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INTERPRETING LAND-USE DURING THE LATE PALEOINDIAN BULL CREEK OCCUPATION ON THE SOUTHERN PLAINS

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INTERPRETING LAND-USE DURING THE LATE PALEOINDIAN BULL CREEK OCCUPATION ON THE SOUTHERN PLAINS

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Land Acknowledgement

The Bull Creek valley is recognized in recorded history as being within the territorial range of the Osage, Kiowa, and Comanche tribes. This is important to acknowledge because European colonists forced Indigenous tribes in and around the region out of their homelands, where their traditions and histories are embedded. Through this thesis I hope to shine a light on some of the original occupants of this land.

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All photos taken by author unless stated otherwise.

ABSTRACT

The Bull Creek late Paleoindian archaeological site (34BV176), located along a tributary of the Beaver River in the Oklahoma Panhandle, is among the few known earliest human occupation sites on the Southern Plains. Located less than 2 kilometers (0.75 miles) away is the contemporaneous Ravenscroft site (34BV198), where investigations have revealed two arroyos containing the remains of at least five separate, large-scale bison hunting events. By applying catchment analysis to the faunal, lithic, and botanical data acquired through excavation at the sites and integrating those results with data on temporality, a land-use model applicable to late Paleoindian occupants of the Bull Creek valley is constructed. This preliminary model outlines their subsistence and settlement strategies and situates them within the surrounding landscape. Utilization of the landscape approach offers a comprehensive and humanizing way of interpreting the late Paleoindian archaeological record in the Bull Creek valley.

CHAPTER ONE

INTRODUCTION

One of the prevailing, most broadly applied goals of modern archaeological investigation is to describe ancient landscapes and the people who inhabited them, each as having conditioned the other to varying degrees. Landscapes are understood to be more than mere terrain scattered with natural resources and camp sites, but dimensions of space imbued with sociocultural meaning. Through the anthropological lens, landscapes are distinct from territory: territory subsumes one or multiple given landscapes, and landscapes may subsume one or multiple territories. For the earliest, highly mobile foraging groups who lived in the North American Great Plains, distinctions between landscapes and territory were likely blurred. Yet during the late Paleoindian period, several thousand years later, a shift is apparent. Projectile point styles—used as a proxy for semi-cohesive sociocultural grouping—began to diversify, with numerous distinct styles found in loosely bounded areas through varying time periods, whereas earlier Folsom and Clovis type points are found across the entire Southern Plains region with little change in design for relatively long spans of time. Hurst (2010) suggests that this indicates the initial formation of identity-based territories on the Southern Plains landscape during the late Paleoindian period.

Ongoing research on late Paleoindian archaeological deposits in the Bull Creek valley, a tributary of the east-flowing Beaver River located in the rolling hills of the Oklahoma panhandle, shows repeated occupation of the valley by socioculturally connected groups, through different seasons, over a span of at least five centuries. The Bull Creek (34BV176) and Ravenscroft

(34BV198) sites sit within two kilometers (around 0.75 miles) of each other and contain among them numerous artifacts and features that, through careful analysis, allow for an increasingly detailed vision of the dynamic cultural lives of the sites' former inhabitants to be pieced together. The Bull Creek valley is revealed as a persistent place on the late Paleoindian, Southern Plains landscape, and, I argue, is a dimension of their territory worthy of fine-grained investigation and a detailed attempt at interpretation. The primary goal of this thesis is to describe and explain late Paleoindian lifeways in the Bull Creek valley through construction of a land-use model. Of central concern are the landscape-situated places which were chosen for occupation, the duration and timing of occupations, and the evident factors that influenced choice of movement within and around the valley space. I propose that data evident between the two sites under study represent not only the actions of a small group or groups of individuals but patterns of movements through the regional landscape for resource acquisition (and certainly much more) which spanned at least five centuries and characterized the lives of countless individuals in and around the Bull Creek valley during the late Paleoindian period.

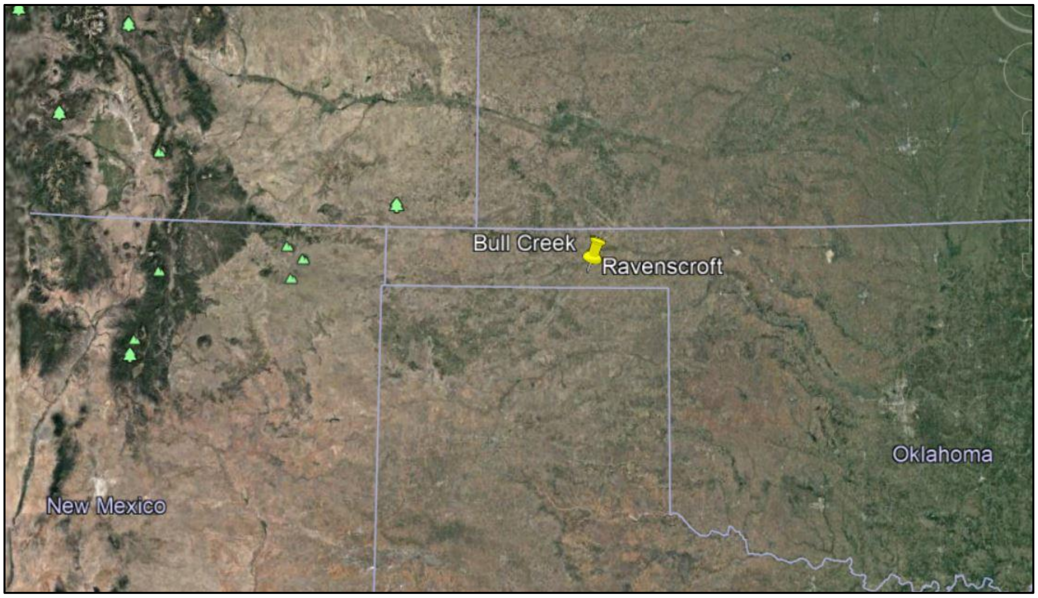

Figure 1-1. Map of satellite imagery showing the approximate location of the Bull Creek valley sites.

Models of land-use in the Plains region and surrounding Americas tend to be constructed through inferences made on data gathered through analysis of stone tools, associated large animal remains, and paleoenvironmental reconstructions (LaBelle 2010; MacDonald and Nelson 2019). Smaller fauna and plant and botanic remains are almost entirely absent from these analyses. This is largely due to how poorly plant and other organic materials preserve in archaeological contexts. Yet regardless of justification of their absence, the resulting subsistence and settlement interpretations are biased towards stone tool production, exchange, and use in the hunting of large animals like mammoths and bison. However, the importance of plants, in particular, is known to be a ubiquitous characteristic of subsistence and settlement strategies among foraging groups in non-arctic environments throughout the ethnographic record (Kelly 1995; Keeley 1999), as well as among archaeologically visible groups as at sites with better preservation (Dent 2007; Hollenbach 2010). Therefore, in order to bring attention to the activities of groups who were not directly engaged in bison small-herd hunting— the main activity represented in the late Paleoindian Bull Creek valley landscape— archaeobotanical data is included and emphasized in my final land-use model.

In the following Chapters 2 and 3, I provide an overview of the relevant environmental and cultural background. Chapter 4 outlines the history of investigation at the sites and details what has been found, with emphasis on the data significant to land-use. Chapter 5 introduces the theories that my research questions are founded upon, and Chapter 6 explains the methods of analysis I used to address those questions. The results of my analyses are synthesized in Chapter 7 into a preliminary land-use model for late Paleoindian occupants of the Bull Creek valley, and further explored in the discussion and concluding thoughts presented in Chapter 8.

CHAPTER TWO

ENVIRONMENTAL BACKGROUND

Modern Environment

The Bull Creek (34BV176) and Ravenscroft (34BV198) archaeological sites are located within nearby depositional landforms adjacent to Bull Creek, an 18 km long northwest-draining intermittent second order stream of the Beaver (or North Canadian) River, which flows eastward through the North American region known as the Oklahoma panhandle (Arauza et al. 2015; Bement et al. 2007a and 2007b). The Oklahoma panhandle is within the southern reaches of the Great Plains, in an ecological region referred to as the Central Plains or Southern High Plains (Mandel 2000; Holliday 1997). The panhandle consists of Beaver, Texas, and Cimarron counties; this study is situated within the borders of Beaver county (Doerr and Morris 1960). This region was long ago levelled by water flow from the Rocky Mountains to the northwest, and over time has been shaped by fluvial and eolian processes (Johnson 2008a, 2008b). The landscape in the Oklahoma panhandle portion of the southern Plains today shifts from massive, basalt-capped mesas in the far northwestern reaches of Cimarron county eastward to long expanses of flat, featureless terrain that gradually roll into hills and valleys, where the sites studied here are found (Doerr and Morris 1960).

Precipitation is typically low on the present-day, semiarid southern Plains (Holliday 1997). Spring-fed streams and playas scattered throughout the landscape are the only predictable sources of water, although playas and intermittent streams like Bull Creek may dry unpredictably from months to years at a time, depending on climatic conditions (Bement et al. 2007b). Paleoenvironmental reconstruction suggests that present climatic conditions generally reflect those that occurred throughout much of the Holocene epoch, for approximately the past 11,000 calendar years (Bement et al. 2007a). Modern and archaeologically evidenced human occupation locations show patterned attraction to those limited water sources for both water and access to the wildlife and vegetation also supported by these places. Lateral migration of Bull Creek has exposed stratigraphic sequences of deposited sediments and buried soils containing archaeological sites in Bull Creek valley that indicate human occupation around the stream dating from the Paleoindian era and through the Archaic period to modern day (Arauza et al. 2016). Similar geomorphology and stratigraphic sequences containing deposits that also accumulated throughout the Holocene are found further south on the Southern High Plains of northwestern Texas and eastern New Mexico (Holliday 1995). The two late Paleoindian sites involved in this study, Bull Creek and Ravenscroft, are preserved within the Bull Creek valley deposits and together reflect details of long-term relationships between humans, the landscape, and other life forms that once coexisted there.

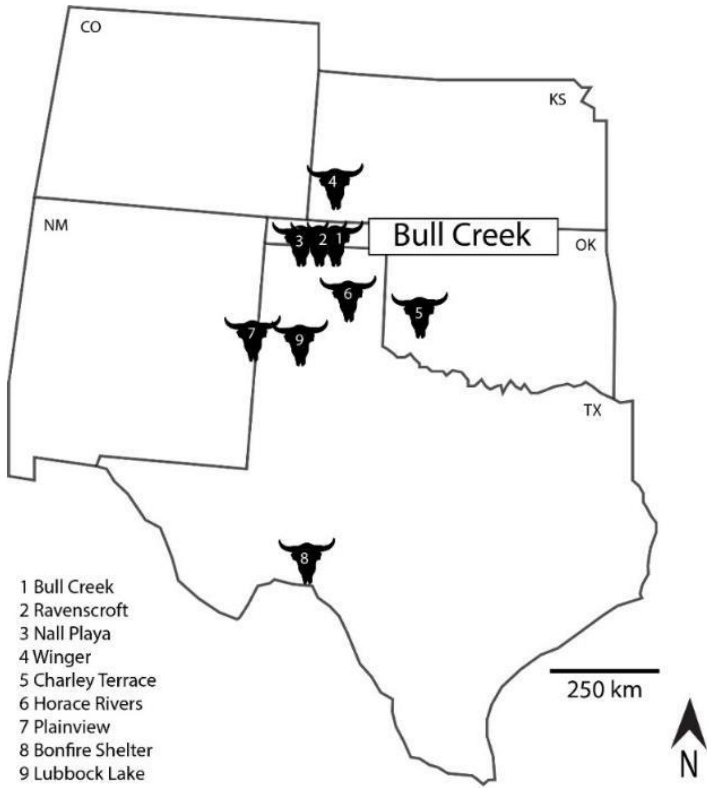

Figure 2-1. Locations with state boundaries of Bull Creek, Ravenscroft, and other roughly contemporaneous archaeological sites (from Bement et al. 2018).

Geology and Physiology

Underlying Bull Creek valley are the Permian-aged Cloud Chief and Doxey sedimentary rock formations, dating from roughly 299 to 252 million years ago (mya), and unconformably above it, the Neogene Ogallala formation, originating roughly 23 to 3 mya (Arauza et al. 2016). During the Permian period, a shallow inland sea covered the Oklahoma panhandle. A thick layer of sediments accumulated and eventually lithified beneath it, forming the limestones, shales, and red sandstones seen today, the latter commonly known today as the Permian red beds. In the Bull Creek valley, Permian rocks are found cropping out of gully walls and terrace cuts (Bement et al. 2007). During the later Paleogene and Neogene periods, from approximately 65 to 1.8 million years ago, fluvial activity from the Rocky Mountains deposited a much thinner layer of sediments eastward across the High Plains, producing the Ogallala formation (Johnson 2008a, 2008b). Around Bull Creek, the Ogallala formation is visible in outcrops of pink, white, or red gravelly sandstone (Arauza et al. 2016). The Ogallala formation contains the fossils of a wide array of extinct mammalian species who once inhabited the region, including mastodons, horses, rhinoceroses, camels (Johnson 2008a, 2008b). These fossils have often been found to have eroded out of their original depositional contexts and were re-deposited, warranting added caution when associating fossils with time periods indicated by the stratigraphy containing them.

In the proceeding Quaternary period and towards the end of the Pleistocene epoch or "Great Ice Age", sediment accumulation and burial was primarily driven by glacial outwash from the Rocky Mountains. Fluvial and eolian activity during that time, through the Holocene epoch and late Quaternary, formed terraces and floodplains of unconsolidated sediments and soil surfaces that still shape the landscape today (Johnson 2008a, 2008b). Drought and wind erosion were and continue to be significant forces of sediment deposition, as reflected in the ever-shifting fields of sand dunes that span the southern Plains, often adjacent to playa basins (Holliday 1997). The dunes primarily consist of substantially reworked Ogallala materials and many contain buried soils, some dating back to the Pleistocene (Thurmond and Wyckoff 1998). Dune deposits are not implicated directly in this study but are significant in discussion of the sites' settings, potentially offering valuable, associated environmental and archaeological data (Holliday 2001). Quaternary period deposits additionally contain a myriad of fossils – some originally from the Ogallala formation – including the remains of mastodons, mammoths, horses, camels, and extinct species of bison (Johnson 2008b).

Climate

The Bull Creek valley today, like the surrounding southern Plains, is semi-arid. Precipitation averages 500mm in annual rainfall alongside 380mm in evaporation (Bement et al. 2007). However, these averages can vary greatly year-to-year, and climatological records providing data for more accurate comparison in the panhandle are non-existent and/or incomplete (Doerr and Morris 1960; Ferring 1990). Droughts are common and devastating occurrences, often depriving all organisms living in the stricken region of critical water resources and increasing the number and intensity of wildfires (Bomar 1983). Most precipitation comes in the form of heavy spring and summer rains between May and August, often accompanied by high winds and frequently brief but potentially disastrous tornadoes and flash flooding (Bement et al. 2007).

Seasons are pronounced on the southern Plains, with cold winters capable of producing catastrophic ice storms and summers that regularly reach over 43°C (around 110°F). Spring and autumn are typically pleasantly temperate; cool nights are followed by days warmed by sunlight largely uninhibited by the mostly sparse vegetation. The air temperature averages annually around 14°C (57°F) (Bement et al. 2007). High winds sweep across the southern Plains almost daily, usually coming from the southwest and west. Less frequent cold winds blowing from the north are those most frequently associated with heavy rainfall and tornadic formation. Measurements of average annual wind velocity fall between 12 to 18 mph (Doerr and Morris 1960; Webb 1931); winds coinciding with storms and tornadoes can exceed 100 mph.

The majority of the ground water in this area of the High Plains is found in the Ogallala Formation. Around the Beaver (North Canadian) River, ground water occurs primarily in alluvium and terrace deposits (Marcher 1979). This water comes from precipitation seeping into bedrock (the volume of which varies yearly, but is expectedly low), which is then held in aquifers or discharged through springs into streams (Marcher 1979). Bull Creek is one of thirty-five named streams that flows into the Beaver River; most of these creeks are spring-fed and hold water throughout the year, however, Bull Creek itself only flows after heavy rains (Bement et al. 2007). Some evidence suggests there is, or at least was in recent history, a cyclical pattern between the highest and lowest precipitation levels spanning approximately 11 years (Doerr and Morris 1960). The length of these cycles has surely changed to some yet unknown degree since those estimations were made half a century ago, due to the rapidly changing climate at present.

Vegetation and Wildlife

The present day Bull Creek valley and surrounding southern Plains region are part of the shortgrass prairie ecosystem that stretches across western Oklahoma, southward into Texas and New Mexico, and far northward into Canada, distinct from the tallgrass and mixed grass prairie ecosystems found elsewhere on the Plains (Woods et al. 2005; Blair 1938). Grasslands blanket the southern Plains, but are absent in many areas today due to overgrazing and other human activities, which result in degradation of the topsoil . This floral ecosystem is dominated by the perineal blue grama (*Bouteloua gracilis)* and secondarily buffalo (*Buchloe dactyloides*) grasses, both of which originally migrated north out of central Mexico following the grazing preferences of large herbivores (Bruner 1931; Quinn et al. 1994). All short grasses are strongly drought resistant, though the quantity and successful survival of each species depends upon conditions of the soil they grow from. The distinction between shortgrass prairie and mixed-grass prairie in the region of Beaver county studied here can also fluctuate with climatic shifts; wetter conditions and areas adjacent to water can allow for the growth of mixed and tall grasses within the broader shortgrass ecosystem (Bement et al. 2007b).

During the growing season, which occurs annually for an average of 190 days between spring and summer months (Doerr and Morris 1960), the landscape flourishes with green vegetation and vibrant wildflowers. Yucca (*Yucca glauca*), sand sagebrush (*Artemisia filifolia*), and sand-hill plum (*Astragulus crassicarpus*) among other shrubs also thrive here, especially where the soil has been disturbed by erosional forces of livestock overgrazing and eolian weathering (Doerr and Morris 1960). Native trees in this area tend to grow near sources of water and along streams like Bull Creek, primarily cottonwood (*Populus deltoids*) and red cedar (*Juniperus virginiana*) (Bement et al. 2007b).

Faunal life around the Bull Creek valley consists of various mammalian, amphibian, avian, reptilian, icthian, and molluscan species adapted to life on the Plains (Bement et al. 2007b). The most common mammals- listed here from largest to smallest in size- include whitetail and mule deer, antelope, coyotes, jackrabbits, cottontail rabbits, prairie dogs, ground squirrels, and numerous species of small rodents. Many avian species migrate in and out of the region seasonally. Reptiles include various species of snakes, lizards, and box turtles. Icthian and molluscan species are most prevalent within the region's rivers and streams today and throughout the Holocene, as reflected within fluvial / alluvial sedimentological deposits (Bement et al. 2007b).

Bison (*Bison bison*) lived as the largest mammals on the Plains for at least 13,000 years after surviving the terminal Pleistocene mass megafaunal extinctions on and beyond the Plains, which occurred around the same time that humans first arrived on the continent (Martin 2005; Martin and Klein 1984). Throughout the Holocene (archaeological Paleoindian to Historic eras) bison remained a pivotal resource for Indigenous peoples' means of survival and culture, until the entire species was brought to the very edge of extinction through intentional and ecologically ill-advised overhunting by the U.S. government and conspirators in the late 1880s (Dary 1989). There are no truly wild-roaming bison alive on the Plains in the continental U.S. today. Of the large mammals whose herds numbered in the tens of millions just a few hundred years ago, only several thousand now exist, confined within a small number of national parks and wildlife reserves (Berger and Cunningham 1994; Flores 2001).

