown. However, use of non-destructive lithic sourcing techniques beyond macroscopic visual identification, including neutron activation analysis (NAA), X-ray fluorescence (XRF), and use of scanning electron microscopes (SEM), amongst others, would greatly enhance the current study. Use of 3D scanners to record artifacts in private collections would ensure that an accurate depiction of artifacts is available to future researchers even if the original artifact is no longer available for study. Implementation of data generated by these technologies could be transferred into an easily assessable electronic database, allowing for continued interactive research of the artifact collections.

This dissertation provides a staging ground for many avenues of potential future research into Clovis and Folsom life ways. Clovis and Folsom research has developed significantly since the initial discoveries in the 1920’s and 1930’s, including documentation of chipped stone technologies and production methods, characterizations of faunal remains from excavated context, butchery, processing, and faunal use at Clovis and Folsom kill and camp sites, and a growing body of reliable radiocarbon assessments. However, many perplexing questions remain. Addressing these issues requires moving beyond characterizations of chipped stone artifacts, particularly projectile points, and incorporation of assemblage level data from secure stratigraphic contexts into interpretations of prehistoric behavior. Artifact assemblages allow for entirely different levels of analysis beyond the scope of this study including interpretations of variability in knapper skill and style, and assessment of the roles of planning depth and anticipated mobility on land use patterns (Sellet 2006, 2013). Unfortunately, assemblage-level information is largely lacking and restricted to only a few professionally excavated sites within the study area that contain sizeable chipped stone assemblages. These include the large artifact assemblages from the Lindenmeier and Cattle Guard sites, and smaller assemblages from the Black Mountain and Kanorado localities. All other excavated sites within the study area contain few artifacts from secure, unmixed context.

Incorporations of GIS and least cost path and network analysis is proving to be a valuable tool in assessing potential routes of prehistoric travel beyond straight line distances between artifact find location and lithic source areas (cf. Boulanger et al. 2015). Assessment of lithic material types and transportation of those materials must be situated in a regional as well as behavioral framework, and should be viewed as a reflection of much larger organizational systems. The effects of aggregation events on chipped stone assemblages and recognition of these events in the archaeological record have been previously addressed (cf. Hofman 1994c). However, trade and exchange of other perishable resources, as well as social exchanges and interactions that do not leave an identifiable archaeological signature, including the sharing of ideas and mates (c.f. MacDonald 1999) would benefit from further research.

Continued research into bison ranges and migration patterns using stable carbon isotopes and trace elements throughout the Central Plains is warranted (Widga 2006), as well as continued efforts to understand herd composition and season of death at Folsom localities. These considerations are key when modeling environmental change and animal as well as human response to those changes during the dynamic climatic events of the terminal Pleistocene.

Recognition and interpretation of household activities and living structures is an exciting and relatively new direction in Folsom research (e.g. Andrews 2010; Morgan 2015; Morgan and Andrews 2015; Surovell and O’Brien 2015; Surovell and Waguespack 2007). These efforts benefit greatly from ethnographic research of modern hunter and gatherer populations (e.g.

Sellet, Graves, and Yu 2006) and aid to enhance understandings of domestic space, household structures and functions, and gender related technologies and behaviors in the archaeological record.

It is no longer realistic to view Clovis as the first people in the Americas and the benchmark technology from which all others sprang. To this end, we must view Clovis technology as the rapid dispersal of an idea throughout an already established human presence in the New World. We must continue to search for evidence of Clovis antecedents and understand the adaptations and technologies of those groups. Similarly, comparisons to post-Folsom adaptations and the transition of technological systems in concordance with changing behaviors will enable characterization of Clovis and Folsom life ways in a much larger and more meaningful geographic and temporal framework. Ultimately, addressing many of these issues requires discovery and excavation of new sites of Clovis and Folsom age.

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APPENDIX A: CHIPPED STONE MATERIALS

Clovis and Folsom lithic assemblages are renowned for containing exotic lithic materials, often found at considerable distance from original source locations. A preference for high-quality cryptocrystalline materials is apparent, with orthoquartzites and other materials playing a lesser role. Although a variety of high quality lithic sources are available in eastern Colorado and Kansas, the common occurrence of Clovis and Folsom artifacts produced of materials outside the study area indicates that a wider lithic landscape needs to be considered to account for the diversity of lithic material types recovered in Clovis and Folsom toolkits.

The lithic landscape indicated by these materials is massive, covering an estimated spatial area of 2,158,000 km², or 1,660 km north/south from central Texas to south-central North Dakota, and 1,300 km east/west from eastern Iowa to central Colorado. This represents a palimpsest of many generations of different groups operating at different scales of mobility and territoriality, but certainly hints at the vast distances Clovis and Folsom groups transported lithic materials across the landscape. It is not uncommon for Clovis artifacts to be found in excess of 400km straight line distance from the original material source location, and some artifacts have been documented in excess of 800-1,000km distant from the original source area (Holen 2001:186; Tankersley 1991).

The immensity of spatial ranges utilized by Clovis and Folsom groups necessitates lithic analysis at a large geographic scale. Through the careful analysis of Clovis and Folsom chipped stone artifacts and correlation with known lithic source areas, it is possible to reconstruct prehistoric patterns of land use and resource transportation. The following reviews lithic source areas frequently utilized by Clovis and Folsom groups throughout the Great Plains. This list is by no means exhaustive, but rather focuses on lithic materials that were noted within the artifact sample analyzed here.

Generalized distributions of the reviewed material types are visually represented in Figure 44. Notable lithic sources for the study region are reviewed alphabetically below as other means of representation, particularly classification based on geologic formation, is cumbersome and confusing for those unfamiliar with geologic formations, locations, and terminology.