Soils

Soil formation has occurred throughout the Bull Creek valley atop stable surfaces of previously deposited sediments over varying periods of time as depositional and erosional processes simultaneously have continued to affect the landscape (Conley 2010). The semiarid conditions of the southern Plains cause pedocal soils to develop here, which have low amounts of organic matter and high levels of calcium carbonate (Goldberg and Macphail 2006). Soils along the Beaver River and its tributaries in western Oklahoma are generally sandy and loamy, mixed with consolidated minerals and sediments such as gypsum and caliche (Arauza 2016). Modern topsoil layers are thin, measuring on average 30-70 cm below the surface (Doerr and Morris 1960). Studies of the depositional stratigraphy in the Bull Creek valley have identified multiple episodes of pedogenesis (soil formation) upon upper deposits of eolian and colluvial / alluvial sediments, yet none upon the layers of sandy, gravelly alluvium beneath them (Bement et al. 2007). More detailed characteristics of the soil series at sites in the Bull Creek valley are provided in the proceeding sections.

Numerous studies have documented buried soils within Quaternary dune deposits across this region. Though the majority of dunes in the southern Plains date from the middle to late Holocene in age, some have been dated as far back as the late Pleistocene (Thurmond and Wyckoff 1998). Thurmond and Wyckoff (1998), who documented a great extent of such dune fields across the southern Plains, attribute differences in soil types and associated plants and animals in this region to underlying, contrasting Permian and Paleogene/Neogene lithology. Soils formed above the Ogallala formation are deeper and sandier than those above Permian outcrops, and provide for more robust vegetation and a wider diversity of plant and animal species. Soils atop Permian outcrops are comparatively thin and fine grained, supporting shorter grasses and more limited biodiversity (Thurmond and Wyckoff 1998). Of central importance to the archaeological investigation here, is the observation that such short grasses attracted both migratory and residential herds of bison (Lewis et al. 2009; Carlson et al. 2017).

Bull Creek (34BV176)

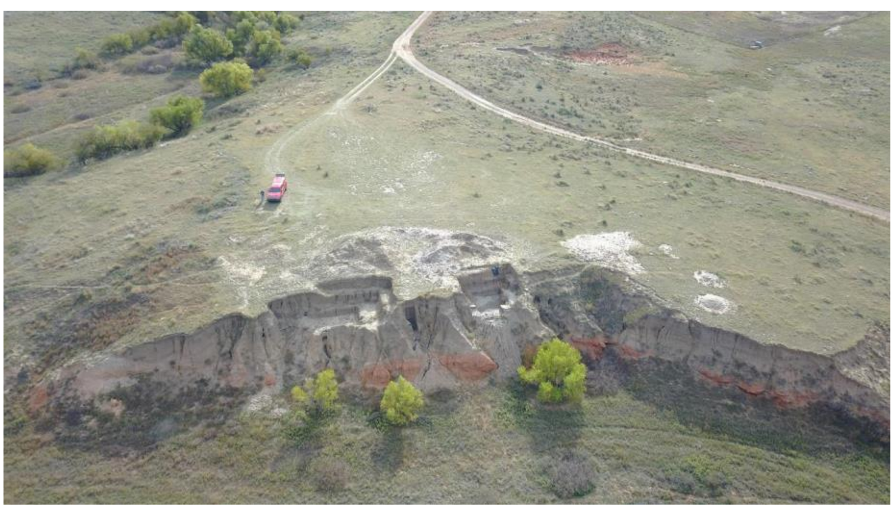

Figure 2-2. Aerial photograph of the terrace containing the Bull Creek site (from Bement et al. 2018).

The Bull Creek open-air camp site is contained within a roughly 5 meters-high T3 terrace remnant under approximately 2.5 meters of sediments and soils below the upper surface, 16 km upstream from where Bull Creek drains into the Beaver River (Bement et al. 2018). Three distinct stratigraphic units are represented in the profile exposed across the terrace edge containing the Bull Creek site and have also been documented along several other T3 terraces in the Bull Creek valley. The lowest, Stratum I, consists of late Pleistocene sands and gravels as well as various megafauna fossils, Stratum II consists of fine-grained alluvium and several buried soil layers, and Stratum III - which extends up to the modern ground surface - also consists of several buried soils and reworked eolian silt loam (Bement et al. 2018). Cultural deposits identified here include a late Archaic occupation reaching across the ground surface and below to a depth of around 20 cm, and stratified late Paleoindian occupations around 2.4 – 3.6 m below the surface with four identified cultural components dating between ~11,588 to ~9020 ± 35 RCYBP. Paleoindian cultural material is believed to extend at least 60 m beyond the cutbank edge and at least 100 m across – potentially totaling 6,000 m^2 of archaeological deposits.

Figure 2-3. Stratigraphy and active erosion exposed on terrace cut at Bull Creek.

Ravenscroft (34BV198)

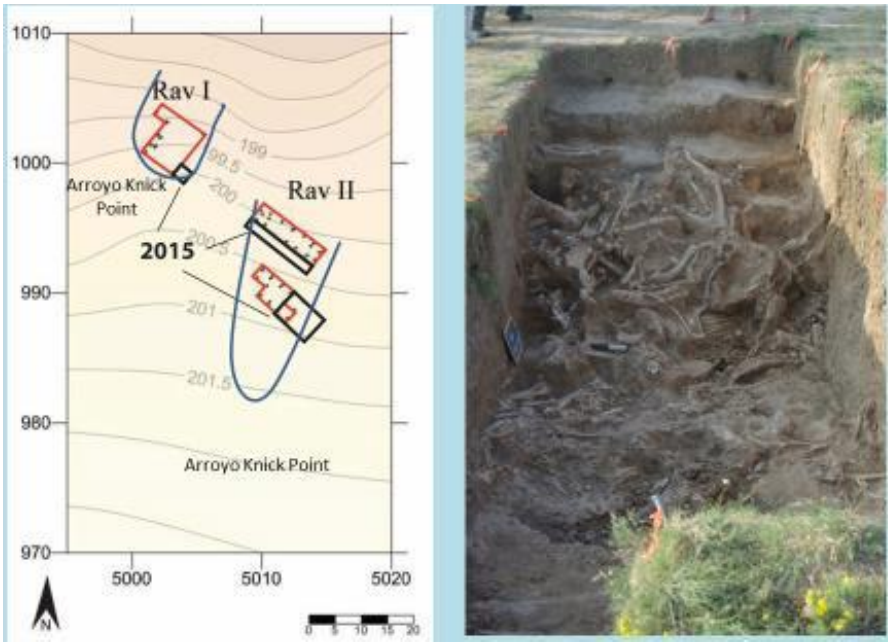

Figure 2-4. Topographic layout and mid-excavation photograph of Ravenscroft (from Bement et al. 2018).

Ravenscroft is a large arroyo trap bison kill site located within the high interfluve of a first order tributary to Bull Creek, 1.2 kilometers south of the Bull Creek camp site (Bement et al. 2018). At this site, two adjacent arroyos were used in at least five evident wintertime large-scale bison hunting events and were later filled by colluvium along with (to a much lesser extent) eolian deposition, preserving the bones and various associated artifacts. The kill events are distinguished based on stratigraphic distinction, varied stages of weathering, and radiocarbon dating (Bement et al. 2018). Despite the lack of direct associations between the Bull Creek site occupations and the Ravenscroft kill events, closely correlated radiocarbon dates and similarity between archaeologically-evident activities prove cultural contemporaneity (Bement et al. 2018).

Though additional camp and kill sites are believed to exist yet undiscovered in the Bull Creek valley, investigation at the Bull Creek camp site and Ravenscroft kill sites together has allowed for reconstruction of a chronicle of late Paleoindian subsistence strategies and the seasonal paleoenvironment to which they were adapted (Bement et al. 2018).

Paleoenvironmental Reconstruction

Recent efforts in paleoclimatic reconstruction in the Bull Creek valley have provided multiple lines of evidence which reveal details and patterns of consistently changing and stabilizing environmental conditions in the area (Bement et al. 2007a). Around 19,000 years ago the general warming transition from Earth's Last Glacial Maximum (LGM) to the present interglacial period began (Clark et al. 2012), culminating in the shift marked at around ~10,000 RCYBP from the Pleistocene to the Holocene epoch (Pillans 2007). This resulted in the near-complete melting of the glaciers that intermittently through the Pleistocene blanketed much of the continent, along with a wide-reaching variety of related environmental shifts. Towards the end of this transition, warming conditions in North America temporarily reversed from around ~11,000 to ~10,000 RCYBP in the period referred to as the Younger Dryas (YD), which was generally associated with changes in vegetation, fauna, and geomorphology (Holliday et al. 2011; Mangerud et al. 1974).

Throughout the Great Plains, commonly employed paleoclimatic proxy records such as tree rings, marine carbonate, packrat middens, speleothems, and paleobotanical materials often are not accessible, pushing researchers toward finding less resolved or common environmental proxies (Holliday 2001). Analysis of stable carbon isotopes present in bison bone samples recovered from Ravenscroft provides insight on climatic change in the southern Plains through the early Holocene (Bement et al. 2018; Carlson et al. 2017). These studies confirm heating and drying climatic conditions at the end of the Allerod followed by the colder and wetter conditions that peaked during the ~1,200 years-long Younger Dryas period. Climatic conditions again heated and dried after the Younger Dryas, generally continuing through the early Holocene to today (Bement et al. 2018).

In the High Plains, researchers have found that eolian deposits offer "the most complete late Quaternary, regionally traceable indicator of the geomorphic response to climatic extremes" (Holliday 2001). Bull Creek's meandering northwestern movement has incised steep terraces in the land, revealing stratigraphic profiles of eolian and alluvially deposited sediments and buried soil and material remains that have been extensively studied and dated to a maximum age of ~13,210 ± 80 RCYBP (Arauza et al. 2016; Bement et al. 2007; Sudbury 2010; Conley 2010). Sedimentary layers in terraces incised by Elm Creek, similar to those found around Bull Creek and only ~20 km northeast along the Beaver River, were dated as far back as ~27,940 ± 230

RCYBP (Bement et al. 2007a). Archaeological sites found preserved within these deposits range in origin from Clovis to Late Prehistoric times (Bement et al. 2018).

The filling and cutting of terraces is attributed to climatological, not tectonic, influence, and the initiation of downcutting is generally attributed to floods and loss of vegetation cover (Arauza et al. 2016). The valley terraces have been categorized here into sets based upon altitude from T0 at the modern floodplain to discontinuous T1A, T1B (limited), T2, and T3 (Arauza et al. 2016). Over half of the sediment record is contained within T3 terrace remnants at the highest altitude above the modern stream channel – including the Bull Creek site (Arauza et al. 2016). Dating organic material samples pulled in-situ from strata exposed in profiles indicates that the T3 terraces spanned the ~7,000 radiocarbon-year period between ~13,210 ± 80 RCYBP at the bottom and ~6200 ± 90 RCYBP at the top (Arauza et al. 2016).

Figure 2-5. Soil stratigraphy and associated radiocarbon dates; cultural materials found between stratum 22 to 28 (from Carlson and Bement 2017). All dates shown are uncalibrated.

Analysis of phytoliths and faunal remains buried within the Bull Creek site stratigraphic profile suggest that the environment during the late Pleistocene and early Holocene was wetter and cooler on average than present conditions, resulting in an increase in alluvially-deposited sediments and a rise in elevation of the stream (Bement et al. 2007a; Arauza et al. 2016). This data, along with the recent analysis of stable carbon isotopes contained within the collagen of bison bone samples collected from the sites studied here, coincides with global records of climatic conditions and the timing of the Younger Dryas period (Arauza et al. 2016; Carlson et al. 2017). Stratigraphic records in the Bull Creek valley show an effective decrease in moisture and an increase in eolian erosion and deposition during the early to middle Holocene, indicative of regionally pervasive warming and drying (Arauza et al. 2016). Extensive sand dunes are found across the northern and eastern slopes of the Beaver River basin, formed by wind-blown sand deposits derived from the river's stream channels (Bement et al. 2007b). The dunes attest to the episodic nature of arid periods following the onset of the Holocene. Aridity increased further during the middle Holocene; drought conditions continued with reduced severity into the late Holocene and through to present day (Arauza et al. 2016).

Grain size analyses of sediments deposited in stratigraphic profiles studied in 2007 at the Bull Creek site indicate shifting periods of precipitation and stream flow correlated with periods of aridity. Coarse alluvial grains in the lowest layers of sediments indicate rapid stream flow, layered above by finer grains deposited during a slowing of the stream, integrated with colluvial and overbank deposits. Next, a thin layer of wind-blown silts points to a brief period of aridity, followed by alluvial / colluvial sands indicating an increase in precipitation around ~10,850 RCYBP. There is little change in the sediments deposited up to a point dated at ~10,400 RCYBP. Above these strata and to the modern ground surface, fine grain sizes indicate a long period of eolian deposition. Periods of relatively high moisture are indicated by buried soils dated to ~9850 RCYBP, ~8270 RCYBP, ~7660 RCYBP, and ~6200 RCYBP. The age of the youngest soil is indicative of a roughly six-thousand radiocarbon year period of little to no deposition between that soil and the present (Bement et al. 2007a).

Biostratigraphy

Paleobotanical remains, including pollen and phytoliths, are scarce but provide primary proxies for making inferences about the climate and vegetation of the paleoenvironment in recent studies within the Bull Creek valley and broader Plains region. The analysis of stable carbon isotopes and particle size distribution are secondary sources of information. Pollen data from the 2007 stratigraphic profile at the Bull Creek site indicates a water-front ecological zone prior to the Younger Dryas and dense vegetation, where oak, elm, willow and walnut trees grew above mixed grasses, shrubs, and species in the sunflower family (Arauza et al. 2016; Bement et al. 2007a). Grasses during this period around ~11,000 RCYBP were predominantly C3 species, favoring cooler seasons (Bement et al. 2007b). Increased eolian deposition, C4 grass species, and a decrease detected in the prevalence of high-spine Asteraceae- which thrives in more moist conditions- potentially marks a drying environment by around ~10,850 RCYBP, during the period of soil formation around the Bull Creek site (Arauza et al. 2016; Bement et al. 2007a).

Within the Bull Creek drainage basin, extinct forms of mammoth, horse, camel, bison, and smaller fauna including water shrew, chipmunk, ground squirrel, and prairie dog have been recovered and dated to the terminal Pleistocene / early Holocene (Bement et al. 2007a). Amidst the warming conditions at the end of the Pleistocene, many megafauna previously adapted to survival in colder climates became extinct, including mammoths, a food source for humans in North America during the Early and Middle Paleoindian periods. An estimation of up to 34 mammalian genera are believed to have gone extinct across the Americas and around the world during that time (Martin 2005; Grayson 1991). Debate is ongoing regarding the roles that climate change and human hunting pressure played in the extinctions; some assert that there is no evidence to support the hypothesis of significant human influence (Grayson and Meltzer 2002), while others hold that megafaunal extinctions in the Americas and elsewhere appear to have been caused by the combined influences of both (Metcalf et al. 2016; Emery-Wetherell et al. 2017; Saltré et al. 2019).

During this time, between 11,000 – 5,000 years ago, two forms of bison disappeared (*Bison antiquus* and *Bison occidentalis*) and bison as they exist today (*Bison bison)* emerged (Lewis et al. 2009). All of the 10 individual bison that have so far been documented at the Ravenscroft bison kill site (of an estimated 80 to 100 animals involved in the original kill) are of the *Bison occidentalis* species. This species is believed to have existed between the extinct *Bison antiquus* and modern *Bison bison* (Muhammad 2017). The bison recovered in components II and III at the Bull Creek have been defined as *Bison occidentalis.* Measurement of one bison thoracic spine from the lowest component I at the Bull Creek site potentially suggests it belonged to the species *Bison antiquus* (Bement et al. 2018). Numerous other species have been identified in the faunal remains recovered at the Bull Creek site, including small and medium mammals, warm season reptiles, birds, amphibians, and mollusks (Bement et al. 2018).

As this chapter provided the relevant environmental context, the following chapter will provide an overview of the known cultural heritage in the region in relation to which archaeological investigations in the Bull Creek valley may be understood.

CHAPTER THREE

CULTURAL BACKGROUND

Evidence shows that the history of human occupations on the Southern Plains stretches as far back—and potentially even further—as the Clovis period (a known maximum of ~11,110 ± 40 RCYBP: Waters et al. 2020). However, our knowledge concerning the details of that history is fragmentary. This is due to a combination of factors including the limited amount and types of materials that remain preserved in archaeological contexts, the difficult-or-impossible-to-access locations of many intact deposits, and the scant systematic research that has been conducted in this region to-date. Professional and avocational archaeological research on the Southern Plains began during the late 1800s, in line with the onset of anthropological research across the continent (Albert 1984). Compared to the rigorous standards of modern archaeological science, early investigations were poorly and informally conducted; the majority were not carefully excavated, documented, or curated well, if curated at all. Contributing to the issue of lost data are the immeasurable number of sites that were destroyed during and following the time of the land-runs, when tens of thousands of acres of newly Oklahoman land were converted to agricultural plots, automobile and rail roads, and towns (Albert 1984; Byington 1912).

Archaeological investigations across the state became more thorough and structured after the 1966 passing of the Moss-Bennett bill, which designated a portion of federal funding for cultural resource mitigation (Albert 1984). However, the Panhandle remains to this day the region of Oklahoma that has received the least investigative attention. Perhaps the most fundamental goal of all archaeological research in the Panhandle and across the state, foundational to all further investigations, is the delineation of a chronologically-framed cultural history that extends to include the earliest inhabitants. Yet largely because of the lack of available or reliable data, regional culture or group identifications in relation to temporal staging have been tenuously defined. Therefore, the following chapter presents only a broad outline of human occupation across this stretch of the Southern Plains (Bell 1984). I outline in a chronological framework what is currently known of the earliest occupations in this region of the Plains, focusing on those closest in date and relevance to the Bull Creek and Ravenscroft sites. Cultural transitions are defined by identification of changes in evident social continuity as reflected in the archaeological record of material culture (Wood 1998).

Paleoindian Period

In the era referred to as the Paleoindian period, the Southern Plains' first human inhabitants entered and adapted to life on the rolling, open prairie. This period, as with the Archaic, is considered in broad stages of Early, Middle, and Late; each stage encompasses sub-stages determined primarily through lithic typology. Paleoenvironmental reconstructions indicate that the landscape at that time was broadly shifting from the cool and moist conditions coinciding with the Pleistocene epoch to a warmer and drier climate, with increasing seasonal variability (Johnson 1987). As described at more length in Chapter 5, groups of people during the Paleoindian period are generally characterized as having been highly mobile; they were most likely egalitarian bands of hunter-gatherers with minimal accumulation of material goods due to the long distances that would have been travelled to procure specific resources across the landscape (Hofman 1989). Little is known of their lives beyond their presence and distribution in the landscape and their subsistence strategies, and evidence of trade among groups is scarce. This lacuna of data is due in part to the distance in memorable time and the nature of archaeological preservation on the Plains. Calcareous soils in the study area lend to the preservation of bone, stone and shell, but other organic materials such as floral remains, wood, and household fibers (including hides, textiles, or basketry) decay within a few hundred years at maximum. Archaeologists presume, based upon studies of modern foraging groups, that these materials were procured and used as regularly as those needed for the hunting and animal processing activities definitively indicated by stones and bones. Additionally, radiocarbon dates are generally rare and debatably semi-unreliable for Paleoindian sites across North America for various reasons, making chronologies and interpretations all the more tenuous (Meltzer and Holliday 2010; Waters and Stafford 2007).

Sociocultural activity during the early Paleoindian period is primarily visible in the buried locations of large-scale hunting events where aggregated groups of people strategically hunted large herbivorous mammals, namely bison and mammoth (Carlson and Bement 2018). Human involvement at these sites is determined most directly by the buried association of skillfully produced lithic projectile points and the bones of extinct megafauna. Since initial professional recognition of such sites beginning in the first few decades of the 1900s, the variety of Paleoindian sites and types of activities indicated across the Plains and beyond grew to include encampments occupied for varying lengths of time, lithic quarries, caches, and more.

Pre-Clovis

There is at least one recorded site in northwestern Oklahoma where pre-Clovis occupation is suggested, but the validity of evidence there pointing towards human involvement remains contentious, as is the presence of humans anywhere in the Americas before the Clovis period (Meltzer 2015). The Burnham site was found in 1986 during the construction of a pond dam, when bone and shell were observed within stratigraphic layers of grey sediment. Follow-up investigations proved Burnham to be a valuable Paleontological site, providing detailed information on Pleistocene environmental conditions and fauna including species of bison, horse, and mammoths (Wyckoff et al. 2003). Two radiocarbon assays on excavated snail shells and charred wood returned dates of >38,000 RCYBP and ~31,150 ± 700 RCYBP. Utilized lithic materials and bison bones exhibiting modification by humans were recovered from the site, but it was argued that the materials originated in a deposit apart from the Pleistocene sediments at Burnham and were at some unclear point in time re-deposited there via fluvial activity (Buehler 2003). Potential Pre-Clovis deposits dating between ~14,350 ± 910 to ~14,070 ± 910 RCYBP were documented at the Friedkin site in central Texas (Jennings 2012).

Clovis

The earliest agreed upon cultural complex, Clovis, refers to a span of around 300 to 650 radiocarbon years during which time a distinctively large, lanceolate, fluted projectile point style was created and used across North America. The Clovis complex dates from approximately ~11,110 ± 40 to ~10,820 ± 10 RCYBP, from the terminal Wisconsin glacial maximum to the late Pleistocene to early Holocene transition (Waters et al. 2020). Models of Clovis cultural adaptations typically fall within two categories based on mobility: highly mobile and focused on big-game hunting (Haynes 2002), or low residential mobility with more varied diets (Meltzer 2004). Hill (2007) reviewed the faunal assemblages from a comprehensive set of Clovis sites ranging across the Great Plains and Rocky Mountains regions of North America and concluded that primary reliance on large game was unique to areas with relatively lesser faunal diversity, such as the Plains. In more ecologically diverse areas, such as in alluvial valleys and mountains, large game was more often supplemented with smaller game.

Clovis lithic caches are abundant across the Great Plains region (Huckell and Kilby 2014), yet campsites are less uniformly dispersed. Camps are more commonly found in the Southern Plains, suggesting the possibility that Clovis groups had more permanent residency in the south while venturing north for logistical exploitation of megafauna (Jennings 2015). Buried Clovis points on the Plains are most commonly found in association with mammoth bones and *Bison antiquus*, as well as other extinct species of horses, camels, bears, and smaller mammals. In the Southern Plains, the points and other lithic tools are typically made of Edwards or Alibates chert, sourced in central and northwestern Texas respectively (Bement et al. 2007). Major Clovis hunting locales in this region include the Domebo (Leonhardy 1966) and Miami (Meltzer 2009) mammoth kills, the Jake Bluff bison hunting site (Bement and Carter 2010), the bison (among other fauna) kill and butchering episodes at Lubbock Lake (Johnson 1987, 1997), and the mammoth and bison kills at the Clovis type-site, Blackwater Draw, in New Mexico (Boldurian and Cotter 1999; Hester 1972). Evidence indicative of seasonality suggests that Clovis kills were conducted from late summer-time through winter (Jennings 2015). However, despite the predominance of kill sites in the Early Paleoindian archaeological record on the Plains, it should be emphasized that they offer only a limited view into the whole of Clovis lifeways.

Campsites dating to the Clovis period on the Southern Plains, though more numerous than elsewhere on the Plains, are still few and far between. The small sample size means that all hypotheses concerning Clovis social organization are subject to change dependent on further research (Jennings 2015). Following Jennings (2015) and Andrews et al. (2008), campsites are categorized into four types: "single use / single activity (kill sites), single use / multiple activity (small campsites), multiple use / multiple activity (medium-sized campsites), and large generalized multiuse (base camps)". No small Clovis campsites have been recorded to-date, and as aforementioned, most known medium-sized and base camps are situated in the Southern Plains each at least 400 km south of the study area. The largest are the Gault camp in Texas, approx. 900 km southeast (Waters et al. 2011), and Blackwater Draw, 400 km to the southwest. Some areas of occupation are inferred at the same locations where kills were conducted, such as at the Lubbock Lake site in Texas and at Blackwater Draw in New Mexico.

The Aubrey campsite is a rare and extensive example of a Clovis occupation on the Southern Plains roughly 600 km southeast of the study area in Denton County, Texas (Ferring 1990). Radiocarbon dating on charcoal samples from a hearth date the site to ~11,550 RCYBP, a result supported by numerically consistent dates acquired from the stratigraphic layers above and below the cultural material. Buried between 7 to 9 meters below ground surface on a Clovis-age waterfront, excavations uncovered over 9,800 lithic artifacts, 4,000 faunal specimens, and distinct activity areas including lithic concentrations, hearths, and what appears to be a well. Lithic sources vary but include the Alibates chert and Dakota quartzite materials also seen in the Bull Creek valley during the late Paleoindian period. The faunal assemblage indicates occupants procured a broad range of animals, similar to the assemblage at the Bull Creek site. Researchers surmise that the site's Clovis occupants were highly mobile and socially cohesive with strong intra-group task differentiation (Ferring 2001).

Almost as contentious as debate over the peopling of the Americas is discussion of the relation of human hunting to the extinction of megafauna (Martin 2005; Grayson and Meltzer 2002). By the onset of the Holocene, 35 mammalian genera in North America were extinct (Faith and Surovell 2009). It is argued that Clovis people not only experienced the gradual, sweeping extinction of megafauna, but had a strong hand in causing it (Haynes 2013). Some researchers assert that evidence in the archaeological record does not support an anthropogenic driver of the extinction (Grayson and Meltzer 2002). This possibility is supported by the data showing Clovis peoples had broad-spectrum diets and did not rely solely on large game, and the animals that *were* hunted constituted a small portion of the sum of genera that were lost. Conversely, Haynes (2013) and Martin (2005) explore how the hunting episodes, however infrequent, were part of the process of human colonization of the Americas that involved targeting vulnerable, fragmented sub-populations of megafauna already dwindling due to the warming, post-glacial climatic conditions. Haynes speculates that the continuation of this dynamic over a span of several thousand years contributed to the extinctions. Regardless of the cause, the disappearance of megafauna and coinciding ecological changes forced Clovis peoples to find new ways to live.

After the megafaunal extinctions, bison were left to reign as the largest mammal on the Plains. Humans who previously pursued mammoths (and occasionally horses or camels), were forced to figure out where and when to find this newly important resource, and even more challengingly, how to procure it. The locations of Clovis bison kill sites along the east-west Plains bison migration route shows that hunters were able to predict and follow the movements of herds (Bement and Carter 2015). The largest Clovis-age bison kill site documented to-date, Jake Bluff, is dated between ~10,780 ± 40 to ~10,838 ± 17 RCYBP, post-dating all Clovis sites associated with mammoth hunting (Bement and Carter 2010). At least 22 bison were trapped within an arroyo and speared from above; this is the earliest recorded instance of the arroyo-style strategy of bison hunting that became common during and after the Folsom period. Its appearance during the Clovis period suggests that at the terminal Pleistocene, ecological changes demanded humans to re-structure their use of the land in ways that were to continue afterwards for thousands of years (Bement and Carter 2015).

Folsom

The Younger Dryas (YD) was a climatic episode lasting from ~10,900 to ~9,700 RCYBP. in which post-Pleistocene warming was abruptly reversed by widespread cooling and coinciding environmental shifts across North America and elsewhere on a potentially global scale (Peteet 1995). The Folsom cultural complex appeared on the Plains during the YD and lasted from around ~10,600 to ~10,400 RCYBP (Surovell et al. 2016). Although a minimal radiocarbon record makes discerning site dates and the exact timing of its onset difficult, an amalgamation of other evidence clearly distinguishes Folsom from Clovis occupations.

Lithic technology was the earliest recognized indicator and remains the most prominent Folsom distinction. No Folsom points have ever been recovered in association with the megafauna targeted by Clovis hunters. Folsom technology has to-date been exclusively associated with ancient *Bison antiquus* and smaller mammals (Amick 1999). Folsom-style points are medium in size, lanceolate-shaped, and fluted from base to tip, and in general show greater flaking precision than preceding Clovis points (Turner et al. 2011). Hofman (1993) shows that Folsom points in the Oklahoma portion of the Southern Plains are most commonly made of Edwards chert. As with Clovis, since discovery in the early twentieth century, data provided by studying lithic technology has come to be enhanced and expanded by stratigraphic and artifactual data indicative of environmental conditions, settlement patterns, and subsistence strategies (Carlson and Bement 2017; Carlson et al. 2013; Meltzer 2006).

People and the biotic communities around them were continuously adapting to shifting post-glacial environmental conditions. During the YD, populations of bison on the Plains grew exponentially in size, though the distribution of bison across the continent simultaneously decreased (Hill 2007). The growth spurt among Plains bison is argued to have been spurred by the widespread expansion of grasslands and the disappearance of other megafaunal predators and competition (Scott 2010; Meltzer and Holliday 2010; Lewis et al. 2010). The majority of recorded Folsom sites to-date are bison hunts, indicating that during that period these animals became a profoundly important resource for Plains occupants, a tradition that was to last for roughly the next ten thousand years to come. However, some researchers rightly caution against the interpretative bias that exists as a result of the prominence of bison kill sites. For Folsom people, bison were just one— albeit important— part of a broader-spectrum diet most likely comparable to the diets of modern foragers (Johnson 1987; Meltzer 2006). Data on the various smaller mammals procured by Folsom groups exists, but is comparatively sparse (Cannon and Meltzer 2004; Johnson 1987).

Current research suggests that Folsom groups were the first to establish any degree of permanent residency in both the Southern and Northern Plains (Andrews et al. 2008; Frison and Bradley 1980). In contrast to the uniquely large Clovis campsites, Folsom camps are found in the full range of sizes, from the smallest single-use occupations to large, repeatedly occupied locales (Jennings 2015; Wilmsen and Roberts 1978). In many cases, distinct activities performed by individuals are inferred by variations within the artifact assemblages of a camp or quarry site. Well-studied Folsom camps on the Southern Plains include the Lindenmeier (Wilmsen 1974; Wilmsen and Roberts 1978), Mountaineer (Stiger 2006), Linger (Jodry 1999b), and Cattle Guard (Jodry 1999a) sites in Colorado, Blackwater Draw in New Mexico (Boldurian 1981, 1991), and the Lake Theo (Harrison and Killen 1978), Lubbock Lake (Johnson 1987, 1997), and Adair-Steadman (Hurst and Johnson 2016) sites in Texas.

Amick (1999) reminds us of the importance in remembering that Folsom groups, as with Clovis and later Paleoindian cultures, were each composed of women, men, and children of varying ages and abilities. Researchers, including Amick, have suggested that certain apparent task differentiations may reflect social divisions of labor determined by gender and age (Jodry 1999a). These hypotheses are based upon ethnographic documentation of modern foraging societies that seem to identify large game hunting (with some exceptions) as a predominantly male activity, while smaller game hunting and flora gathering is most commonly done by adult females (Wantanabe 1968; Amick 1999). There has been for the last half century much debate over the validity of such models of sociality and their applicability to the archaeological record (Dahlberg 1981; Gero and Conkey 1991), and archaeological studies on sites dating as far back as the Paleoindian period tend to avoid them (Meltzer 2006). Ethnographic analogies drawing specific comparison to modern Plains tribes, however, have proven in some cases to be useful and arguably necessary to interpretative efforts dating on cultural complexes as far back as Folsom (Jodry 1999a).

From widespread evidence of the transportation of lithic materials across long distances, a high degree of mobility among Folsom groups across the greater Plains landscape has been assumed (Amick 1999). This assumption is frequently supported by assertion of the supposed unpredictability of bison herd movements and the spatial demands put upon bison hunters (Janetski 2002). As a result, some have suggested that Folsom hunting was conducted largely by chance, either through encounter or ambush (Meltzer 2006). Other studies, however, suggest that bison were not totally unpredictable, and that Folsom mobility appears to have varied differentially throughout the Plains (Janetski 2002). Further, some researchers propose that Folsom hunters in fact appear to have been aware of ancient bison migration routes and to have adapted the locations and timing of their hunts to them (Bement 2003).

In northwestern Oklahoma, 120 km east of the study area, investigations at the Folsom-age Cooper and Badger Hole bison hunting sites revealed a pattern of large-scale bison hunting strategies on the Southern Plains. At the Cooper site are three distinct events buried successively within the same arroyo: in each of which, a minimum of 20 bison were hunted and selectively butchered (Bement 2003). The Badger Hole arroyo sits 700 m upstream from Cooper and contains the buried remains of a hunting event that occurred just 200 years after the last hunt at Cooper (Bement and Carlson 2018). Excavations there uncovered a minimum of 12 bison which had been butchered similarly to the animals at Cooper. Analysis of each bone element from the Badger Hole kill and middle and upper kills at Cooper demonstrated that of the relatively few cutmarks identified, most were concentrated around ribs and thoracic spines, indicating that the butchery in each event was focused on the acquisition of high-quality meat. Based upon the age at death of the youngest animals in each kill as related to the annual calving season, all kills were determined to have been conducted at some point between late summer to early fall (Bement 2003).

The patterns of scale, butchery, and seasonality at Badger Hole and Cooper align with both Clovis and Folsom-age components of the Jake Bluff site, located on the north bank of the Beaver River just a few hundred meters from Badger Hole to the west and Cooper to the east (Bement and Carter 2010). These patterns are also seen elsewhere, such as at the Lipscomb (Hofman 1991), Folsom (Hofman 1991), and Lake Theo (Harrison and Smith 1975) bison hunting locales, where a minimum of 10 bison were hunted via entrapment in arroyos during the late summer to early fall. Conversely, at the Waugh (Hofman et al. 1992), Lubbock Lake (Johnson 1987, 1997), and Blackwater Draw (Boldurian 1981, 1991) bison hunting sites, 2-6 animals were hunted and extensively butchered adjacent to water sources and in diverse seasons. This dichotomy of kill site types is referred to as the Cooper model, named after the site where the pattern was first recognized (Bement 1999, 2003).

Reconstruction of the Southern Plains bison herd migration route during the Paleoindian period shows that it had an east-west trajectory and appears to have developed during the Younger Dryas (Graves 2008, 2010). During the late summer to early fall months, migratory herds would have been making their gradual way east, towards where they wintered in the eastern Oklahoma / southwestern Missouri area before returning to their spring calving grounds in the Rocky Mountain foothills (Graves 2018). The Cooper model suggests that during that time, Folsom groups aggregated at pre-determined locations and conducted large-scale hunts with the intention of quickly acquiring a large amount of high-quality meat (Bement 2003). Such aggregations could have served the purpose of facilitating the trade of materials and information among groups, as well as the potential meeting of new mates. Potential Folsom aggregation is interpreted elsewhere at the Lindenmeier site in the Front Range area of Colorado (Hofman 1994; LaBelle and Holen 2009). Notably, the repeated use of one place in the landscape over a span of hundreds of years hints at the beginnings of territorialism on the Southern Plains, akin to the processes of territorialization documented by Zedeño et al. (2014) among groups on the Northern Plains.

Evidence of ritual activity during the Paleoindian period is very rare. One of the few and earliest cases was discovered in northwestern Oklahoma approximately 120 km east of the Bull Creek valley at the Folsom-age Cooper bison kill. At the arroyo’s knickpoint, an adult male bison skull with a lightning bolt painted on its forehead in red ochre was found lying beneath the bones of hunted bison. The skull was weathered and sun-bleached in contrast to the bones above and around it, apparently selected from exposed skeletons from an earlier kill event and repurposed for ceremonial placement prior to the second use of the arroyo. The Cooper skull and another bison skull sitting atop several vertically-placed bison mandibles at the Folsom-aged Lake Theo site just over 300 km southeast are the only known Folsom-age archaeological features attributed with potential ritual significance (Harrison and Killen 1978; Bement 1999, 2003).

Late Paleoindian

Cultural stages during the late Paleoindian period across the Southern Plains are considered to coincide with a wide variety of projectile point styles. Triangular, shouldered, and stemmed forms appeared, while the lanceolate form which originated with Clovis and Folsom continued to prevail. Fluting ceased to be common practice. Defined point types attributed to the late Paleoindian period on the Southern Plains include Plainview, San Patrice, Agate Basin, Scottsbluff, Milnesand, Hell Gap, Eden, Angostura, Cody, Frederick, Allen, (or Frederick-Allen), and Dalton (Turner et al. 2011). A significant increase in the number and variety of sites and artifacts associated with this time period is evident, as opposed to prior time periods, which could suggest widespread population growth (Bement et al. 2007; Thurmond 1990). Hurst (2010) hypothesizes that diversification of projectile point types is evidence of groups across the Plains beginning to distinguish their identities from others' due to population growth and possibly environmental change.

Bison hunting continued to be of central importance to groups across the Plains. There is, however, evidence for increasing diet breadth during this period, such as that indicated by the diverse faunal assemblage found at the Bull Creek camp (detailed in Chapter 4). Broad spectrum foraging is interpreted elsewhere in the region at the late Paleoindian Horace Rivers site in Hemphill County, TX, with a faunal assemblage wherein bison, deer, antelope, wolves, badgers, rabbits, muskrats, skunks, squirrels, prairie dogs, birds, snakes, turtles, fish, frogs, mussels and more are represented (Mallouf and Mandel 1997).