Alibates Agatized (Silicified) Dolomite and "look-alikes"

Alibates silicified dolomite, or agate, is a member of the Permian age Quartermaster Formation, with primary bedrock sources restricted to a small area in the southern Texas panhandle along both banks of the Canadian River in Potter County (Banks 1990:91; Hofman 1991:340; Patton 1923; Wyckoff 1993:35), and along the eastern edge of the Llano Estacado from Donley to Kent Counties (Holliday and Welty 1981; LeTourneau 2000:434). These outcrops occur as massive sheets several meters in thickness, as well as more isolated lenticular nodules (Bowers 1975:66; LeTourneau 2000:434). Alibates is also commonly found in alluvial gravels of the Canadian and Washita Rivers, with cobbles as large as 30 cm occurring 200-300 km downstream the Canadian drainage (Banks 1990:91; Kraft 1997; Kraft and Lail 1998:28; LeTourneau 2000:434-435; Wyckoff 1993:35). This material ranges in color from variegated, streaked, and mottled dark purples, blue and maroons, to light pinks, brown, tan and even white. The lighter banding in Alibates has a distinct ultraviolet signature (Hofman, Todd, and Collins 1991:299). Alibates occasionally contains quartz crystal filled vugs (Banks 1990; LeTourneau 2000:434). Day Creek Dolomite occurs as chert or chalcedony, and can macroscopically resemble Alibates, but typically is more translucent. Day Creek is derived from a localized outcrop of the same formation in south-central Kansas and north-central Oklahoma (Stein 2006:274). Similar materials include Tecovas jasper, discussed below, as well as materials that outcrop at Baldy Hill in northeastern New Mexico, and range in color from orange to reddish brown (LeTourneau 2000:436; Shelley 1984; Warren 1979). This particular material is typically highly fractured and of poor quality (LeTourneau 2000:437). Other Alibates, Edwards, and Tecovas "look-alikes" have been noted in the Tertiary-age Ogallala Formation in the Southern High Plains (Holiday and Welty 1981; Shelley 1984). An additional Alibates "look-alike" occurs as cobbles secondarily redeposited in alluvial gravels in the southern Black Hills of South Dakota.

Basalt (Trachite)

Knappable cobbles of basalts, or trachite, occur throughout the igneous regions of the Raton Section of southeastern Colorado and northeastern New Mexico, and are frequently found redeposited in Tertiary gravels of eastern Colorado and western Kansas. The original source area for basalts that occur as lag gravels in Ogallala deposits outwashed from the Rocky Mountains onto the Great Plains has not been located (Holen 2001). A heavily utilized source prehistorically is San Antonio basalt from the slopes of San Antonio Mountain near the New Mexico and Colorado border (Jodry 1999:93). Basalts typically range in color from black to dark gray, but may patinate to creamy white.

Burlington Crescent

Burlington Crescent outcrops as bedded lenses in the Mississippian-age Burlington-Keokuk Limestone Formation of west-central Illinois, southeastern Iowa, east-central and southwestern Missouri, and the extreme southeastern corner of Kansas (DeRegnaucort and Georgiady 1998:172; Ray 2007). It also occurs as out-washed stream deposits throughout this region. Five varieties of Burlington chert have been recognized and colors are highly variable, but creamy white to gray are the most common (Ray 2007:193). Burlington chert exhibits a dull luster, but when heated turns pink and waxy (Ray 2007:196). Burlington is one variety of Undifferentiated Osagean chert because shared physical attributes often make it indistinguishable from other Ozark cherts, including Pierson, Reeds Spring, Elsey, and Keokuk (Ray 2013).

Chuska Chalcedony

Chuska chalcedony, also called Narbona Pass, Washington Pass chert, or colloquially referred to as “Paleo Pink”, occurs as nodules and veins in volcanic lavas of the Chuska Mountains of the San Juan Basin near the New Mexico-Arizona border (Cameron 2001:83; LeTourneau 2000:459). Specifically, Chuska is found weathering out of vesicular porphyritic trachybasalt, and is present in alluvial gravels up to 16 km down slope of the Chuska Mountains (LeTourneau 2000:459-460; Shelley 1980:42). Chuska is typically a waxy translucent pink to reddish orange, but can occur in banded grays and pink, blue, and banded grays and cream (Banks 1990:63; Jodry 1999:3322). The pink colors in Chuska fluoresce bright green under shortwave ultraviolet light (LeTourneau 2000:461). Chuska as well as Cumbres Pass appear almost exclusively as Folsom artifacts, and present less frequently in later assemblages (LeTourneau 2000).

Cumbres Chert

Cumbres chert (Cumbres Pass) is a silicified welded tuff formed by hydrothermal actions within geothermal fields of the San Juan Mountains that occurs in Rio Grande River gravels throughout the San Luis Valley (Jodry 1999:94). Various knappable hornfels and rhyolites are also found in this region, but don’t become a common source material for tool production until later Paleoindian times. Cumbres Pass is also present in Tertiary age alluvial gravels as mottled opaque white-gray or tan nodules, and often contain small rounded inclusions of chert and chalcedony in a chert matrix (Amick 1994:135; LeTourneau 2000:457).

Edwards Chert

Edwards chert is found in the Cretaceous age Antlers Sand and Edwards Limestone deposits of west Texas as lenticular and irregular nodules, horizontal bedrock deposits, and alluvial gravels (Banks 1990; Boldurian and Cotter 1999:23; Hofman 1991:340; LeTourneau 2000:450). A macroscopically similar source occurs near Roswell New Mexico from the San Andres Formation (Hofman 1991:340; Shelley 1984:36), but LeTourneau (2000:432) suggests the two materials are readily distinguishable. Edwards chert is generally fine-grained and ranges in color from grays, blues, and browns (Hofman 1991:340). A thick pale chalky white cortex is often found on nodules (Boldurian and Cotter 1999; Hofman 1991:340). Edwards has a distinctive ultraviolet fluorescence signature (Hofman, Todd, and Collins 1991).