The Bull Creek campsite and nearby Ravenscroft bison kill in the Bull Creek valley represent two of very few recorded late Paleoindian localities in the Oklahoma panhandle region. Ravenscroft is the sole reported large-scale bison kill site in the panhandle dating to the Paleoindian period. Closest in comparison is the Mayhan site in the North Canadian river valley of Cimarron county, where one point was recovered in association with a single hunted bison. Stucky (1974) interpreted the point to be vaguely between Clovis and Plainview, while Hofman (2010) later categorized the point as Allen. Paleoindian campsites in this region of the Southern Plains are equally rare. Besides Bull Creek, the only other documented Paleoindian camps in or directly around the Oklahoma panhandle area are the Nall (LaBelle 1997; Ballenger 1999; Baker 1957) and Muncy (White 1987) sites. Repeated occupations over a span of several thousand years in a playa wetland environment are evident at Nall. Researchers identified two buried paleosols with high potential for containing cultural materials. Radiocarbon dates suggest that the Baker soil represents a possible surface for Frederick/Allen/Angostura artifacts, and that the Nall soil was a likely surface for Plainview artifacts, despite none being recovered during excavations. Hundreds of full and partial projectile points have been recovered from the modern ground surface at Nall spread across a .4 km^2 area, and geoarchaeological testing confirmed that the buried deposits extend across an estimated 30,000 m^2 (LaBelle et al. 2003). The points span from Clovis and Folsom through later Paleoindian types, however, Plainview and Frederick/Allen forms constitute the majority of the assemblage. (LaBelle 1997; Ballenger 1999; Baker et al. 1957).

Goff Creek is a tributary of the Beaver River in Cimarron County just northeast of Nall. In 1996 an individual donated a collection of 82 projectile points gathered from its banks between 1971 to 1989 to the Oklahoma Museum of Natural History. The span of point forms represented resembles that of the Nall site, including examples of Clovis, Folsom, Plainview and Frederick/Allen, as well as Agate Basin, Midland and Scottsbluff. The artifacts were interpreted to have most likely been lost during hunting activities at destroyed or yet-undocumented kill sites or discarded at similarly undocumented campsites in the stream valley (Ballenger 1999).

Ballenger (1999) analyzed the Plainview and Frederick/Allen materials from the Nall site alongside those from the Goff Creek collection in order to draw from them an interpretation of late Paleoindian land-use between the valley and playa environments. He inferred that the significant presence of both point types in each collection shows a "shared reliance" on these landscapes. A greater abundance of Plainview materials exhibiting tool maintenance were recovered from the Nall site than similar materials associated with Frederick/Allen, which suggests that Plainview occupations were longer in residential duration than Frederick/Allen occupations. LaBelle et al. (2003) were inconclusive in identifying the time frames of distinct occupations following their excavations and geoarchaeological investigation at Nall.

Ballenger proposes that Plainview occupations at Nall could have been longer because of higher resource stability across the open Plains during the Plainview period, allowing Plainview groups to have higher mobility and less need for the biological predictability that comes with river valley environments. This was potentially followed by an increased necessity of “retreat” into more permanent residency within biologically concentrated-but-diverse river valleys during the later Frederick/Allen period. He calls attention to the still-standing question of what role river valleys specifically played in settlement strategies during both periods and the impossibility of determining answers from the sites and artifact assemblages available at that time, urging the need for further research (Ballenger 1999).

With the exception of one potential Clovis point found eroding out of the cutbank at Bull Creek in 2015, full and partial projectile points recovered from the Bull Creek and Ravenscroft sites are categorized as Plainview-like, though they are similar as well to Frederick/Allen (Carlson and Bement 2017; Muhammad 2017). Paired with contemporaneous radiocarbon dates, this places the sites potentially within the same time span as the late Paleoindian components of the Nall site, and simultaneous as well with the origin of materials in the Goff Creek assemblage. Research on late Paleoindian activity in the Bull Creek valley therefore provides the opportunity to expand on the land use questions posed in the studies by Ballenger (1999) and LaBelle (2003).

Ethnographic Record: Plains Bison Hunting and Foraging

Various strategies and scales of communal bison hunts are found in different regions of the Plains throughout time. On the Northern Plains, ethnographic records are replete with accounts of bison hunts wherein the animals were lured into constructed wood and hide- or brush-covered enclosures, ‘buffalo pounds’, hidden from their (notably poor) sight in the landscape. This strategy was common among tribes including the Blackfeet, Omaha, and Assiniboine (Verbicky-Todd 1984). Another strategy less commonly seen in ethnohistory, but well represented archaeologically spanning the last 5,000 years on the Northern Plains is the bison jump, where herds are driven through constructed ‘lanes’ and over cliff faces high enough to ensure death, or at least injury severe enough to allow the animals to be easily killed after impact (Brink 2008). There are no ethnographic accounts of the arroyo-trap style of bison hunting evident at Ravenscroft and in archaeological sites further south on the Plains as early as the Clovis period (Bement 2009).

All large-scale hunts historically known-of on the Northern Plains involved cooperation between individuals from a single ‘band’ or multiple bands joined together for the sake of the hunt (Verbicky-Todd 1984). Meat and hides were the primary resources sought (Schultz 1966:306). In Schultz (1966), one story-teller, Many-Tail-Feathers, recounts bison hunting as it was done “in that very-far-back time” when the Blackfeet were one unified tribe, versus the four known in the late 1800s. He describes how the unified Blackfeet tribe had to move camps every few days, as each time they settled down, the nearby fauna—buffalo, elk, deer, antelope, moose—would flee for fear of human presence in the area. This pushed the hunters of these large animals, adult males in the tribe, to travel farther in pursuit of them, with bringing food back for the women and children as their most important goal (Schultz 1966:307).

He tells of how one man, one of the Blackfeet tribe’s “Far-Back Fathers” (Schultz 1966:310), discovered that he could flap his buffalo leather clothing like wings (initially in effort to shoo away fierce biting flies) and frighten a herd of bison over a cliff. When others learned of this, surprised that bison could be decoyed as antelope could, they designed the first bison drive and jump by constructing a corral at the bottom of a tall cliff face and a lane of brush and rocks across the cliff’s surface, which they called a “*piksan* (corral, fence)” (Schultz 1966:310). The day of the hunt, following the conduction of “prayers and songs to Sun”, a herd led by cows—“more alert, inquisitive than bulls”-- was successfully frightened and funneled over the edge (Schultz 1966:310). Because of this newly learned hunting strategy, the tribe no longer needed to travel such long distances in the summer heat in pursuit of large animals, but could build permanent hunting structures and remain longer in one landscape. Notably, the strategy was not without risk; occasionally the bison would break through the lanes, trampling the people in position to frighten them often to their deaths. According to Many-Tail-Feathers, over time, this hunting practice drove the tribe's population up, and resulted in the splitting of the one tribe into three. *Piksan* hunts continued for thousands of years until the European introduction of the horse into the Americas and the Blackfeet adoption of hunting on horseback, which allowed for many more animals to be quickly hunted. However, occasional *piksan* hunting was still conducted for the sake of not letting such a deep tradition to be lost. Many-Tail-Feathers describes one such traditional *piksan* hunt he participated in as a child in which 181 animals were killed. He stated that the men, women, and children all worked into the night butchering the animals, and that the meat lasted for many days (Schultz 1966:315).

One aspect of these events strongly emphasized across ethnographic accounts is the high risk of a hunt's failure. Because of this, rituals and rules around the hunt were critically important, like the prayers and songs offered by the Blackfeet to their 'creator', the Sun. One severely punishable rule, described across numerous accounts, held that no man could hunt bison during the time leading up to the communal event, so as not to disturb the larger herd (Verbicky-Todd 1984). Following completion of the arduous hunt, other accounts echo that of Many-Tail-Feathers' in that all group members took part in butchering activities. However, the intensive task of hide preparation was usually taken on by women (Verbicky-Todd 1984).

Written accounts also describe plant foraging and smaller animal hunting by Plains tribes, and the uses and processing of these resources, though in significantly lesser breadth and detail than descriptions of hunting. Kindscher (1987:4) appropriately states, "The importance of wild plant foods to the Indians has been overshadowed by the romance of the adventure of hunting the large grassland herbivores…". Gilmore (1977) names over 150 species of plants used medicinally and for other purposes by various tribes in a book on plant use by Indigenous groups around the Missouri River. In *Edible Wild Plants of the Prairie*, Kindscher (1987) details 123 species of plants used by 17 different Plains tribes for food, including the three whose historic territorial range encompasses this thesis' study area; for 14 other tribes, no ethnographic or otherwise written accounts of plant-use were found. A multitude of reasons are posed as to why each plant was chosen, from good taste, availability, and nutrition to relative scarcity of other foods, such as in cases of failed large game hunts (Kindscher 1987:5). Citing Fletcher and LaFlesche (1911), she notes that the Omaha tribe determined the route of their summer bison hunts by the locations of plant foods such as prairie turnips (Kindscher 1987:4).

CHAPTER FOUR

SITE OVERVIEW: BULL CREEK AND RAVENSCROFT

Located roughly 1.25km apart, Bull Creek and Ravenscroft represent contrasting components of the late Paleoindian subsistence spectrum. Bull Creek is a stratified open-air camp with at least two diametrically opposed winter and summertime occupations, while Ravenscroft is a stratified, two-arroyo bison trap locale containing bone beds from five successful hunts, each during the winter. Together they provide a view of how late Paleoindian groups in the Bull Creek valley interacted with the myriad of natural resources on the landscape around them. Excavation of these two sites provided the requisite raw data necessary for construction of a land-use model.

Ravenscroft (34BV198)

All bones collected from Ravenscroft from 2008 to 2017 have been processed and analyzed. Details of analyses on the bones recovered from 2008 to 2015 are provided in Bement et al. (2012) and Muhammad's (2017) master's thesis. Summary information on the results of those excavations plus work at Ravenscroft from 2016 to 2019 are presented here. Bones excavated in summer 2019 are currently being processed and await analysis. Therefore, data from the 2019 work at Ravenscroft is subject to change.

Figure 4-1. Morning on-site at Ravenscroft in 2019, overlooking tributary.

The two buried arroyos (RAV I and II) constituting the Ravenscroft arroyo-trap bison hunting site sit just eight meters apart, mid-slope on the southwest bank of a 400-meter-long first order drainage into the modern Bull Creek tributary. Five temporally separate hunting events are distinguished through comparison of stratigraphy, bone conditions, and radiocarbon dating: two within the RAV I arroyo and three within RAV II (Bement et al. 2018). Human involvement in the bison's demise was confirmed by the recovery of a single projectile point within the RAV II bonebed, as well as observation of the disarticulated condition and unnatural positioning of the skeletons and the identification of cut and fracture marks on various bones attributed to butchering processes. Through analysis of the bonebeds, research questions sought focused on understanding what the site reflects of the relationships between the ancient landscape, animal behavior, and the strategic practices of the site's late Paleoindian human occupants. These dynamic interpretations are built upon data gathered on environmental context and animal demographics, as well as the scale and season of the hunting events and specific cultural activities represented on and, by proxy, off-site.

The site's first radiocarbon date was acquired from a sample of bone eroded from RAV I, which initially dated the kills within that arroyo to ~7380 ± 50 RCYBP. Additional radiocarbon testing on petrous bones from bison skulls excavated from RAV I in 2008 yielded dates of ~8730 ± 20 RCYBP and ~9090 ± 30 RCYBP. The dates correspond to the late Paleoindian archaeological period (Bement et al. 2012). Three petrous bones recovered from adult bison skulls within RAV II between 2013 and 2015 were selected for radiocarbon dating and returned results of ~9210 ± 30, ~9340 ± 30, and ~9335 ± 30 RCYBP (Muhammad 2017). These dates confirm that the hunting events represented within both arroyos occurred during the late Paleoindian period, with the events in RAV II pre-dating those in RAV I. A radiocarbon date has yet to be acquired from the lowest hunting event in RAV II.

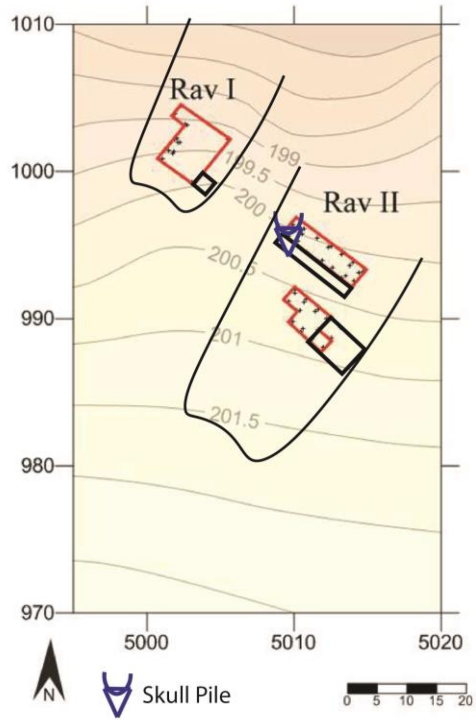

Figure 4-2. Boundaries of RAV I and II arroyos and excavation areas, plus location of skull pile.

Initial geoarchaeological testing determined that a total of 10 x 2 meters of the original RAV I arroyo remained buried and preserved. During proceeding excavation, the deepest bison bones within the arroyo were found lying in contact with the arroyo floor and sides. The remains ranged in articulated completeness from whole animal halves to individual limbs and bones. An initial minimum number of individuals (MNI) of five in RAV I was determined by the discovery of four isolated skulls missing their hyoids and mandibles as well as one complete skull still articulated with the cervical spine.

Figure 4-3. RAV I upper bonebed during initial excavation in 2009.

Excavations continued into 2009 by participants in the University of Oklahoma's annual archaeological field school. An additional MNI of five bison were uncovered, bringing the total MNI of bison excavated from RAV I to ten. Among them were the bones of one fetal calf approximately 6 months into development. If the rutting season for these bison is assumed to be the same as modern bison, roughly around July, then the presence of a 6 month old fetus suggests that the kill occurred during wintertime (Muhammad 2017).

Young animals are identified by varying degrees of tooth eruption and use-wear as well as limbs with unfused epiphyses. The recovery of both mature and young animals in RAV I suggests that the hunters targeted a cow/calf herd. Bone surfaces in RAV I were found to be significantly degraded by taphonomic factors, primarily etching by plant roots and fossorial animals. These conditions hamper the visibility of cutmarks and accordingly interfered with more fine-grained interpretation of butchering techniques (Bement et al. 2012).

In 2009, researchers discovered and outlined the boundaries of the second arroyo, RAV II, as excavation in RAV I concluded. Geophysical testing identified an anomalous area of approximately 5 x 9 m into the hill which was confirmed by hand augering to be the location of the bone bed. The sediments within RAV II were observed as being identical to those within RAV I, supporting the similar nature of the two deposits. This arroyo was chosen as the location for the University of Oklahoma's field school in 2013, 2015, 2016, and 2019.

Figure 4-4. Profile view of RAV II arroyo contour.

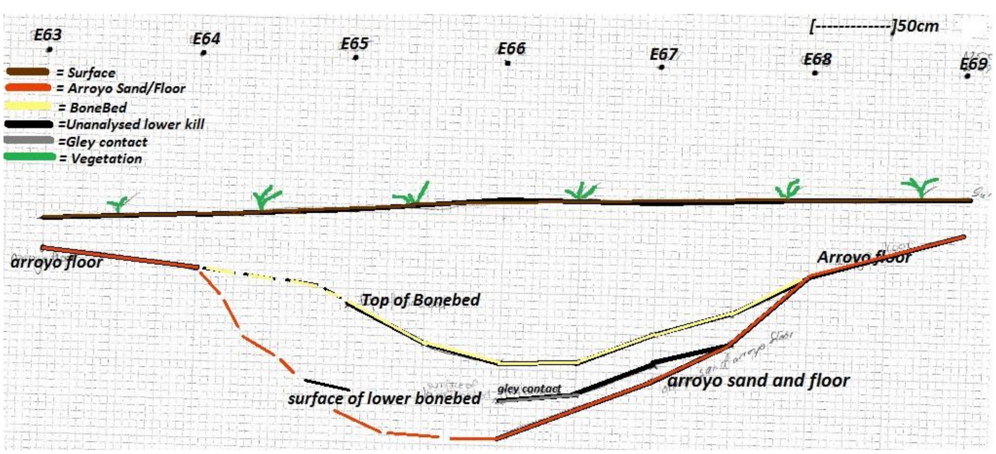

Figure 4-5. Digitalized profile sketch of RAV II arroyo, drawn on-site by author in 2017.

By the end of the 2013 and 2015 seasons some 673 bones were excavated, mapped, and extracted from the RAV II arroyo. Ravenscroft's one and only complete projectile point was found in RAV II in association with adult bison ribs, as well as one freshwater mussel shell knife. Of the total bones excavated between 2013 and 2015 an MNI of 10 was recorded, bringing the site's cumulative MNI to 20 with a minimum of 10 animals in each arroyo. Based upon the known size of the arroyo and density of the bonebed excavated thus far, it was estimated that just 10% of the total RAV II arroyo had by that time been excavated, or 10 of a projected 80-100 animals (Muhammad 2017).

Figure 4-6. Large freshwater mussel shell knife recovered from RAV II.

Bones excavated from RAV II in 2013 and 2015 largely retained their structural integrity and appear to have been subjected to rapid burial. However, many of the intact bones lay adjacent to more heavily weathered bones. This means that either some bones were buried while others from the same event remained exposed, or that the hunting event which left the intact bones was conducted on top of an older and yet un-dated one. No specimens were found to have signs of pre-burial crushing, carnivore gnawing, or sediment abrasion (skid marks). All bones were affected by post-burial root-etching. Several bones had been gnawed on by burrowing rodents. Like the bison carcasses in RAV I, skeletons within RAV II were found separated into articulated halves, limbs, and individual elements. One vertebral column was found still attached to a pelvis, and another was found with articulated ribs.

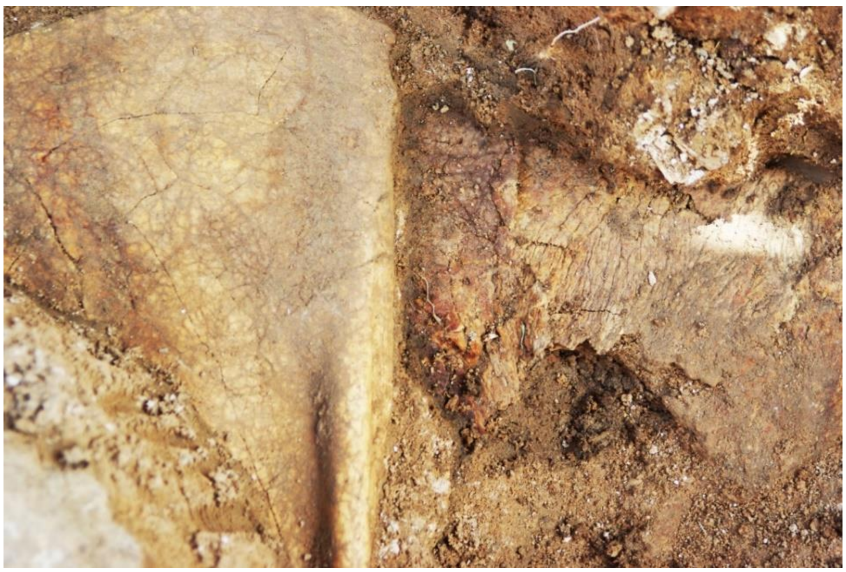

Figure 4-7. Differential weathering between middle (left) and lowest (right) bonebeds in RAV II.

Cut marks were only observed on the distal end of a single tibia. Johnson and Bement (2009) discuss how the absence of cut marks at occupational sites may be because of blade dulling caused by contact of the blade with bone. Twenty-five of the bones analyzed from RAV II display spiral fractures, which would have been inflicted while the bones were still fresh as a result of percussive action by humans with the intention of removing marrow or repurposing the bone itself. Spirally fractured bones include limb bones such as femurs, tibias, humeri, radii, metatarsals and metacarpals, as well as ribs, scapulae, and pelvis fragments.

The skeletons of several animals in both RAV I and RAV II indicate that they were laid with their backs on the ground following halving of the carcass mid-way through the thoracic spine, which would have allowed the butchers access to their abdomens. Among a cow/calf herd during the winter, a much higher amount of fetal material is expected than what little is represented at Ravenscroft. At the nearby penecontemporaneous Bull Creek camp, fetal bison remains have been uncovered, supporting the possibility that fetal remains were targeted, procured, and brought to a secondary processing site by those butchering the Ravenscroft animals. This hypothesis could be tested by determining exactly how many animals in each kill at Ravenscroft were female and should have been pregnant in order to make an estimate of the expected amount of fetal material, and then comparing that with the actual fetal material represented. Such an analysis has yet to be done.

Figure 4-8. Segmented bison carcass showing supine position in lowest bonebed of RAV I (2008).

The last remaining bones from the main units opened in RAV II between 2015 and 2016 were removed in the spring of 2017. Bones that were exposed but still mostly buried by surrounding units in the pit "walls" were left in place. Ravenscroft was not excavated again until 2019, when another field school through the University of Oklahoma worked to expand on the profile trench area of RAV II where several large skulls were found near the sole full projectile point.

From within the profile trench, on the western edge of the arroyo's original mouth, a total of 11 adult bison skulls were recovered in a vertical cluster. An additional four adult skulls were found stacked on the opposite eastern edge. Most of the skulls came from the middle hunt in RAV II, though the uppermost positioned skull in the pile matched in dating to the events in RAV I. Most of the skulls were missing mandibles, suggesting they were removed for retrieval of tongues. None of the skulls recovered from within the stacks in RAV II or from the bonebeds in either arroyo showed evidence of "bashing", an otherwise common practice in bison butchering by Plains groups from the Paleoindian period up to present in which the skull is broken open for retrieval of the brain, typically for use in hide tanning.

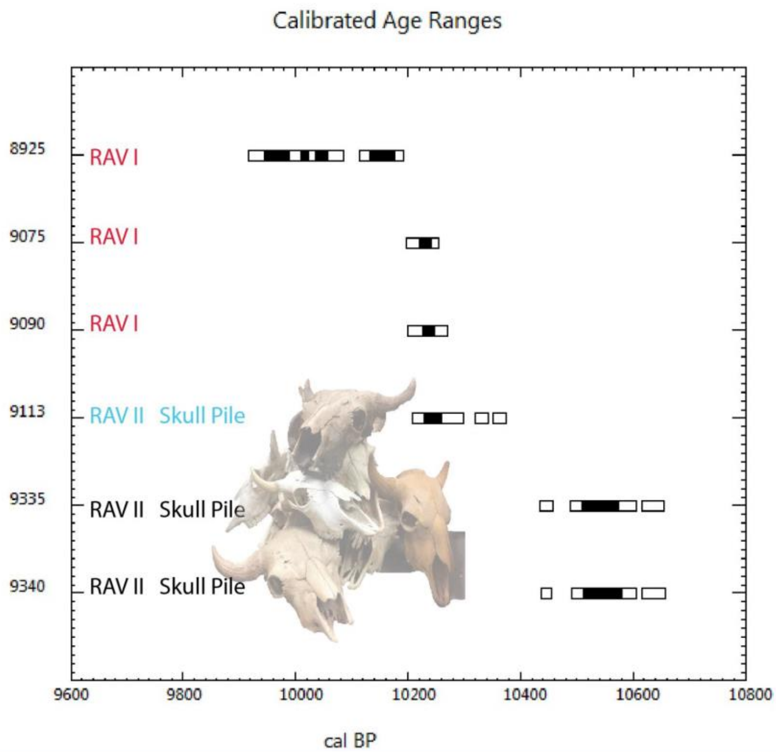

Figure 4-9. Calibrated (x-axis) and uncalibrated (y-axis) radiocarbon age ranges for bison skull pile in RAV II (black), compared with bison in RAV I arroyo (red), and the uppermost skull in the pile within RAV II (blue). Calibrated dates derived through CALIB 6.2 and Intcal20 curve.

The dense accumulation of skulls may have contributed to the decision to conduct later kills in the nearby RAV I arroyo. Potential reasons proposed for the skull stacking include general discard following removal of the tongues, stockpiling for future use, cairn building to commemorate successful hunts, or other ceremony intended to will success unto future hunts. These possibilities are derived from comparison with similar archaeological features as well as with ethnographic and historic examples. If the skulls were placed in the two piles as a result of non-subsistence decisions, Ravenscroft becomes one of the few early large-scale bison hunts with evidence of ceremonialism (Larrick et al. 2019).

Figure 4-10. Excavation in 2019 in the profile trench at RAV II arroyo opening, around skull piles.

Figure 4-11. Map of the stacked skulls (red) in RAV II with adjacent bones (green) prior to further excavation in 2019, when 7 more skulls were uncovered.

Figure 4-12. Skull from pile in RAV II, with foam encasing having been removed in-lab.

The single complete projectile point recovered from Ravenscroft at the floor of RAV II is described in Muhammad (2017) using the analytical criteria applied by Pitblado (2003) to late Paleoindian projectile point technology on the Plains of eastern Colorado. It is a durable granulated pink/brown quartzite material, lanceolate-shaped and exquisitely knapped, with subtly ground basal sides for hafting. The point is 9.8 cm long, has an average base-to-tip width of 1.3 to 2.1 cm, and shows no sign of ever having been re-worked. Researchers typify it currently as Plainview or potentially Jimmy Allen (Figure 4-13; Figure 4-14, shown in-situ).

Figure 4-13. Plainview-like point recovered from the RAV II arroyo (from Muhammad 2017).

Figure 4-14. Ravenscroft point in-situ, pierced through bison chest cavity.

Six pieces of lithic debitage were recovered from RAV I in 2008. The flakes are made of Alibates, quartzite, and coarse white chert (Bement et al. 2012). Bement et al. (2012) infer that the presence of both exotic and local materials may be indicative of seasonal mobility or trade with southern groups. Between 2013 and 2015, four potentially utilized flakes were found and inspected in-lab through a Bauch and Lomb stereoscopic microscope (10-70x zoom) to determine material and identify use-wear if present. Three of the flakes were Alibates unifaces with worn edges, signaling their use in the butchering. The fourth flake is Dakota quartzite and appears to be debitage from the re-sharpening of an unknown tool (Muhammad 2017). Small projectile point edge and basal ear fragments made of Alibates were also recovered within the RAV II bonebed.

In sum, five large-scale, wintertime bison hunting events dated to the late Paleoindian period are represented within the two Ravenscroft arroyos. These large-scale hunts were intended to accumulate large amounts of animal remains to be butchered and distributed among participants and group members for consumption and other practical uses. Much of the carcasses were discarded on site, while some parts were chosen to be re-located elsewhere for secondary processing and use. Those choices were determined by various factors related to the situational context of the hunt and sociocultural norms. In general, the animals were segmented into fore and aft sections as well as into separated crania and limb bones. Evidence suggests targeted procurement of tongues and fetal material alongside meat and marrow. The recovery of two stacks of skulls at the mouth of the RAV II arroyo suggests either general discard or a non-subsistence related practice, potentially ceremonial in nature, and is worthy of further study. The terminus or knickpoint of RAV I was excavated fully while the RAV II arroyo's knickpoint to-date remains buried and preserved for future excavation.

Bull Creek (34BV176)

The results from investigations from 2009 to 2017 at the Bull Creek camp site are detailed in Carlson and Bement (2017) and Bement et al. (in press). I review and update them here with information on excavations and analyses up to 2019. In this section I also present the results of my analysis of bones excavated in 2018, which expanded the variety of animal species represented during the summertime occupation at the site up to a total of 26 distinct taxa. This data informs the catchment analysis I use in the proceeding chapter to model occupant's land-use.

Figure 4-15. View from Bull Creek site terrace over tributary and across landscape, 2018.

Bull Creek is the nearest known penecontemporaneous camp to the Ravenscroft bison hunting locale. It sits 1200 meters due north, buried deeply within a terrace cut into by the modern Bull Creek tributary. Other potential sites nearer to Ravenscroft are indicated by the observation of cultural materials eroding from Paleoindian-aged strata in cutbanks similar to that of the Bull Creek site, yet these locations remain to be investigated further (Conley 2010). The Bull Creek site consists of at least four stratified occupational components dating to the late Paleoindian period, between ~11,588 to ~9020 ± 35 RCYBP (Bement et al. In Press). Comparing and contrasting the layout of features and artifacts as well as the faunal and lithic assemblage characteristics between these components illuminates aspects of cultural continuity alongside seasonal differences in subsistence strategies and other activities indicated. The two densest components contain artifacts indicating that the lower strata was a wintertime occupation while the upper strata was occupied during the summer. In general, bison dominate the faunal assemblage in the wintertime occupation while a much broader spectrum of animals- though still including bison- is represented in the summertime occupation. That two apparently different subsistence strategies were found at the same site in association with a continuous time span, but with different seasons, suggests that groups here during the late Paleoindian period did not need to seasonally travel to distant locations for acquisition of the majority of their resources, but instead adapted the means to survive in one area during different seasons of the year.

Figure 4-16. Terrace containing Bull Creek site during a particularly wet early summer.

The depositional extent of the site's cultural sequences was defined through systematic coring, soil profiling, and excavation (detailed in Chapter 2). From the ground surface to approximately 20 cm below surface is a late Archaic cultural component. The recovered Archaic assemblage consists of one Alibates corner-notched Williams/Marcos/Marshall-type dart point, washed out hearth features, burnt and un-burnt lithic flakes, fire-cracked quartzite cobbles, and small pieces of bone and freshwater mussel shell. A single radiocarbon date of ~1786 ± 24 RCYBP was obtained on a deer bone awl fragment (Bement et al. 2020b). The Williams point type is dated to between ~2500 to ~1500 RCYBP (Bement and Buehler 1994). Soil between the archaic levels to around 2.4 m below the ground surface is mostly sandy and sterile, representing a long period of very arid conditions. From 2.4 to around 2.8 meters below the surface, a large amount of cultural materials and radiocarbon dates coinciding with the late Paleoindian period have been documented.

Table 4-1. Radiocarbon and calibrated dates for cultural components in the Bull Creek site, reproduced from Bement et al. 2020b.

Bone no.	Material	$\delta^{13}C$	$\delta^{15}N$	%C	%N	C:N atomic	Lab no.*	^{14}C	±	Component
176-0	Deer bone	−24.4	3.34	nr**	nr	nr	A26010	1786	24	Late Archaic
								(1627-1736 cal yr BP)		
										Late Paleoindian
2015	Bison bone	−8.6	9.1	14.4	5.2	3.26	P-2475	9020	35	Summer 2
965B	Bison bone	−11.7	4.16	41.75	14.63	3.30	A40140	9013	24	Summer 2
							Average***	9015	20	
								(10,184-10,229 cal yr BP)		
1190	Bison bone	−10.7	8.6	42.8	14.7	3.39	P2489	9195	35	Summer1
1844	Bison bone	−8.8	10.57	nr	nr	3.20	A36675	9108	26	Summer1
							Average	9139	21	
								(10,233-10,299 cal yr BP)		
185	Bison bone	nr	nr	nr	nr	nr	90952	9280	25	Winter
727	Bison bone	−9.0	9.3	29.9	10.5	3.31	173186	9290	30	Winter
512	Bison bone	−9.8	8.9	42.3	15.2	3.25	166047	9300	35	Winter
							Average	9288	17	
								(10,475-10,562 cal yr BP)		

*No prefix letter = UCAIMS; P = Penn State; A = UGAMS
** nr = not reported
***Mean age calculated following Reimer et al. (2013) (Calib 7.0.4).

As of 2019, an estimated 86 m^2 of the site has been excavated. Documented within the late Paleoindian deposits up to this point are a cumulative total of at least 3500 mapped artifacts, eleven potential postholes, and at least twelve features/ activity areas divided between four stratigraphic components. In the following sections I describe each component of Paleoindian occupations at the Bull Creek site, from the oldest in age to the latest (most recent). My focus is on providing a general overview of findings to date while updating previous publications with some results from later excavations, with an emphasis on the materials relevant to land-use. Additional details on the Bull Creek site are available in Bement et al. (In Press) and Carlson and Bement (2017).

Component I

The location of the lowest and oldest component at Bull Creek was initially indicated by observation of large bison ribs eroding out of the Paleoindian-aged terrace strata in-between the two main areas of excavation (opened in 2009 and 2016 respectively). Following successful test excavation of a 1 x 1 m unit where a dense accumulation of bison bones were uncovered, this area- deemed the West Trench- became an expansion of the location of a high-wall soil profile done in 2015. A total of 47 bison elements, one piece of fragmented turtle carapace, and a single chert flake with evidence of utilization were recorded. The bison bones, predominantly ribs and thoracic vertebrae, belonged to at least three individual animals; the measurement of one thoracic vertebra at 55 cm suggests that at least this individual could have belonged to the species *Bison antiquus*. The utilized flake, coated in calcium carbonate, is identified as likely being sourced in the Edwards Plateau. Protein analysis conducted on the flake by Teteak (2018) detected no remnant organic proteins.

Due to poor collagen preservation, none of the four attempts to radiocarbon date bones from this area have succeeded. However, a projectile point was found in 2009 eroding from the Component I stratum which appears to have been produced in the Clovis tradition (Figure 4-21, Artifact F). This strengthens the possibility of much older occupational components on or near the site. A maximum age for Component I of ~11,588 RCYBP was acquired by radiocarbon dating soil organic matter from the sediments surrounding the artifacts.

Component II

Component II, which consists of a layer of fine sandy loam containing a large assemblage of artifacts and activity areas, underlies Component III. The stratigraphic division between the two components is most visible in the southern major excavation block; distinction between the two strata is less clear in the more northern areas of excavation. Through 2018, approximately 1150 animal bones and at least 143 lithic artifacts are recorded in Component II's assemblage. The great majority of bones belonged to bison, with an MNI of seven grown individuals. Among them are also the remains of at least five fetuses, each in the 5 to 6 month stage of development. If the reproductive cycle of those bison is assumed to be the same as that of modern bison herds, this level of fetal development would indicate that they were procured and processed during the winter (Bement et al. In Press).

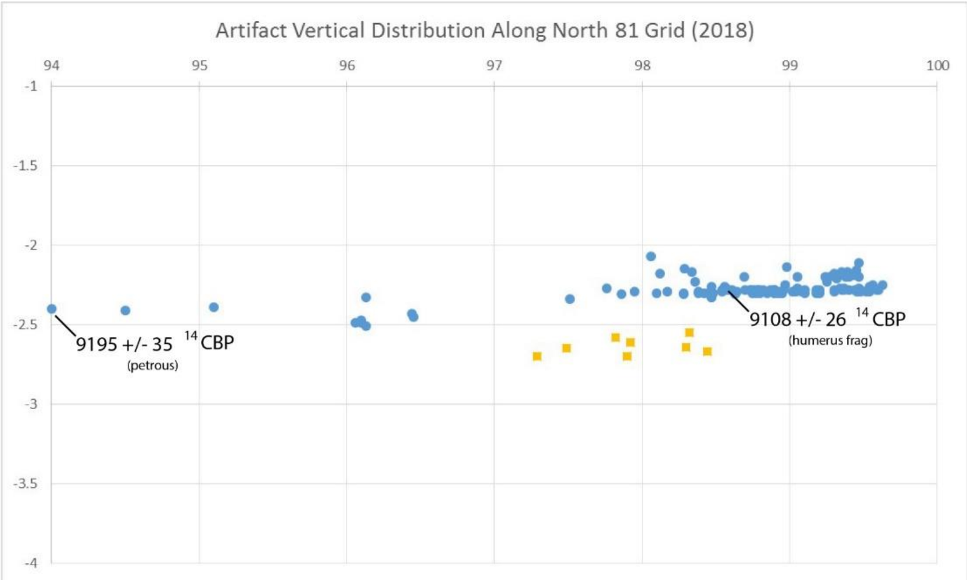

Figure 4-17. Back plot distribution of artifacts along N81 grid demonstrating two, possibly three distinct cultural strata.

The assemblage of bison bones from Component II displays extensive evidence of processing in various ways, for differing purposes. A large number of the bison limb bones have green fractures (Carlson and Bement 2017), indicating that they were broken shortly after the animal was hunted. This was done presumably for the purpose of extracting bone marrow, a dense source of fats and calories (and particularly tasty when roasted over flame). Many bones also show cutmarks, which is direct evidence of being cut in the process of harvesting the animal's meat and other edible or useful parts. Even some fetal skeletal elements were found to have cutmarks, suggesting that they were selectively procured from the adult bison for a purpose (or purposes). Some ethnographic accounts among Plains tribes within the last few centuries before present document the preparation of fetal bison soup, as well as the use of fetal hides for baby moccasins (Verbicky-Todd 1984). The single bison skull recovered in Component II is bashed-in directly atop the cranium. This probably was done for removal of the brains, possibly for use in hide-tanning, as practiced by later Plains tribes (Verbicky-Todd 1984; McConnell 2010; Baillargeon 2010).

One hearth has been documented within Component II; it was characterized by a circular, 10 cm deep depression of stained sediments measuring 45 cm across. Though devoid of any charcoal or other artifacts within its immediate area, the hearth was surrounded by an array of charred and uncharred bones, including those of fetal bison, as well as Alibates chert flaking debris (Bement et al. In Press).

Figure 4-18. Remains of hearth and surrounding bones in winter occupation (Component II, Feature 5), 2017.

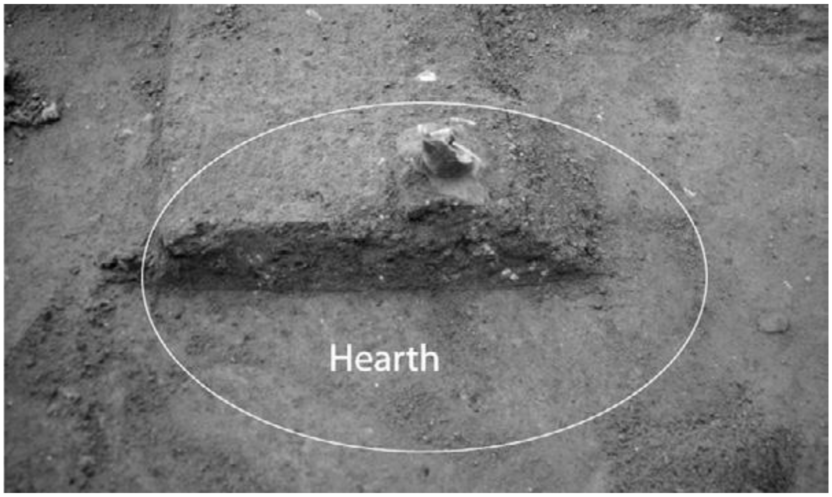

Figure 4-19. Basin hearth from Component II, found in 2009 (from Carlson and Bement 2017).