Hartville Uplift Chert

Outcrops of Mississippian-age Madison limestone within the Guernsey Formation and Pennsylvanian-age Hartville Formation limestones are found in the Hartville Uplift region of east central Wyoming (Miller 1991; Reher 1991:257). These interbedded limestones and dolomites contain high quality colorful dendritic chert (Reher 1991:257). Comparable cherts are also found in the Black Hills Minnelusa Formation, and as alluvial cobbles of the North Platte and Platte River drainages, as well as in the cobble beds of the Chadron and Broadwater Formations in western Nebraska (Francis 1991:309; Holen 2001:93). Hartville chert ranges in color from combinations of dark brown, olive, red, pink, and yellow, and is characterized by black dendritic inclusions (Francis 1991:308). Macroscopic distinction between certain varieties of Hartville Uplift chert and Trout Creek-like jaspers is often difficult.

Knife River Flint

Knife River Flint (KRF) is found as sub-angular cobbles secondarily redeposited in alluvial slope wash and residual Pleistocene-age lag gravels in Dunn and Mercer Counties of west central North Dakota (Ahler 1977, 1985; Clayton, Bickley, and Stone 1970:284). It likely originates from the Eocene-age Golden Valley Formation, and is typically a dark chocolate-brown color, although lighter brown varieties are known, and yellow staining and white patination is common (Clayton, Bickley, and Stone 1970:287; VanNest 1985). A dull waxy luster is frequently found on weathered pieces. A visually similar brown to gray translucent chalcedony occurs in the Morrison Formation of the Bearlodge Mountains of northeastern Wyoming (Church 1996:149-150; Reher 1985:99). Small flakes of this material are easily mistaken for Knife River Flint (Church 1996:150). Scenic Chalcedony, a dark brown translucent chalcedony of the White River Group Silicates can also be mistaken for Knife River Flint (Ahler 1977:136; Hoard et al. 1993).

Although occurring rarely in the sample of projectile points and preforms analyzed herein, Knife River Flint is the primary source utilized at the Bobtail Wolf, Big Black, and Young-Man-Chief sites in North Dakota, where intensive quarrying of this material took place during Folsom times (Root 2000; Shifrin 2000; William 2000). Interestingly, Root (2001) suggests a primarily northern movement of this material from the source area, which is corroborated by the paucity of Clovis and Folsom artifacts produced of this material in this study.

Mosca Chert

Mosca chert, from bedrock outcrops of the Leadville Limestone Formation is found in the upper Rio Grande Basin, and ranges in color from mottled yellow and brown to pink and white

(Jodry 1999:95). This material occurs at the Folsom-age Stewart's Cattle guard Site (Jodry 1999).

Obsidian

Obsidian, or volcanic glass, occasionally appears in Clovis and Folsom assemblages. Obsidian sources are spatially restricted on the landscape, and uniform in chemical composition, allowing for accurate sourcing of obsidian artifacts. Recent developments in sourcing obsidian trace element profiles have noted a variety of source areas used by prehistoric people, including Malad, southeastern Idaho, Wild Horse Canyon, Utah, Obsidian Cliff, northwestern Wyoming, Valle Grande rhyolite, Cerro Toledo, and El Rechuelos rhyolite of the Jemez Mountains of north-central New Mexico, and Sierra de Pachuca, Hidalgo, Mexico (Hoard, Bevitt, and McLean 2008:221). There are at least 28 different obsidian sources recognized for western Wyoming, southwestern Montana, southern Idaho, southern Oregon, northern Nevada, and Utah alone (Scheiber and Finley 2011). Obsidian is typically a waxy translucent black, but mahogany, gray and gray-green varieties are noted.

Opalines

Opalines and cherts occur, although sporadically, throughout the Kimball member of the Ogallala formation in western Kansas and eastern Colorado and formed by the secondary replacement of calcium carbonate with silica (Frye, Leonard, and Swineford 1956). This material is variable in texture and quality (Carlson and Peacock 1975; Muniz and Holen 2005).

Pennsylvanian Chert

Eastern Kansas, western Missouri, southeastern Nebraska, and southwestern Iowa contain outcrops of Pennsylvanian age bedrock which contains chert bearing limestone formations. These cherts occur as small nodules as well as thin, laterally uniform beds, but are often deeply buried under glacial till, except in western Missouri where Pennsylvanian formations form resistant caps of topographic highs (Lopinot, Ray, and Conner 1998:225; Stein 2006:269). Prehistoric quarrying of Pennsylvanian-age chert was common near the town of Nehawka in southeastern Nebraska, the derivative of “Nehawka chert” occasionally encountered in publications (Carlson and Peacock 1975). Pennsylvanian cherts occur in a variety of colors, including white and black, but are typically hues of gray or yellowish brown (Ray 2007:298). Fossil inclusions are common, including crinoids and bryozoa.

Permian (Florence) Cherts

Permian chert nodules erode from Permian system limestone outcrops throughout the Flint Hills Upland of Kansas and northern Oklahoma, and are found extensively throughout eastern and southeastern Kansas in river gravel deposits (Merriam and Harbaugh 2004; Stein 2006:270). At least thirteen different chert bearing formations are found in a confined belt of exposures (80 km wide on average) that cross the state of Kansas from north to south into northern Oklahoma (Banks 1990:96; Carlson and Peacock 1975; Stein 2006:271). Southern sources within this belt typically range in color from buff yellow-gray and light brown while more northerly sources are usually a light to dark blue-gray (Stein 2006:271). Fusilinid inclusions are common, as well as chalky white to tan cortex.

Porcellanite

Porcellanite occurs as a metamorphosed shale formed by the burning of subterranean coal seams in the Fort Union Formation, with major deposits located in south-central Montana and northern Wyoming (Francis and Larson 1996:90; Fredlund 1976:207-208; Miller 1991:466). Other sources are known from the Little Missouri Badlands of eastern Montana, western North Dakota, and northwestern South Dakota (Church 1996:12; Root, William, and Emerson

2000:244). Porcellanites are typically a waxy gray or red/maroon depending on the intensity of the heat that formed it (Francis and Larson 1996:90; Fredlund 1976:207-208). The Cloverly-Morrison Formations, famous for “Spanish Diggings” quartzite on the western slopes of the Hartville Uplift also contain porcellanites (LeTourneau 2000:507; Miller 1991:464).