On the near north side of the hearth, on-site reduction of an Alibates biface is evidenced by a concentration within an area 50 cm in diameter of 118 Alibates chert flakes averaging in size 9.1 mm by 7.7 mm by 1.3 mm in respective length, width, and thickness. The debitage appears to represent the in-situ mid-to-late level reduction of a stone biface. The possibility of this feature representing the dumping location of flintknapping activities done elsewhere on-site is considered, however, the likelihood of this is called into doubt by the presence of microdebitage mixed into the sediments immediately underlying the reduction area. The presence of debitage varying in size between 10 mm to a microscopically small < 3 mm as well as the sequential re-fitting of various flakes suggests that post-depositional disturbance of the site, at least in the vicinity of this activity area, has been minor (Bement et al. In Press).

Figure 4-20. Bifacial thinning flakes recovered near winter hearth (Feature 5).

Sequential re-fitting of the flakes also revealed a pattern strikingly similar to the flaking pattern apparent on an Alibates chert projectile point preform which was found eroded from an unknown context at the site in 2017 (Figure 4-21, G; Figure 4-22). The preform appears to have been discarded in the final stages of production, possibly due to the breaking off of its tip. The evident reduction process is described as parallel oblique transverse flaking. Comparison to the dimensions of the flakes from the concentration showed a close match, suggesting that the same technique was utilized by both the knapper of the preform and the knapper responsible for the flake concentration. More fine-grained details on the metrics the flakes, the preform, and their comparison are available in Bement et al. (In Press:13-14).

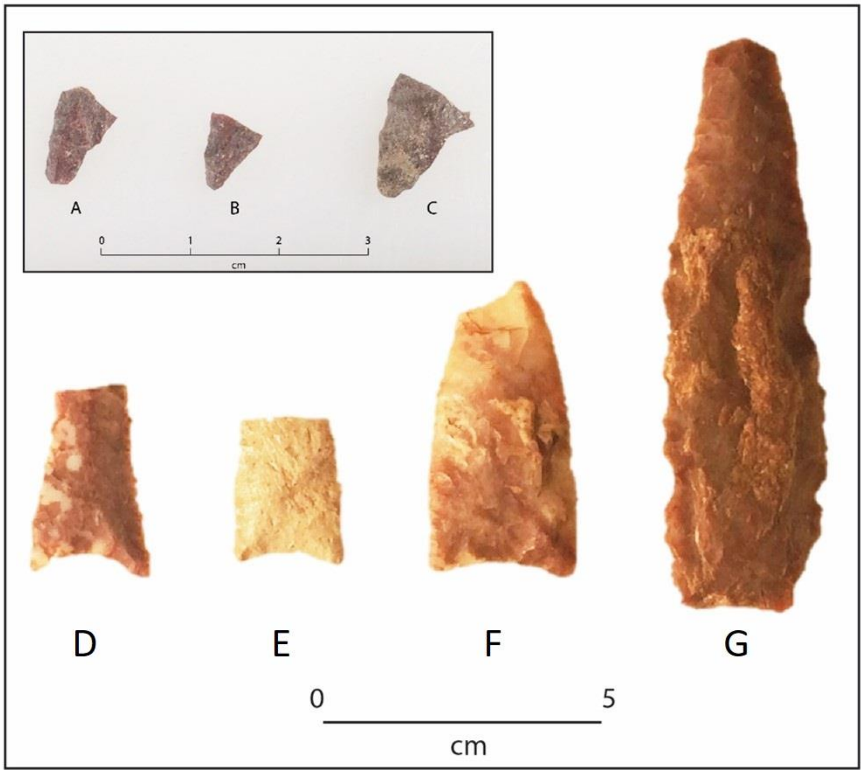

Figure 4-21. A-C: Dakota quartzite proximal ears or corners from concave-based lanceolate points (excavated within and adjacent to hearth Feature 19-1). Bottom row, D: heavily reworked Alibates lanceolate point from winter occupation (CII); E: proximal portion of reworked Dakota quartzite lanceolate point (eroded); F: Alibates lanceolate point (eroded, possible assc. with CI); G: Alibates pre-form (eroded from 2009 excavation area).

Figure 4-22. Broken Alibates projectile point pre-form recovered from Bull Creek, eroded in 2017.

Two post holes have been documented within Component II. Each hole measured 8 cm across and 10 cm deep, and were filled following feature-abandonment with dark sandy loam sediments, which contrast with the lighter, fine sandy loam of the surrounding deposit. No pattern could be discerned in their location of placement. Other artifacts found in Component II include a broken, heavily reworked lanceolate projectile point, also crafted from Alibates chert (Figure 4-21, D).

The calculated mean between uncalibrated radiocarbon assays on three bison bone elements from Component II places this wintertime occupation at around ~9288 ± 17 RCYBP. Analysis results of stable carbon and nitrogen isotopes conducted on two of these bison bone samples suggests that the bison were not a migrating herd, but resided in and around the Bull Creek valley throughout the year (Carlson and Bement 2013; Bement et al. 2018).

Component III

In the areas excavated thus far, Component III sits 0 - 25 cm above Component II, separated by a soil level darker than the two strata flanking it. Artifacts and features found in Component III are subsumed within a tan, fine sandy loam. To-date, a total of approximately 1856 animal bone elements from at least 28 distinct taxa have been recovered from this occupational level (Table 4-2). Of those taxa, two could be identified at the class level, one to the order, one to the family, four to the genus, eighteen to the species, and two to the sub-species. All animals represented in Component III are listed in Table 4-2 and visualized in the following composition of photographs.

Table 4-2. List of all faunal taxa observed in Bull Creek site assemblage.

	Taxa	Common Name		Screen NISP	Mapped NISP	Total NISP
Mammals						
	Bison antiquus	Bison			1	1
	Bison occidentalis	Bison		110	422	532
		Bison	Burned	16	8	24
		Fetal Bison		13	26	39
		Fetal Bison	Burned		1	1
		Bison/Deer		826	11	837
		Bison/Deer	Burned	54	2	56
	Camelops hesternus	Camel			3	3
	Cervus canadensis	Elk			1	1
	Odocoileus sp.	Deer		13	7	20
		Deer	Burned	9	1	10
		Deer/Pronghorn		9		9
	Antilocapra americana	Pronghorn			6	6
	Canis dirus	Canid cf. Dire Wolf			11	11
	Canis sp.	Wolf-size		4	4	8
	Canis latrans	Coyote-size			4	4
	Taxidea taxus	Badger		1		1
	Lepus californicus	Jackrabbit		1		1
	Sylvilagus floridanus	Cottontail Rabbit		4		4
		Cottontail Rabbit	Burned	1		1
	Cynomys ludovicianus	Prairie Dog			1	1
	Spermophilus sp.	Squirrel-size Mammal			1	1
	Dipodomys sp.	Kangaroo Rat		1		1
	Neotoma albigula	Wood Rat			3	3
	Peromyscus maniculatus	Deer Mouse		1		1
	Microtus pinetorum	Vole		2	2	4
	Scalopus aquaticus	Common (Eastern) Mole			1	1
		Unidentified Rodent	Burned	1		1
Birds						
	Grus canadensis	Sandhill Crane			1	1
	Aves	Small Bird		1	2	3
		Small Bird	Burned	1	1	2
Reptiles						
	Crotalus sp.	Rattlesnake		2		2
		Non-pit Viper Snake		5		5
	Trachemys scripta	Slider Turtle		10	4	14
	Terrapene carolina	Box Turtle		43	25	68
		Box Turtle	Burned	5	4	9
		Unidentified Turtle			6	6
Amphibians						
	Anura	Frog/ Toad		1	1	2
Fish						
	Cyprinidae	Minnow			2	2
Mollusks						
	Lampsilis teres	Freshwater Mussel			5	5
Gastropods						
		Snail		12		12
Misc.						
		Unidentified Bones			52	52
		Unidentified Bones	Burned		19	19
		Unidentified Bones			72	72
				1146	710	1856

NISP = number of identified specimens

Figure 4-23. Composite visual of all fauna represented at Bull Creek site. Petroglyph shown is found in Black Mesa area to the west and appears to represent Big Horn Sheep.

As the recovery of fetal bison within the 5-6 month stage of development in Component II is indicative of a wintertime occupation, the recovery of neonatal bison in Component III indicates occupation during late spring to summer. The status of Component III as a spring-to-summer occupation is further signaled by the presence of deer fawn as well as other animals that are only active in warm seasons, such as some reptilian and amphibian species (Bement et al. In Press). *Bison occidentalis* constitute approximately half of the faunal materials in Component III and the majority of the site's cumulative faunal assemblage by NISP (number of identified specimens). Yet despite the prevalence of bison, the presence of such a high number of other animal species in Component III and at an open-air Paleoindian-aged camp site in general is striking. This adds to a growing body of evidence that demonstrates late Paleoindian groups engaged in a much more varied diet than historically believed was the case among pre-agricultural nomadic groups in the Americas. Furthermore, the distinction between a broad-spectrum diet in the summer/fall versus reliance on bison during the winter is indicative of subsistence practices that the Bull Creek valley occupants had specifically adapted in synchronization to seasonal changes in the local environment.

In addition to the diverse faunal assemblage, a wider variety of tool types have been found in Component III relative to Component II. Tools from this level of occupation include one symmetrically ovate Alibates unifacial scraper (Figure 4-41), large, utilized flakes of Dakota quartzite and Alibates chert, at least three shards of large mammalian bones appearing to have been shaped into needles (Figure 4-24; Figure 4-25), and various expedient animal butchering tools. These objects were found within and around roughly 11 activity areas: six hearths, ten post-holes set across three separate areas, and two bison butchering features.

Figure 4-24. Possible bone needle fragments excavated from CIII in 2015 (N99 E98, -145cmbd).

Figure 4-25. Possible bone needle or awl fragment excavated from CIII in 2019 (BN 2175, N82 E 99, -281cmbd).

The densest feature (Feature 2016-1) is a bison butchering area representing the apparent dismantling and harvesting of the muscles and flesh from the hump, back strap, and ribs of a large bull (Figure 4-26). The butchered elements found in this feature include all vertebrae from the axis (C2) to the second lumbar vertebra (L2), at least six ribs from each side of the animal, a portion of the sternum, the cranium, atlas vertebra, and both mandibles. All are visualized in Figure 4-29, showing the animal's right side, and Figure 4-30, the left side. Several of the ribs were found piled near the axial vertebrae, while some snapped rib fragments remained near their original places of articulation with the thoracic body. Ovate blow marks are present at the base of each thoracic and some axial vertebrae (Figure 4-27) and near the heads of many ribs (Figure 4-28).

Figure 4-26. Overlayed photos of two primary units containing bison butchering Feature 2016-1; associated cranium found in two units directly north during a later phase of excavation.

Figure 4-27. Butchered axis vertebral body from Feature 2016-1 (photo from Munger et al. 2017).

Figure 4-28. Puncture mark on proximal end of butchered bison rib from Feature 2016-1 (photo from Munger et al. 2017).

Uniformity in the shape, depth, and placement of the marks suggests they were left by the same tool, and likely as well the same person. The only cut mark observed on any bone in Feature 2016-1 is found at on the occipital condyle at the back of the feature's associated (though not articulated) skull, suggesting that a durable and most likely lithic tool was used to sever the head from torso. This cranium was bashed-in at the top, suggesting procurement of the animal's brain. A radiocarbon assay dated this activity to ~9195 ± 35 RCYBP. The animal's sex was initially thought to be female (Bement et al. In Press), but additional comparison of measurements on its atlas as well as the size and shape of its horn cores with those of the animals found at Ravenscroft determined it to be male.

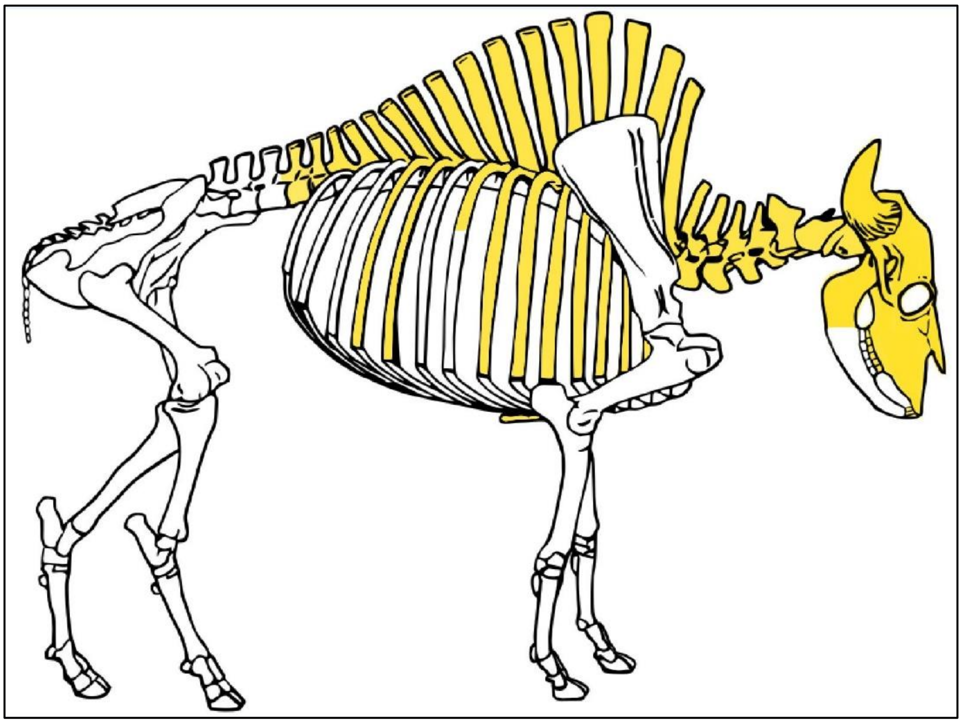

Figure 4-29. Butchered bison elements in Feature 2016-1, animal's right side. Illustration by author.

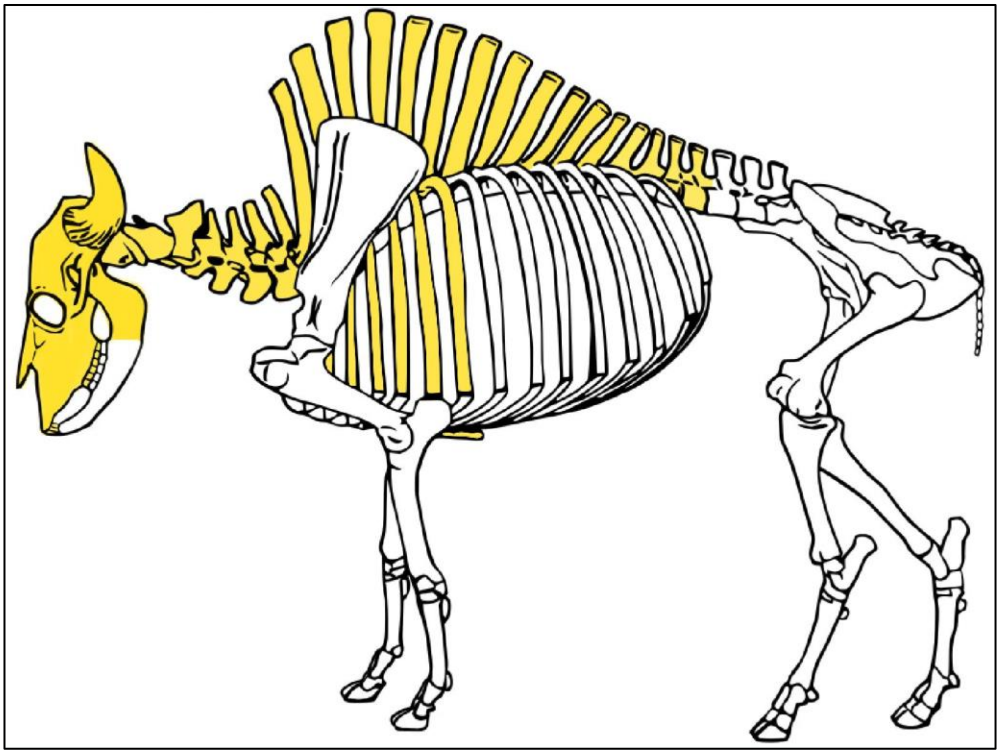

Figure 4-30. Butchered bison elements in Feature 2016-1, animal's left side. Illustration by author.

The exact tools used for butchery of the axial carcass, severance of the skull from the connected bodies, and smashing-in of the crania remain a subject of investigation. Around the feature, numerous medium-sized durable quartzite flakes were found which would have been sufficient for use in butchering, though likely not for the above-described activities.

Three meters east of the feature and within the same level of occupation, two large cobbles with use-wear were uncovered. The hammerstones were surrounded by spirally-fractured bison limb bones, though some fragments possibly sourced from other large mammals. It appears that the two stones were used in a hammer and anvil method to break open the limb bones, most likely to extract marrow; this activity area was deemed Feature 2018-1. Among these fragments was a small piece of a bison metapodial shaft; this piece was later discovered to fit to a large, broken-off distal end of a bison metacarpal, recovered over 6 meters to the south.

Measurements of its size suggest it originated in a large bull. Recovery of the shaft fragment near the hammer/anvil feature suggests that the metacarpal was broken there and then transported over 6 meters away.

Figure 4-31. Bone tools and possible post holes in summer occupation (CIII), 2017.

Figure 4-32. Feature 2018-1, hammer and anvil stones surrounded by associated bone fragments.

The spiral fracture that isolated the distal metacarpal end resulted in the formation of a short, thick, and pointed projection. At other sites, similar bone projections have been documented as used in the butchering of bison, such as at the Folsom-aged Cooper bison hunting locale (Bement 1999) and at Lubbock Lake (Johnson 1987). The tip of one such bone tool was found embedded within a puncture mark found on a bison's thoracic vertebra at Cooper (Johnson and Bement 2009). The puncture marks at Cooper bear a strong resemblance to the puncture marks on the bison axial butchering Feature 2016-1 at Bull Creek. Therefore, we hypothesized that the distal metacarpal fragment could have been used in the butchering activity at Feature 2016-1.

As one means of testing this, we produced a finely-detailed 3D scan of the broken metacarpal and then 3D-printed the object; weight was added to printed model to mimic the weight of the actual artifact in the form of heavy metal beads (Figure 4-33). We then pressed the pointed projection of the printed model into clay, replicating the dimensions of the puncture marks the object would make if used in butchering. The dimensions and morphology of the metacarpal's puncture closely matched with those of the puncture marks on the bones in Feature 2016-1, supporting the argument that this tool could have been used there.

Figure 4-33. 3D-printed model of the broken distal metacarpal fragment.

Also within Component III and in the same southern excavation block as the axial butchering and long bone processing features, two large scapulae from adult bison were uncovered, both with their blades intentionally broken off. The scapulae are each from the animals' right sides, demonstrating procurement from two different animals. The measurements of one scapula, found in the washed-out hearth area of Feature 2019-1 in the far northeast corner of the southern excavation block, suggest that the animal was a bull. The other scapula, found three meters southwest of the bull bison scapula, appears to have come from a younger animal. Excavations in Component III recovered three objects identified as possible bone needles (Figures 4-34, 4-35, 4-24, and 4-25).

Figure 4-34. Possible bone needle in-situ, adjacent to post-hole in CIII (2018).

Figure 4-35. Close-up image of possible bone needle in-situ (CIII, 2018).

Each was in very fragile, poor condition, and disintegrated upon extraction from surrounding sediments (Figure 4-34; Figure 4-35). Measurements of their diameters upon recovery in the excavation grid averaged 2 mm. The lengths and thickness of the artifacts suggests that they were constructed from the broken-off blades of the two butchered scapulae found nearby.

Figure 4-36. Butchered bison scapula, 2019 (N81 E100, -220cmbd).

Figure 4-37. Butchered bison scapula, 2019 (N81 E100, -220cmbd).

Six hearths have been identified in Component III. All were located within the southern major excavation block. Across this area, it appears that the majority of the Component II deposit is gone, likely having been fluvially washed-out. Each of the hearths located in this component appeared to have also been washed or blown out, and then filled in again with fine-grained, potentially aeolian sediments. These hearths were identifiable by the presence of a clearly defined basin depression of stained sediments and associated debris. Hearth 2019-1 was identified by observation of a relatively dense scatter of charcoal flecks and small pieces of burned bone among patchy areas of oxidized sediments.

Ten post holes associated with Component III were documented, all in the southern major excavation block. Four post-holes, recovered between 2018 and 2019, were found next to a hearth as well as the Alibates ovate scraper mentioned above. The other six postholes were located in two groups of three, also adjacent to hearths. All measured between 8 – 10 cm across and 6 – 10 cm deep. The association of some post holes with potential hearths suggests the construction of windbreaks for small surface fires, lit for cooking, warmth, and/or heat-treating stone for finer tool and weapon production. Multiple fragments of charred bone and charcoal found alongside relatively many more un-burnt pieces of bone adds likelihood to the possibility that cooking was done on-site. The post holes could also reflect the construction of drying racks or roasting support structures, particularly those adjacent to Hearths 2015-1 and 2015-3, which appear to be set in tri-pod-like formations (Bement et al. 2018:11).

The lithic materials found in and around Component III's features consist of flakes produced by the knapping of primarily Dakota quartzite and secondarily Alibates chert. Bement et al. In Press quantified the amounts of Alibates chert and Dakota quartzite artifacts documented in Component III from excavations up to 2017: Dakota quartzite flakes represented 89% of the assemblage, and Alibates chert only 11%, while in Component II, Alibates chert represented 91% of the lithic materials and Dakota quartzite only 9%. Subsequent excavations in the vicinity of Feature 2019-1 yielded several hundred pressure flakes of Alibates chert, outnumbering the quantity of Dakota quartzite flakes in the assemblage.

Figure 4-38. Large quartzite core recovered in 2019 from Bull Creek, Component III.

Excavation in the southern major block in 2019 uncovered a startling lithic object: a broken, fluting channel flake from production of an obsidian projectile point, which had been re-worked into a usable blade form (Figures 4-39 and 4-40) (Bement et al. 2020a). The two obsidian pieces were found in association with lithic debitage produced in the reduction of Dakota quartzite and Alibates chert bifaces. No obsidian beyond these two fragments has been recovered at the Bull Creek or Ravenscroft sites. The debitage lay within a meter of both one of the butchered scapulae and the marrow extraction area of Feature 2018-1. Analysis by energy dispersive x-ray fluorescence (EDXRF) determined the original source of the obsidian material to be in the Jemez Mountain region of north-central New Mexico, roughly 450 km west of Bull

Creek (Bement et al. 2020a). The implications of this finding are further explored in the following chapter.

Figure 4-39. Butchered scapula, flaking debris, and obsidian pieces shown circled in northeast corner, 2019.

Figure 4-40. Obsidian channel flake (two pieces) recovered in 2019, refitted for photo into original form.

Several lines of evidence in Component III point towards activities associated with hide-working. A variety of medium-to-large sized flakes found in all components could have been easily utilized in the cutting or scraping of hides. The Alibates ovate, unifacial scraper recovered near a hearth in Component III bears similarity to other chert circular-shaped scrapers known to be used in traditional hide-working activities (Figure 4-41) (Reilly 2015). Several ribs were vertically positioned in the deposited sediments, indicating that they were stabbed into the ground prior to site burial. This may suggest that they were used as stakes to hold down hides during processing activities like scraping and the application of a tanning agent (typically a mixture of animal brains and water) (Baillargeon 2010; Brink 2008*;* McConnell 2010). The association of post-holes with hearths could indicate that in these places, hide drying or smoking racks were placed, a mode of processing that renders hides waterproof (Quigg 1986). The implications of evidence of hide-working are further explored in Chapter 8.

Figure 4-41. Alibates ovate unifacial scraper found in Component III near hearth Feature 2018-2.

Stable carbon and nitrogen isotope analysis on one bison petrosal and one bison humerus yielded a relatively high CV compared to the isotopic analysis conducted on bison bones from Component II. These values suggest that the bison in Component III came from a more mobile herd than those hunted during the Component II occupation (Carlson and Bement 2013; Bement et al. In Press). Two radiocarbon assays on the two bison bones used as well for isotopic analysis place Component III at approximately ~9139 ± 21 RCYBP (Bement et al. 2021).

Component IV

During excavation within the West Trench in 2017, Component IV was identified by the discovery of a bison pelvis and sesamoid within the sandy loam that overlays Component III. Two meters east of the axial butchering feature (2016-1) in Component III, a second, also smashed-in cranium of another slightly smaller bison was found, which was dated to ~9013 ± 24 RCYBP, placing it within Component IV. Lack of further excavation has of-yet prevented the connection of Component IV to any of the other site components aside from Component I, which sits approximately 1.5 m directly below IV. No other artifacts or evidence of cultural manipulation of the bones were recovered. A radiocarbon assay of ~9020 ± 35 RCYBP on the bison pelvis suggests some degree of correspondence with Component III (Bement et al. In Press). Association with Component III is further indicated by two lines of evidence: first, the observation of a thin layer of sandy loam above Component III during the 2018 and 2019 excavations in the far northeast corner of the southern major excavation block; and second, the correspondence in radiocarbon assays between the pelvis found in Component IV and the bison skull mentioned above, which was excavated in 2016 and positioned only slightly above the surrounding upper boundary of Component III.

Artifacts and Features from Unknown Components

In 2018, a 2 x 2 meter excavation grid was opened at the far southern edge of the site-subsuming terrace, primarily intended to test the extent of the site. Here, the Paleoindian strata laid just 1.2 m below the surface. Several flakes (Alibates, Dakota Quartzite, and one Edwards chert flake) were recovered, no features were observed, and the associated component could not be determined.

Figure 4-42. 2 x 2 meter grid excavated in 2018 along southern terrace edge.

Additionally in 2018, a deep trench measuring 1 x 4 meters was opened approximately 15 meters east of terrace edge. Within it, excavation recovered fragments of turtle shell, various

Alibates and Quartzite flakes, and scattered flecks of charcoal. These artifacts were located within the Paleoindian-aged sediments but could not be correlated to a specific level of occupation. It is hypothesized that they belong to the summertime Component III and that the wintertime Component II deposit lay deeper than was able to be excavated in the trench. This possibility is only speculation, however, and is subject to further investigation.

Figure 4-43. Location of backhoe trench, opened and filled in 2018.

Figure 4-44. Backhoe trench opened and filled in 2018. Shown with tape marking breaks between soil strata.

The most recent phase of excavation in 2019 uncovered a particularly unusual artifact: a Permian-aged shark’s tooth (approximately 290 mil years old). The tooth was found within the Paleoindian-aged sediments in the far southeast corner of the southern major excavation block. No other large gravels were found in the same level, signaling reduced likelihood that the tooth was washed-in fluvially. The unit surrounding the tooth was sterile of cultural materials. Whether the tooth was brought in by a mouse, a strong gust of wind, or picked up by the hand of another human as surprised as modern day archaeologists at finding a shark’s tooth in the middle of the Southern Plains, remains a mystery.

Figure 4-45. Permian-aged shark's tooth uncovered in 2019.

Archaeobotanical Data at Bull Creek

The presence of plant matter in archaeological deposits at the Bull Creek site was first documented in the palynological analysis by Bement et al. (2007), which identified numerous genera and probable species of vegetation contained within the sedimentary strata subsuming the site. These identifications were woven into a paleoenvironmental reconstruction that envisions flora in the Bull Creek valley before, during, and after the valley's occupation during the late Paleoindian period (see Chapter 2). More recently, flotation of bulk sediment samples collected from an area of highly concentrated refuse artifacts in the 2018 and 2019 excavation(s) resulted in the recovery of 11 taxonomically identified plant seeds belonging to three, possibly four plant genera, which are proposed to be potential evidence of plant-use by site occupants. These charred plant remains were associated with a blown or washed-out hearth Feature 2019-1 in Component III. More details on these findings and their consequences are provided in the following chapter.

Inter-site Comparison

No direct evidence connecting the Ravenscroft and Bull Creek sites has yet been found. However, chronological and sociocultural correlations between the two sites are suggested by multiple strong lines of evidence, including correspondence between represented activities alongside radiocarbon and relative dating. These correlations, summarized in the following section, are described more in-depth in Bement et al. In Press. Each of the five bison hunting episodes at Ravenscroft occurred during the winter. The predominance of bison in the wintertime faunal assemblage at the Bull Creek camp suggests that camp occupants were engaged in the same large-scale, wintertime bison procurement evident at Ravenscroft and at other contemporaneous bison hunting locales in the region, such as at the Norton and Winger sites in western Kansas (Hofman 2010).

More specific artefactual evidence concerning lithic materials and forms as well as the processing of the hunted bison give support to this general inter-site connection. The only complete projectile point recovered from Ravenscroft is crafted from Dakota quartzite and is typologically described as Plainview-like. A single, heavily-ground basal ear or corner from an Alibates chert projectile point was also recovered. The Bull Creek site is dominated by Dakota quartzite and Alibates chert. Several of the projectile point fragments and the Alibates pre-form recovered in 2017 also appear Plainview-like in form.

Fetal calf remains were recovered in Component I, II, IV at Ravenscroft in the same 5-6 month stage of development as the fetal remains found in the wintertime Component II at the Bull Creek camp (Bement et al. In Press; Bement et al. 2012). Among the cow-calf herds hunted at Ravenscroft, many cows appear to be missing their fetuses and are positioned upon their backs, suggesting the fetuses were intentionally procured. The fetal bison remains found among bison processing features at Bull Creek appears to confirm the hypothesis that the fetuses were procured from the Ravenscroft cows and taken for processing elsewhere to another secondary processing camp(s), if not to Bull Creek specifically.

In Figure 4-46, the radiocarbon record from both Bull Creek and Ravenscroft are combined into a single dataset and then divided into apparent groups of temporal components according to age in calendar years with a 95% confidence interval. The ordering of occupational groups 1 and 2 is contingent upon the future acquisition of radiocarbon dates for these components. Occupation 3 consists of the wintertime Component II at Bull Creek and the Component II kill at Ravenscroft, Occupation 4 of the summertime Component III and Bull Creek and the Component III kill at Ravenscroft, Occupation 5 of the upper summertime Component IV at Bull Creek and the Component IV kill at Ravenscroft, Occupation 6 of only the Component V kill at Ravenscroft, and Occupation 7 of the Fulton Creek camp site (34BV178) (further described in the next chapter).

The chronological grouping of components in this way prompts a number of questions and potential avenues for future research. The wintertime bison kills at Ravenscroft occurred between an approximately 415 radiocarbon year span from ~9340 ± 40 to ~8925 ± 30 RCYBP. Radiocarbon assays on the wintertime Component II at Bull Creek, in comparison, span 34 radiocarbon years from ~9305 to ~9271 RCYBP (Bement et al. In Press). If the radiocarbon assays are true to their given degrees of accuracy, this places the wintertime occupation of Bull Creek during exactly the same time frame in which bison were hunted upstream at Ravenscroft. However, the Bull Creek camp would have been a lengthy walk 1.2 km north from the Ravenscroft kill site, particularly with heavy animal carcasses in tow. Though not entirely unfeasible, it seems more likely that a camp was established nearer to Ravenscroft for secondary processing of the animals hunted there, and similarly a bison hunting locale nearer to Bull Creek existed where the bison which were processed in this wintertime occupation were hunted.

It is hypothesized, then, that Bull Creek and Ravenscroft sites each represent distinct site types or nodes within a pattern of localized land-use over time. As described in Chapter 2, surveying and paleoenvironmental reconstruction efforts in the Bull Creek valley identified extensive Paleoindian-aged sediment deposits within terraces throughout the valley. Both the sediments and a number of artifacts found eroding from them match the characteristics of what has been documented at Bull Creek and Ravenscroft. Further investigation in the Bull Creek valley holds significant promise to further understand late Paleoindian occupations in this region and of late Paleoindian lifeways in the Southern Plains more broadly.

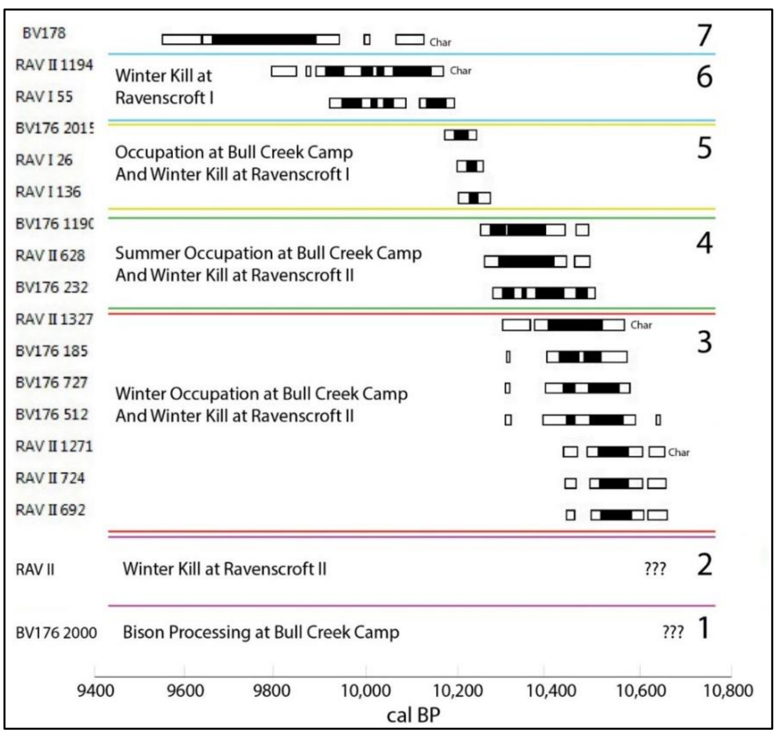

Figure 4-46. Bull Creek valley components, correlating cultural deposits at Bull Creek, Ravenscroft, and Fulton Creek (top component) sites.

In sum, both the Bull Creek and Ravenscroft sites were occupied repeatedly over a span of approximately five centuries during the late Paleoindian period, testifying to their status as fixed places on the cultural landscape of the people who occupied them. Bement et al. (In Press) further propose that the evident indicators of inter-site correlation support the idea that Bull Creek and Ravenscroft together represent the pattern of a residential or base camp being established in a strategically chosen location per the needs of arroyo-trap bison hunting, a mode of bison herd hunting dominant in the Southern Great Plains. They pose that the activities seen at the Bull Creek camp reflect decisions made concerning the transportation of procured animal parts from the location of the hunt to the camp and the secondary processing activities that would then occur (Hill 2005, 2008). However, this explanation only addresses occupation at Bull Creek during the wintertime, when bison hunting and harvesting were of central subsistence importance. I propose that what drew groups to live in the Bull Creek valley area during the summertime was not just the presence of water and ideal grounds for bison hunting to occur later in the year, but more importantly, the varied smaller animals as well as plants that this local biome supported.

In the following chapter, I describe the theories that inspire and inform my interpretation of late Paleoindian archaeological deposits in the Bull Creek valley.

CHAPTER FIVE

THEORY

The following sections present an outline of the theories I apply to describe and evaluate land-use by late Paleoindian occupants of the Bull Creek valley. My interpretation is built upon three main theoretical frameworks: analogy, Central Place Foraging theory (CPF), and landscape archaeology.

Inference Through Analogy

In an effort to interpret archaeological records as sparse as those dating as far back as the early Holocene, archaeologists rely heavily on analogies, which can be categorized as either direct historical or general comparative. In its most basic form, an analogy has two components: the subject analogue and the source analogue. Comparison between known elements of the two allow for inferences to be made about unknown elements based upon similarities and differences observed (Randall and Hollenbach 2007). The potential accuracy of such inferences are strengthened or likewise weakened by the relative quantity and quality of the apparent similarities and differences. Direct historical analogies are used when continuity between the subject and source groups is evident, while general comparative analogies are used when no continuity is apparent. Continuity is difficult and usually impossible to identify when concerning groups who lived earlier than around the late prehistoric period; in these cases, such as when the subject of interpretation originated in the Paleoindian period, general comparative analogies are used (Randall and Hollenbach 2007).

Making comparisons between archaeological and ethnographic records has significant pitfalls, largely due to the limited quantity and varying quality of relevant ethnographic records (Kelly 2013). Applying ethnographic analogy to archaeological records as distant in time from the present, such as the Paleoindian period, and in space from the research area (such as comparisons drawn from studies with the !Kung and Hadza in Africa, Aché in South America, and Inuit in the artic northern North America) is particularly fraught. There are of course no contemporary, direct analogues to human experiences during the Paleoindian period (Wilmsen 1970). Consistently changing environmental conditions mean that the landscape they lived in was much different from its present form, and likely very different from the environs surrounding contemporary foraging groups. By the time that the first semi-professional ethnography and written recording of Indigenous oral histories began on the Great Plains of North America, around 300 years after the first Europeans entered the continent, tribal populations were significantly diminished, and many cultural practices had shifted. That all being noted, there are strong parallels between ethnographic and Paleoindian archaeological contexts that warrant potentially fruitful comparison, particularly on the North American Plains.

Defining a Foraging Group

In 1980, Lewis Binford published his formative paper on hunter-gatherer subsistence and settlement systems in which he introduced the concept of an evident organizational dichotomy in such systems between groups of foragers and, in contrast, collectors. Foraging groups "map-on" to resource patches, moving the entire group in accordance with temporal and spatial conditions of resource availability. Collectors occupy places for relatively longer spans of time and send small task groups away to collect resources and bring them back to the central places of occupation. Foraging therefore implies high mobility, while collecting entails low-mobility or sedentism. Though opposing in theory, these adaptations are understood not as a strict dichotomy, but rather, a continuum of behaviors with variable real-world expressions (Perreault and Brantingham 2011).

The forager/collector spectrum is significant to archaeology because each respective behavioral pattern, in general, leaves a unique material trace. Collectors, on the more sedentary end of the spectrum, are expected to produce sites with more ample and diverse materials, resulting in greater inter-site variability. Conversely, foragers occupy sites for shorter periods of time and therefore leave less of a material record in terms of both quantity and variety (Binford 1980; Perreault and Brantingham 2011). This theory aids in interpretation of already known sites as well as aiding in the formulation of predictions for further investigations.