Quartzites (Cloverly, Dakota, Morrison, Bijou, Windy Ridge and unnamed varieties)

A variety of quartzites were utilized during Clovis and Folsom times. Of these, the most common include Cloverly and Morrison quartzites, and to a lesser extent orthoquartzites found in Ogallala Tertiary-age gravels of eastern Colorado and western Kansas, and Dakota quartzites, most common from southwestern Kansas and southeastern Colorado. Cloverly quartzite occurs in Cretaceous-age deposits of the Hartville Uplift Formation of east-central Wyoming and the Fall River Formation of the southern Black Hills (Francis 1991:309; Holen 2001:93; Reher 1991). Cloverly quartzite is typically fine grained and ranges in colors from golden brown, to light grays and purples (Holen 2001:93).

Jurassic-age Morrison quartzite is found in the same area, as well as in Tertiary gravels of eastern Colorado and throughout the southern Rocky Mountains (Church 1996:146; Jodry 1999:97; Kornfeld et al. 2007; Reher 1991:257). Both these quartzites are occasionally lumped under the classification of “Spanish Diggings” after the famous quarry complex area near Lusk, Wyoming, but Morrison quartzite also occurs in many other locations throughout Colorado and Wyoming. LeTourneau (2000:507) classifies these quartzites as Cloverly-Morrison as stratigraphic distinction is often difficult to discern. Comparable quartzites are also found in Arizona and New Mexico (LeTourneau 2000:446). Morrison quartzites range in various hues of mottled grays (Reher 1991:257). A macroscopically similar material ranging in color from mottled light tans and grays to deep maroons and red is found near Colorado Springs but is technically a welded tuff of the Dawson Formation rather than a true quartzite (Stielow and Lindsey 2014). Microscopic observation is required to differentiate between these materials, and it is likely that some artifacts recorded as Morrison or Cloverly quartzite may in fact be Dawson Formation welded tuff.

Dakota quartzites are found as localized cobbles in the Cretaceous-age Dakota Formation of Kansas and southeastern Colorado, and are typically light brown or grey to greenish-tan, but can be found in white and dark red or purple, and pale orange (Banks 1990:94; Mandel 2006a:16). The Dakota Formation occurs as resistant mesa caprock in northwestern Arizona and northern New Mexico, and is also present in western Oklahoma (LeTourneau 2000:453). Dakota quartzites are commonly found redeposited in Tertiary gravels of eastern Colorado and western Kansas, and are found in abundance in Baca County, Colorado (Banks 1990:94). Quality is variable for these deposits.

Bijou Hills Quartzite is a Pliocene/Miocene quartzite of the Valentine and Ash Hollow members of the Ogallala Formation in north-central Nebraska and southcentral South Dakota, with smaller fluvial and glacial gravels found in northwestern Iowa (Ahler 1977:137-138; Bakken 1995; Stein 2006:278). This material is typically light green or greenish-grey in color (Ahler 1977:137).

Windy Ridge quartzite outcrops near the Continental Divide in north-central Colorado. The primary source area is located at over 2860 m in elevation and contains high quality quartzites in various hues of silver and gray significant for having been extensively quarried in prehistoric times (Bamforth 1998, 2006:512). However, this material is rarely found at considerable distance from source, and it is currently uncertain if Clovis or Folsom people utilized it. One possible exception is the Watts Clovis cache from near Fort Collins, Colorado

(Holen 2014:181). Wheat (1979:123) mentions variable quality quartzites ranging in browns, tans, and gray from local gravel deposits near Greeley, Colorado (LeTourneau 2000:510). Other knappable Precambrian quartzites are present in the southern Sangre de Cristo Mountains, and typically range in color from gray to white (LeTourneau 2000:415; Montgomery 1963:10-11).

Quartz Crystal

Quartz crystal appears more frequently in Clovis assemblages than in Folsom. Most quartz crystal is clear translucent, although smoky or frosted and opaque varieties are also found (Reher and Frison 1991:376). The source areas for quartz crystal used by Clovis groups is unknown, but several locations are possibilities. One possible source has been noted near Atlanta, Idaho (Kilby 2008:155), with additional sources present in the Laramie Range of the Rocky Mountains of Wyoming and associated tributaries, as well as further south into the Rocky Mountain front of northern Colorado where frosted crystals are secondarily redeposited as river cobbles in the South Platte River (Reher and Frison 1991:387). In addition, large quartz crystals are found around Crystal Peak in central Colorado (Holen, personal communication 2013), as well as in Paleozoic shales and sandstones in the central belt of the Ouachita Mountains in western Arkansas (Engel 1946:598).

Silicified Wood

Silicified wood occurs commonly as secondary deposits in northeastern Colorado and western Nebraska. The most common source is Elizabethan wood, also called Bijou Basin petrified wood, Parker petrified wood, or Black Forest wood, which occurs as lag deposits between Denver and Colorado Springs in the Dawson Arkose and Denver Formations of the Black Forest region of Colorado, and is available in northeast flowing tributaries to the South Platte River throughout the Colorado Piedmont and High Plains (Banks 1990:66; Hofman, Westfall, and Westfall 2002; Holen 1983, 2001:93; Jodry 1999; Johnson 1982:51; Kornfeld et al. 2007:262; Wedel 1986:66). This material is typically a mottled opaque brown and yellow, but also occurs in shades of red and orange, and is occasionally translucent with small crystal inclusions (Jodry 1999:91). Banding from the grain of the wood is often visible.

Silicified woods are also found in the study region throughout the Tertiary-age Ogallala Formation, redeposited in South Platte, Platte, and Arkansas River gravels, as well as in glaciofluvial gravel deposits in the northwestern portions of the San Luis Valley (Holen 2001:93; Jodry 1999:88). Southern Wyoming and Weld County, Colorado in particular contain abundant silicified woods in Tertiary-age gravels (LeTourneau 2000:510). The Morrison Formation, best known for its quartzites, contains outcrops of silicified woods that range in various hues of translucent yellows and pinks (Warren 1967:123-124). Near West Rainy Butte in North Dakota is found a silicified wood characterized by reds and translucent browns that sometimes retain bark-like cortex known as Rainy Buttes silicified wood (Root, William, and Emerson 2000:240). This material occurs as blocky pieces up to boulder size in this area, and is also found as pebble-size cobbles in stream gravels, and was utilized by Folsom people at the Bobtail Wolf Site (Root, William, and Emerson 2000:240). The Cretaceous-age Mesaverde Group of northwestern New Mexico and northeastern Arizona also contains extensive outcrops of silicified wood, including entire logs (Powers, Gillespie, and Lekson 1983:52). Silicified woods also occur sporadically in glacial gravels of northeastern Kansas, but quality is variable.

Smoky Hill Jasper

Smoky Hill Jasper, variously called Republican River Chert, Niobrara Jasper, Niobrarite, Alma and Graham jasper, is found in northwestern Kansas and south-central Nebraska in the Smoky Hill chalk member of the Cretaceous-age Niobrara Formation (Banks 1990:96; Hofman

1991:341; Stein 2005, 2006:275; Wedel 1986; Wright 1985). It typically is found bedded in thin tablets in bedrock sources, but also occurs secondarily in the Republican and Saline River basins. Smoky Hill Jasper ranges in color from tan or yellow to light/dark brown, but also occurs in white, green, maroon, red, purple, and black (Banks 1990:96). Dendritic inclusions as well as small chalk inclusions are relatively common, and chalky cortex is occasionally present (Stein 2006:276). Smoky Hill Jasper is the principal chert-bearing source in the central Great Plains.

Tecovas Jasper

Tecovas Jasper, also called Quitaque flint, occurs primarily in the southern Texas panhandle on the eastern, southeastern, and northwestern escarpment of the Llano Estacado as cobbles and discontinuous chert lenses in the Triassic age Tecovas Formation (Hofman 1991:340; Holliday and Welty 1981; LeTourneau 2000:435; Mallouf 1989:315). Other similar materials are found in the Canadian River basin west of Amarillo, and at the headwaters of the Cimarron River in northeastern New Mexico (Banks 1984:72). Tecovas is usually an opaque mottled combination of shades of orange, red and dull yellow, and is often confused with Alibates Agatized Dolomite found in the northern panhandle (Boldurian and Cotter 1999:25; Hofman 1991:341; Kilby 2008:148). However, the two can typically be distinguished macroscopically as Tecovas tends to be mottled yellows and reds while Alibates is typically banded grays, purples, and white (LeTourneau 2000:436). Also, vugs of quartz crystal are more numerous in the Tecovas materials (LeTourneau 2000:436).

Tiger Chert

Tiger chert, also called Green River Formation chert or Bridger Basin chert, is a banded dark brown to black and tan or cream chert from the Eocene Green River Formation (Bamforth 2014:43). Tiger chert is technically fossilized stromatolites, and occurs in the mountains northeast of Lone Tree, Wyoming, and also outcrops extensively in northwestern Colorado (Bamforth 2014:43; Kilby 2008:150-151). The Mahaffy Clovis cache is notable for containing artifacts produced of Tiger chert (Bamforth 2014).

Tongue River Silicified Sediment

Tertiary-age Tongue River silicified sediment (TRSS), or Tongue River silcrete (TRS), is an indurated quartz siltstone or fossil soil from the contact of the Ludlow Member and overlying Tongue River Member of the Fort Union Formation in the Powder River Basin of Wyoming, and is visually similar to Morrison quartzite (Francis 1991:310; Francis and Larson 1996:87). It typically is found in shades of dull, mottled light to medium grays with limonitic staining common on weathered surfaces (Christensen 1984:15; Francis and Larson 1996:87). TRS are also found throughout southwestern North Dakota and northwestern South Dakota (Root, William, and Emerson 2000:240), and is also found secondarily redeposited in the Pawnee Grassland area of northeastern Colorado (Holen 2001:145).

Troublesome Chert

Troublesome Chert, also called Kremmling, is a Miocene-age mottled semi-translucent white chert, formed in altered volcanic ash beds of the Troublesome formation near Kremmling, Colorado on the east side of the Gore Range in Middle Park (Black 2000:134; Kornfeld, Frison, and White 2001; Surovell et al. 2001). Folsom chipped stone artifacts from Barger Gulch Locality B are composed of over 99% of this material type (Surovell et al. 2001). This material is also found in numerous terrace gravel sources, and visually indistinguishable cherts occur in eastern Pitkin County, in the North Park formation in Jackson County, and in the Browns Park formation in Routt and Eagle counties on the west side of the Gore Range (Black 2000:134; LeTourneau 2000:510).

Trout Creek Chert

The primary source location of Trout Creek chert or jasper is found in eastern Chaffee County in Trout Creek Pass in the Sawatch Range near Buena Vista. Trout Creek chert is formed in Ordovician dolomite that occurs in slide blocks of Eocene or Oligocene age, and ranges in colors from deep red to yellow-brown, often with black, red, or green inclusions of pseudomorph carbonate crystals, commonly mistaken as dendrites (Black 2011; Heinrich 1984:90; Jodry 1999:92). However, Black (2000, 2011) indicates that there are more than twenty-five source locations of jaspers in Chaffee, Fremont, and Park Counties that outcrop primarily to the southeast of the Trout Creek source, and range in age from Paleozoic to Tertiary. An additional source of jasper similar to Trout Creek is found in the San Juan foothills in the northwestern San Luis Valley (Jodry 1999:92). Many of these jaspers are macroscopically indistinguishable from true Trout Creek.

White River Group Silicates (Flattop Chalcedony); Various Chalcedonies

A material that frequently appears in Clovis and Folsom assemblages is Flattop Chalcedony, a member of the Oligocene-age White River Group silicates (WRGS) from exposures of the Chadron and Brule Formations (Grieser 1983:6). Flattop, named after Flattop Butte in northeastern Colorado, is one of several chalcedonies (or cherts as defined by LeTourneau 2000:508) that comprise the White River Group silicates, with other localized deposits of chalcedonies occurring in outcrops in eastern Wyoming, southwestern South Dakota, southwestern North Dakota, and western Nebraska (Hoard et al. 1992, 1993:698; Hofman, Todd, and Collins 1991:302; Huckell et al. 2011; Grieser 1983:6). Flattop chalcedony is typically translucent to creamy-white and pinkish-red or lavender in color and often exhibits a dull waxy luster (Ahler 1977:134-135; Asher 2009:27).

Other chalcedonies within this formation include West Horse Creek chert, which ranges in color from “light purple to gray, often with banding, gray lenses, and occasionally a reddish tint or vein” (Hoard et al. 1993:700), and Scenic chalcedony which is usually dark brown in color. Both West Horse and Scenic chalcedony are found in western South Dakota. In Nebraska, comparable chalcedonies are known as Kimball, or simply as Purple and White chalcedony (Ahler 1977:134; Carlson and Peacock 1975). An additional White River Group silicate from Sentinel Butte in southwestern North Dakota has recently been identified (Kilby and Huckell 2013; Huckell et al. 2011). Plate chalcedonies, occasionally called Badlands chalcedony, occur as primary and lag deposits as angular, parallel-sided plates, and typically range in color from gray to pink, and are often translucent (Ahler 1977:136). They are commonly found throughout the Badlands region of northwestern Nebraska and southwestern South Dakota. Macroscopic distinction of these various chalcedonies is typically not possible, but neutron activation analysis and ultraviolet fluorescence can differentiate between different sources (Hoard et al. 1992, 1993, 1995; Hofman, Todd, and Collins 1991; Holen 2001). A clear chalcedony, colloquially termed Holiday Springs, is occasionally found in eastern Colorado. The exact source area of this chalcedony remains unknown, but may be near Pawnee Buttes (Kornfeld et al. 2007:261). Holiday Springs exhibits a bright neon green ultraviolet response. An additional white chalcedony is commonly found in Ogallala Formation gravels (Banks 1990:95). An additional translucent white to gray material characterized by dark dendritic inclusions occurs in secondary alluvial context along Moss Agate Creek in east-central Wyoming, and is colloquially called Moss Agate chalcedony (Kilby 2008:152).

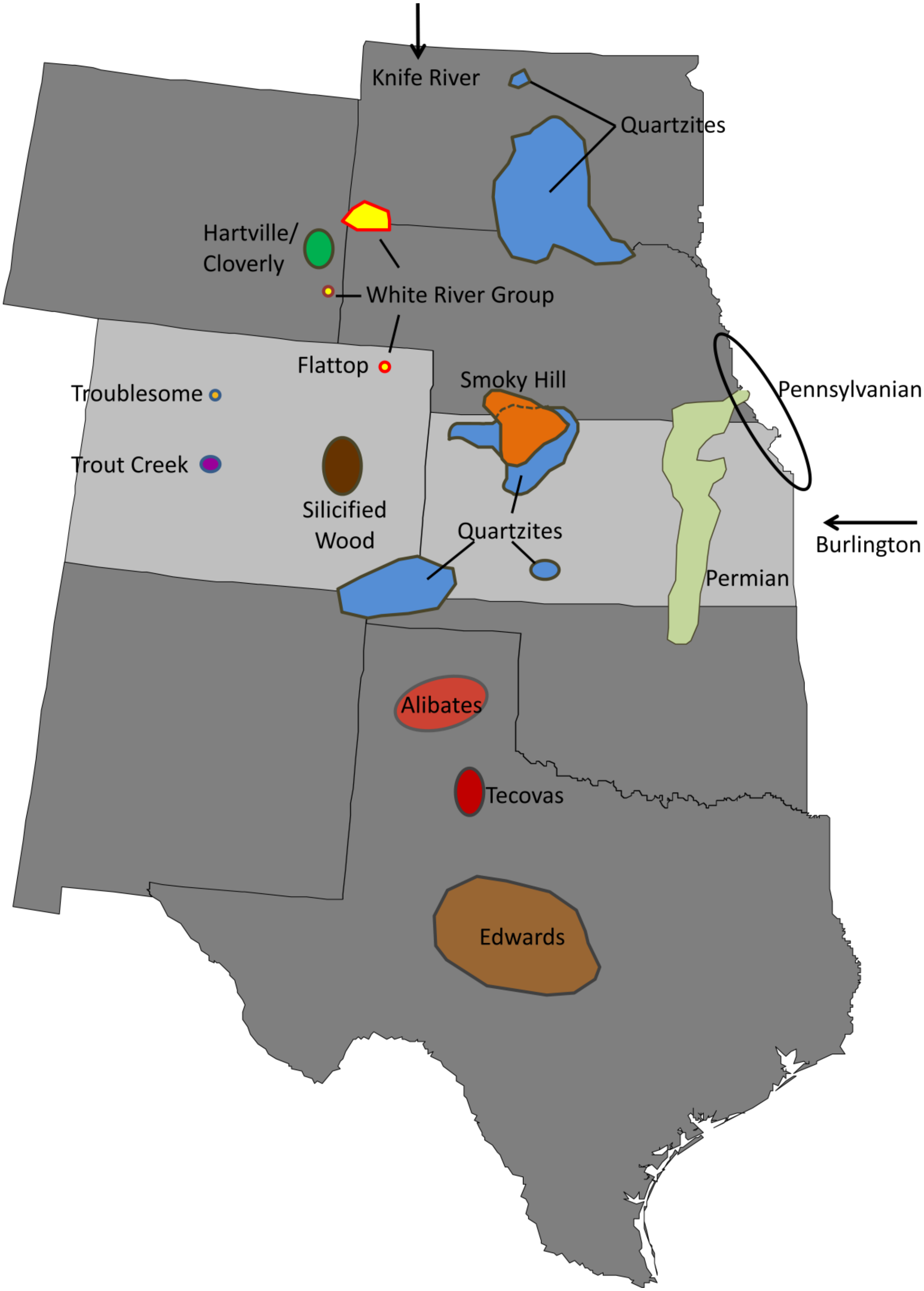

Figure 44. Generalized lithic source areas discussed in this study.

APPENDIX B: Fluted Point Survey Form Developed by Jack Hofman

GREAT PLAINS FLUTED POINT SURVEY **specimen record**
DATE: ; RECORDER: ; SPEC. NUMBER: ; TYPE:

COLLECTION OF:

SPECIMEN FOUND BY: DATE FOUND:

FIND SPOT: STATE: ; COUNTY: ; RIVER SYSTEM;

SITE: ; LEGAL: 1/4; 1/4; SEC. ; T ; R

CONTEXT (field, pasture, road, streambed, terrace, upland, slope, excavation, collection, other):

SPECIMEN TYPE: POINT--(FLUTED / UNFLUTED) ; PREFORM—(FLUTED/UNFLUTED)

PORTION PRESENT (complete, base, base & blade, base corner, tip, blade, edge, channel flake, other):

BREAK TYPES (snap, impact, perverse, hinge, burinated, ear hinged, inhaft snap, crushed, plow nick, other):

LITHIC MATERIAL (translucence, color, texture, source, inclusions):

ULTRAVIOLET RESPONSE: LW ; SW

THERMAL ALTERATION (pot lids, crazing, crenated breaks, luster, color change):

ABRASION/PATINA:

REWORKING (tip/base/blade/edge):

FLAKE BLANK: (Y/N) ; FLAKING PATTERN: face A ; face B

BASE OUTLINE: ; NIPPLE (present/absent/remnant): ;

EDGE OUTLINES: ; EDGE GRINDING (A / B): ; BASE GRINDING:

FLUTE TERMINATIONS: A (hinged/feathered/missing/flaked off) ; B (hinged/feathered/missing/flaked off) ;

PHOTOS (Y / N): ; TYPE: ; FLAKE SCARS/CM: FACE ; MARGIN

LENGTH (cm/in): ; WIDTH: ; BASE WIDTH: ; THICKNESS:
FLUTED THICK: ; BASAL DEPTH: ; STEM LENGTH: ; WEIGHT(gm/oz)
FLUTE LENGTH A: ; FLUTE WIDTH A: ; NUM. FLUTES A:
FLUTE LENGTH B: ; FLUTE WIDTH B: ; NUM. FLUTES B:
DRAW SPECIMEN HERE OR ON BACK [DRAWING, PHOTOGRAPH, MAP]

NOTES:

APPENDIX C: Assignment of Counties to Physiographic Regions

Physiographic Region/County	**Land Area (km^2)**	**Clovis**	**Folsom**	**Midland**
Rocky Mountains				
Boulder (CO)	1946	1	0	0
Chaffee (CO)	2629	4	4	0
Clear Creek (CO)	1027	0	0	0
Custer (CO)	1916	0	0	0
Douglas (CO)	2183	0	1	0
Fremont (CO)	3973	0	0	0
Gilpin (CO)	389	0	0	0
Hinsdale (CO)	2909	0	4	0
Jackson (CO)	4198	0	0	0
Jefferson (CO)	2015	0	0	0
Lake (CO)	994	0	0	0
Mineral (CO)	2273	0	0	0
Park (CO)	5726	0	1	0
Rio Grande (CO)	2362	1	0	0
Teller (CO)	1448	0	0	0
Total	35988	6	10	0
San Luis Valley				
Alamosa (CO)	1874	0	22	0
Conejos (CO)	3343	0	1	0
Costilla (CO)	3187	0	0	0
Saguache (CO)	8211	16	85	0
Total	16615	16	108	0
Colorado Piedmont				
Adams (CO)	3061	0	2	0
Arapahoe (CO)	2086	1	3	0
Bent (CO)	3991	7	1	0
Broomfield (CO)	71.2	0	0	0
Crowley (CO)	2013	4	5	2
Denver (CO)	401.3	0	0	0
El Paso (CO)	5517	3	0	0
Elbert (CO)	4794	1	16	0
Kiowa (CO)	4626	4	9	2
Larimer (CO)*	6822	1	19	0
*Larimer County falls primarily within the Rocky Mountains but all artifacts considered here are from the Colorado Piedmont				

Physiographic Region/County	**Land Area (km^2)**	**Clovis**	**Folsom**	**Midland**
Colorado Piedmont (Cont.)				
Lincoln (CO)	6698	5	2	0
Logan (CO)	4779	62	122	10
Morgan (CO)	3351	6	10	0
Otero (CO)	3289	0	1	0
Prowers (CO)	4258	0	1	0
Pueblo (CO)	6211	4	3	0
Weld (CO)	10,417	19	33	0
Total	72385.5	117	227	14
Raton Basin				
Huerfano (CO)	4126	0	0	0
Las Animas (CO)	12368	2	9	1
Total	16494	2	9	1
High Plains				
Baca (CO)	6623	2	3	0
Barton (KS)	2334	0	2	0
Cheyenne (CO)	4614	9	7	0
Cheyenne (KS)	2644	4	0	0
Decatur (KS)	2315	1	1	0
Finney (KS)	3375	3	8	0
Ford (KS)	2846	0	0	0
Gove (KS)	2776	0	0	0
Graham (KS)	2328	0	0	0
Grant (KS)	1489	4	2	0
Gray (KS)	2251	0	0	0
Greeley (KS)	2015	1	2	0
Hamilton (KS)	2585	0	2	0
Haskell (KS)	1497	0	0	0
Hodgeman (KS)	2227	0	0	0
Kearny (KS)*	2256	9	10	4
Kit Carson (CO)	5598	11	11	1
Lane (KS)	1860	1	0	0
Logan (KS)	2779	1	0	0
Meade (KS)	2536	0	0	0
Morton (KS)	1891	0	2	0
*Artifacts from Kearny County were found in association with dune features of the Arkansas River Lowlands, but on upland surfaces of the High Plains				

Physiographic Region/County	Land Area (km^2)	Clovis	Folsom	Midland
High Plains (Cont.)				
Norton (KS)	2282	0	0	0
Pawnee (KS)	1955	1	0	0
Phillips (KS)	1781	0	0	0
Rawlins (KS)	2771	0	0	0
Scott (KS)	1860	2	0	0
Sedgwick (CO)	1423	15	34	2
Seward (KS)	1658	0	4	1
Sheridan (KS)	2321	0	0	0
Sherman (KS)	2735	5	5	2
Stanton (KS)	1761	1	1	0
Stevens (KS)	1883	8	0	0
Thomas (KS)	2784	0	0	0
Wallace (KS)	2367	1	1	0
Washington (CO)	6537	25	47	3
Wichita (KS)	1862	2	0	0
Yuma (CO)	6136	61	48	8
Total	100955	167	190	21
Arkansas Lowlands				
Edwards (KS)	1611	0	0	0
Kiowa (KS)	1873	1	0	0
Pratt (KS)	1906	0	0	0
Reno (KS)	3294	0	0	0
Rice (KS)	1886	0	0	0
Stafford (KS)	2059	0	0	0
Total	12629	1	0	0
Red Hills				
Barber (KS)	2942	0	1	
Clark (KS)	2530	0	0	
Comanche (KS)	2046	1	0	
Total	7518	1	1	
Smoky Hills				
Clay (KS)	1699	1	1	0
Cloud (KS)	1860	0	0	0
Dickinson (KS)	2207	0	0	0
Ellis (KS)	2331	0	0	0

Physiographic Region/County	Land Area (km^2)	Clovis	Folsom	Midland
Smoky Hills (Cont.)				
Ellsworth (KS)	1873	0	0	0
Jewell (KS)	2367	6	0	0
Lincoln (KS)	1865	0	0	0
Mitchell (KS)	1862	0	1	0
Ness (KS)	2784	0	0	0
Osborne (KS)	2315	0	0	0
Ottawa (KS)	1867	0	0	0
Phillips (KS)	2318	0	0	0
Republic (KS)	1865	9	1	0
Rooks (KS)	2318	0	0	0
Rush (KS)	1860	0	0	0
Russell (KS)	2328	0	0	0
Saline (KS)	1867	0	0	0
Smith (KS)	2323	0	0	0
Trego (KS)	2331	0	0	0
Washington (KS)	2328	1	0	0
Total	42568	17	3	0
Wellington-McPherson				
Harper (KS)	2080	0	0	0
Harvey (KS)	1401	0	0	0
Kingman (KS)	2246	0	0	0
McPherson (KS)	2334	0	0	0
Sedgwick (KS)	2613	0	0	0
Sumner (KS)	3069	0	0	0
Total	13743	0	0	0
Flint Hills				
Butler (KS)	3748	1	0	0
Chase (KS)	2015	0	0	0
Cowley (KS)	2932	1	0	0
Elk (KS)	1683	0	0	0
Geary (KS)	1046	0	2	1
Greenwood (KS)	2986	1	0	0
Lyon (KS)	2214	2	0	0
Marion (KS)	2471	0	0	0
Morris (KS)	1821	0	0	0
Riley (KS)	1611	13	1	0

Physiographic Region/County	**Land Area (km^2)**	**Clovis**	**Folsom**	**Midland**
Flint Hills (Cont.)				
Wabaunsee (KS)	2072	5	0	0
Total	24599	23	3	1
Glaciated Region				
Atchison (KS)	1124	2	2	0
Brown (KS)	1481	0	0	0
Doniphan (KS)	1031	4	6	0
Jackson (KS)	1704	0	0	0
Jefferson (KS)	1443	0	1	0
Leavenworth (KS)	1215	0	2	0
Marshall (KS)	2344	2	3	0
Nemaha (KS)	1862	1	0	0
Pottawatomie (KS)	2233	4	5	0
Wyandotte (KS)	404	6	1	0
Total	14841	19	20	0
Osage Cuestas				
Allen (KS)	1308	0	0	0
Anderson (KS)	1513	0	1	0
Bourbon (KS)	1655	0	0	0
Cherokee (KS)	1531	1	0	0
Coffey (KS)	1694	1	0	0
Crawford (KS)	1541	1	0	0
Douglas (KS)	1230	3	0	0
Franklin (KS)	1494	1	2	0
Johnson (KS)	1243	7	0	0
Labette (KS)	1691	0	0	0
Linn (KS)	1570	0	0	0
Miami (KS)	1528	0	0	0
Montgomery (KS)	1686	0	0	0
Neosho (KS)	1497	0	0	0
Osage (KS)	1865	1	0	0
Shawnee (KS)	1440	3	0	0
Wilson (KS)	1489	11	2	0
Woodson (KS)	1308	0	0	0
Total	27283	29	5	0

Physiographic Region/County	**Land Area (km^2)**	**Clovis**	**Folsom**	**Midland**
Chautauqua Hills				
Chautauqua (KS)	1671	0	0	0
Total	1671	0	0	0