Robert Kelly (1995; 2013) drew from hundreds of ethnographies as well as his own ethnoarchaeological experience to explore and attempt to model the sociocultural behaviors of foraging communities. In this, it is made clear that so much variability exists within and between communities that no predictive model can be wholly accurate. However, some significant patterns can be explicated and then employed in archaeological inferences with relatively high degrees of probable accuracy. Kelly (2013) observes that groups of hunter-gatherers generally do not exceed 25 persons. Low population numbers allow greater mobility, which prevents over-exploitation of resources; maintaining small populations is also argued to optimize other conditions for adaptation, such as sharing of information and resources. Among the groups he studied, notably, an average of 65% of their diets consisted of plant foods (Kelly 2013). Additionally, sharing of resources is seen more commonly among such relatively small groups. Foraging groups tend to be more egalitarian, whereas larger and more locally dense populations who practice agriculture tend to experience intensified tensions due to increased power and wealth disparities (Binford 2001; Marlowe 2005; Kohler et al. 2018). Ethnographic and historic studies demonstrate that the highest wealth equality is found among forager populations (Borgerhoff-Mulder et al. 2009).

Agriculture did not emerge on the Southern Plains until approximately 1,200 calendar years before present (Drass 1998). Prior to that time, groups who populated the Plains are generally described as foraging groups who had mid-to-high levels of mobility in order to collect the various resources they required across the landscape. Kelly (2007:129) briefly inquires into mobility patterns among bison-hunting Indigenous groups on the Plains, including the Crow, the Cheyenne, the Kiowa, the Nez Perce, and the Blackfeet. For foraging groups generally, he documents a pattern of increases in the average distance per residential move in tandem with decreasing local temperatures. Plains tribes, as well as groups in the artic and on coastlines, are found to be exceptions to that pattern. He finds that frequent, short-distanced moves to pursue dispersed resources were most common amidst the often harsh conditions of the Plains, prior to the mobility-hindering spread of European colonization. This observation, however, was made after the horse was introduced, which had drastically reduced the time and energy costs of each move, rendering the applicability of this pattern in making inferences on the mobility of pre-equestrian groups on the Plains contentious.

Central Place Foraging Theory

Central place foraging theory (CPF) provides a means of understanding the rationale behind the location of a camp site (or central place) by comparing the costs versus benefits of procuring resources at varying times and places in the landscape. It is assumed that foraging groups will travel longer distances from central places for resources with higher energy returns, and relatively shorter distances for resources with lower energy returns (Orians and Pearson 1979). For example, a hunter may trek for many kilometers in pursuit of bison, but not as far for berries. CPF shares the same energy-expended-versus-return premise as optimal foraging theory (OFT), but with added attention to using the latter data to infer mobility patterns within given landscapes. Similarly, even greater distances might be travelled for the procurement of lithic materials to be formed into points to hunt many animals. These decisions can be accurately modelled mathematically, as done by Hollenbach (2010). However, if enough variables are known, a generalized model can be constructed.

Animal Behavioral Ecology

Of often understated importance to understanding many human behaviors is understanding the behaviors of the animals with whom they interact with, whether for subsistence (e.g., bison) or symbiosis (e.g., dogs). The relationship between humans and bison is one of the oldest and most salient human-to-animal affiliations in North America. The pivotal importance of the bison life cycle to their hunters and the decisions they make is demonstrated strongly in ethnographic records (Verbicky-Todd 1984; Brink 2008). The five, successful small-herd hunting events at Ravenscroft and intensive bison processing at the Bull Creek site demonstrate that the late Paleoindian Bull Creek valley occupants were no exception to this. The bison’s annual mobility patterns undoubtedly influenced the location and timing of these groups’ movements through and settlements within the landscape. Understanding the degree and character of that influence requires first understanding bison behavioral patterns. The diverse faunal assemblage at the Bull Creek site makes it clear that many other, smaller animals were also important to late Paleoindian groups in the Bull Creek valley. Inquiring into the behavioral patterns of these animals, including hibernation, migration, and mating patterns, could potentially shine some light on the strategies and experiences of the groups who procured them. It is only through animal behavioral ecology that a catchment model inclusive of fauna can be accurately construed.

The Landscape Approach

Landscape archaeology came to academic prominence in the mid-1980s, yet its definition has varied so widely since that its utility in this thesis needs preliminary explanation. Many texts published under the categorization of landscape archaeology fail to explain what exactly this category entails or how it is used. In general, all of such studies revolve around details of human interactions with their environments (David and Thomas 2008). While the approach in its early days of use was guided by ecological and economic concerns, it has since grown to be "less about an absolute notion of 'place'… [than] about singular *senses* of place" (David and Thomas 2008:39).

The difference in using 'landscape' as a unit of analysis over 'eco-system' or 'ecology'—landscape archaeology versus ecological archaeology—lies in the goal of analysis: landscape approaches center the perspectives and actions of human occupants in a given area as they relate to occupying that area, whereas more ecological approaches de-center the human perspective. Landscape archaeology, as espoused in this thesis, is as much concerned with ecology as it is how humans experience and influence it. In this context, adoption of a landscape approach shifts the unit of archaeological analysis from singular artifacts or activities to the entire physical and cultural landscape experienced by a subjective group of people. In essence, a landscape approach provides a systematic, regional manner of synthesizing archaeological, paleoenvironmental, and sociocultural information.

Theory Summary

This thesis is intended to contribute to an ever-more holistic understanding of Indigenous groups' experiences and lifeways on the Southern Plains during the late Paleoindian period of the early Holocene. My analysis of the archaeological data at hand is shaped by ideas stemming from various bodies of theory informed by multiple fields of inquiry, spanning from comparative cultural anthropology to animal behavioral ecology. The limited nature of what remains preserved in the Paleoindian archaeological record allows only for conclusive interpretation of the occupants' subsistence strategies, alongside hypotheses of their mobility and settlement patterns. Other aspects of the undoubtedly complex lives of those who occupied these sites- such as social dynamics and incorporeal beliefs and practices- are acknowledged but not discussed at length for lack of material evidence. The following chapter describes the primary methods I used to evaluate land-use among late Paleoindian foraging groups in the Bull Creek valley.

CHAPTER SIX

METHODS

In this chapter I explain the methodologies through which the data I use to interpret late Paleoindian land-use in the Bull Creek valley was acquired and analyzed. The data I focused on fit into three major categories: faunal, lithic, and botanical. All materials composing this dataset were originally collected through phases of intensive excavation, the majority of which were conducted as archaeological field schools in 2009 and then each year from 2013 to 2019. I participated in excavation at both sites as a student in 2015 and returned as an assistant Project Instructor in 2017, 2018, and 2019. I conducted the analysis on faunal remains recovered from the summer 2016 season of excavation at Ravenscroft and on the fauna from the summer 2018 season at the Bull Creek site; the results from those analyses are incorporated into the following Site Overview chapter. Below, I describe the process of excavations at Bull Creek and Ravenscroft, followed by descriptions of each category of data and method of analysis.

Excavation, Documentation, and Processing

Excavations at Bull Creek and Ravenscroft were conducted per established methods up to-date in American archaeology. Following the selection of initial areas for excavation, a permanent datum was placed at each site and corresponding grids divided into m^2 units were set in alignment to the orientation of the drainage. All excavated materials at both sites were documented with horizontal and vertical provenance within the grid in relation to the datum. Photographs of daily progress were systematically taken within excavation areas and of individual units, artifacts, and features. Site scale maps were drawn on paper and digitally scanned post-excavation. Detailed notes were recorded in field journals daily.

At Bull Creek, units were excavated in arbitrary 10 cm level increments. The extensive bone beds at Ravenscroft prompted a different method of excavation: each layer of bones, representative of a single hunting episode, was conceptualized as each being a single feature. Accordingly, large areas were exposed and documented before the removal of any artifacts. This approach originated with the work of George Frison and his colleagues in the 1970s and was more recently developed further within the setting of the Southern Plains by Leland Bement at the Cooper, Jake Bluff, and Badger Hole sites. Through this approach, the buried locations of ancient large-scale bison hunts are viewed and analyzed as holding bountiful information on human behavior within specific landscape contexts (Bement et al. 2012).

Figure 6-1. Field school excavation in-progress in RAV II, summer 2015.

Figure 6-2. Excavation and mapping at Bull Creek in NE grid extension, N81-82 E98-100, 2019. Facing south.

Throughout excavations at both sites, all removed sediments were collected and screened through ⅛ inch (3mm) mesh hardware cloth. Artifacts recovered in this manner were bagged together and labelled by provenience. Bulk sediment samples were collected for in-lab finer screening or water flotation from select units which showed heavy artifact density and/or in which features were present. Water flotation and fine screening of those samples produced the charred plant remains introduced in Chapter 4, which I integrate into the discussion of land-use in the following chapter. Some bulk sediment samples also produced a large amount of Dakota quartzite and Alibates chert microdebitage.

Geoarchaeological methods were applied throughout the span of investigation. Several soil profiles across the cut bank at Bull Creek were cleared and studied for information on the extent and nature of cultural deposits and their paleoenvironmental context. Field school students were introduced to the fundamentals of sediment analyses. During excavation, soil characteristics and changes were recorded on each level form.

Following completion of each phase of excavation, thick plastic sheets were laid across the grid and covered with several feet of backfill for long-term protection of the intact deposits. All excavated specimens, boxed together according to cataloged numerical order, were transported to the lab. The cataloged artifacts were inventoried to review the sum of collected materials and check for any missing cataloged specimens, and then carefully cleaned where appropriate. After being cleaned, the artifacts retained their cataloged numbers, but were separately stored according to material type—lithics, fauna, flora, and sediments. All materials, as of this thesis' preparation, are currently being curated in-lab at the Courson Family Bison Research Center in the Oklahoma Archeological Survey, and will eventually be stored and curated at the Sam Noble Museum of Natural History in Norman, Oklahoma.

Figure 6-3. Boxed and foam-encased bones from Ravenscroft at the Courson Family Bison Research Center, 2020.

Figure 6-4. Artifact curation at the Courson Family Bison Research Center, Norman, OK.

Faunal Analysis

Zooarchaeological remains can be used to address a wide range of questions concerning human behavior. Analysis of the faunal assemblages at Bull Creek and Ravenscroft provides insight into the occupants' subsistence strategies, the duration and seasons of on-site occupations, and potentially even social organization. Such information can then be used in combination with other sets of data (lithic, botanical, etc) to inform broader questions of annual and seasonally patterned land-use. All artifacts identified as fauna were subject to analysis.

Analysis consisted of three major phases: analysis of each cataloged element using a pre-coded form, analysis of each specimen bearing evidence of potential cultural modification, and attempted re-fitting of any fragmented and modified specimens, which might have once been parts of a whole bone. During all phases, the relative depths below datum and locations within the excavation grids of each specimen were kept in mind. Prior to any re-fitting or cultural analyses, each specimen was measured and identified in terms of species, skeletal unit, age, and sex of the animal. Each bone or bone fragment was also assessed for cultural alterations, including cut marks, burning, or anthropogenic breakage patterns (IE, spiral green bone fractures), alongside taphonomic factors including degree of weathering, root etching, and carnivore or rodent gnawing. Unfortunately, poor conditions of many bones, consequential of the long span of time passed since deposition, rarely allowed for all these determinations. Most bone specimens from both sites have at least a light layer of calcium carbonate covering the entire surface, and many have thick carbonate crusts or isolated spots where the mineral accumulated. With each specimen also having been subjected to at least the first stage of weathering damage, the visibility of the original bone surface is significantly obstructed, leading us to estimate that a number of cut marks have either been destroyed or lay concealed under carbonate. However, many of the bone specimens from Bull Creek displayed cultural alteration, and in most cases, the identification of genus and sometimes species is possible.

The bison bones, particularly of the Ravenscroft assemblage, were analyzed specifically for characteristics that inform on herd dynamics, including sex, age, and size.

Lithic Analysis

Sourcing lithic raw materials and analyzing tool form and use produces information on communities of practice (the groups through which knowledge of production techniques was shared), subsistence strategies, and regional mobility patterns. After being cleaned and separated from the rest of the artifact assemblages, lithic materials from Ravenscroft and Bull Creek were broadly categorized according to these criteria: source material, artifact type (projectile points, knives, hide scrapers, debitage etc.), and their apparent status in terms of stages of production (un-finished, finished, broken, waste). In the case of debitage scatters, as found at Bull Creek, analyses were conducted to determine precisely which lithic reduction activities were conducted on-site, for what purpose(s), and with what evident results. Each finished artifact was carefully scrutinized through macro and microscopic means in order to identify flaking patterns and use-wear.

Eleven potentially utilized lithic flakes alongside two sediment samples deposited at Bull Creek were sent to the Laboratory of Archaeological Sciences at California State University for protein residue analysis testing. Protein residue analysis (specifically, cross-over immunoelectrophoresis [CIEP]) on utilized stone tools and other archaeological materials aids in interpretations of their uses by detecting the ancient organic residues of both animals and plants. Identifications made were at the taxonomic level of Family (Teteak 2018). The results of these tests are presented and interpreted in chapters 6 and 7.

Botanical Analysis

Compared to the available breadth of knowledge on human associations with lithic and faunal resources during the Paleoindian period, human and plant associations are severely under-represented, particularly on the Great Plains. Addressing the debate as to whether this is due to a lack of preserved materials, absence of the necessary methods to isolate and identify plant remains among Plains archaeological projects, or a combination of both factors is beyond the scope of this thesis. In order to isolate any botanical materials from the archaeological deposits at Bull Creek, sediment samples were taken from evidently high-activity areas in the site and later processed through flotation in the lab. Flotation is a technique that entails the use of fine mesh and flowing water to separate more dense materials, such as bone and stone, from buoyant light materials like carbonized plant matter. The isolated plant matter is then subjected to taxonomic identification; specimens are most commonly identified to the level of Family and occasionally Genus.

Determining Seasonality

The determination of seasonality is a pivotal factor in modelling land-use. Landscapes change dramatically over the course of a seasonal year; in locations such as the panhandle which experience the full, four-season cycle, the availability of many plant and animal resources shifts according to season. When daily temperatures cool, many animals migrate or move into hibernation and plants become dormant, pushing local human populations to adapt to their availability. Various lines of evidence indicate seasonality at Paleoindian archaeological sites on the Southern Plains. Taxonomic identification among faunal assemblages demonstrates which animals the occupants had access to around the time of occupation and accordingly the season of occupation, as the habitats and availability of most species are seasonally conditioned. At sites where bison remains are present, such as at Bull Creek and Ravenscroft, seasonality may also be inferred through observation of fetal or infant bison development. Zooarchaeological and isotopic data support the hypothesis that ancient bison herds- like ethnohistorically observed herds- followed set annual migratory routes with predictable times when rutting and calving occurred.

Among modern herds, rutting tends to occur in the summer, from July to September; gestation lasts approximately 9.5 months or 285 days; and the birthing or calving season occurs in the spring, from around April to July (Berger and Cunningham 1990). Therefore, the presence of neonates at a site indicates a springtime or early summer occupation, and the presence of fetal remains indicates that the mother was hunted sometime during gestation between autumn to early spring. Observation of the particular stages of fetal development can further indicate when the mother was hunted relative to her predicted summertime insemination; less developed fetuses would correlate to wintertime hunts, and more developed fetuses correlate with the transition from winter to spring. The presence or absence of particular botanical remains at a site may additionally provide clues as to the seasonality of occupation. However, the sample size of botanical materials at Bull Creek is currently too small to use as a reliable indicator of seasonality.

Catchment Analysis

Catchment analysis relates an archaeological site (and in turn, its occupants) to the surrounding landscape by defining the geographic range of the natural resources constituting the site's artifact assemblage. This methodology originally came from geology, but proves valuable when applied in archaeological analyses. Catchment analysis focuses on sourcing evidently procured resources in the landscape, therefore locating the sites and sometimes even seasons of procurement. In the case of fauna and flora, this entails identifying the probable habitats and relevant behavioral patterns of the represented animals and plants. Almost all of the twenty-eight distinct faunal taxa identified at Bull Creek, including the genera evident at the site via protein residue analysis on utilized tools, are still found throughout the region today. The late Paleoindian-era habitats of the few extinct genera represented can be predicted based upon the locations of paleontological findings, as well as through comparison to closely related species extant elsewhere in ecologically comparable landscapes. For lithic materials, determining catchment entails locating the source of the raw material in the landscape, while factoring in the possibility that finished tools and raw materials could have been acquired through trade.

CHAPTER SEVEN

LATE PALEOINDIAN LAND-USE IN THE BULL CREEK VALLEY

In this chapter, I integrate the theory presented in Chapter 5 with the results of the analyses outlined in the previous chapter in effort to sketch late Paleoindian land-use in the Bull Creek valley. Previous publications on the Bull Creek and Ravenscroft late Paleoindian archaeological sites in the Bull Creek valley, Oklahoma Panhandle, are focused on describing the activities conducted by occupants in the immediate vicinity of the sites. Discussions have primarily involved the characteristics of apparent activities with some attention to how they varied seasonally, with the exception of inquiry into the large-scale bison hunting strategy that enabled repeated successes at Ravenscroft (Bement et al. In Press; Carlson and Bement 2017; Bement et al. 2012; Muhammed 2017). This thesis adds to those lines of investigation a third question: how were the valley occupants' activities arranged seasonally *and* across the surrounding landscape? Did bison hunting determine their movements throughout the year, or only part of it?

Due to the limited variety of archaeological remains at Bull Creek and Ravenscroft, the task of drawing out landscape-set interpretations is difficult. However, I propose that at late Paleoindian sites in the Bull Creek valley, there are indicators of human movement-through and use-of the surrounding land sufficient in quantity and quality for a land-use model to be proposed. Through this model I attempt to predict where people were choosing to go, when (during which seasons and how often), and for what reasons. The key method I apply involves conducting a site catchment analysis, incorporating fauna, flora, and lithic source materials. Faunal and floral resources are placed on the landscape according to their niche habitats and further segregated by seasonal availability, provided there is evidence of their procurement. The origins of lithic resources are located on the landscape and combined with a typological analysis to extrapolate the place and process of their acquisition. The locations and availability of all of these resources are finally synthesized into a model of late Paleoindian land use applied to groups inhabiting the Bull Creek valley spanning at least 400 years during the late Paleoindian period.

Locating Resource Procurement

Catchment Analysis: Fauna

A cumulative list of animals procured by the inhabitants of the Bull Creek site has been generated through faunal analysis of recovered bones following each phase of excavation. A total of 28 taxa have been identified (Table 4-2, Chapter 4). Two additional taxa were identified through residue analysis of flaked stone tools. Testing conducted at the Laboratory of Archaeological Sciences at California State University identified proteins on two utilized flakes belonging to a small mammal (most likely rabbit or guinea pig) and to sheep. As the variety of sheep nearest to Bull Creek during the time of late Paleoindian occupation would have been bighorn sheep found in the Black Mesa region to the west, this residue is assumed to indicate procurement by site occupants of bighorn sheep in that area. Testing for protein residue on flake tools by Cummings and Clark (2019) indicated that camel also was processed. Camel went extinct at least 2000 years before the occupation of Bull Creek. However, a camel first phalanx was recovered during the 2017 excavation which appears to represent a scavenged fossil bone worked into a handle intended to secure lithic flakes for use as a tool. This camel bone tool was radiocarbon dated to ~25,903 ± 62 RCYBP (A42013a), far pre-dating the Paleoindian period and thus confirming that this taxa represents a heritage resource and not a living animal on the late Paleoindian landscape.

Other than the camel, all faunal taxa identified at Bull Creek are found across the Southern Plains today, or were until recent history (e.g., bison), in presumably the same or similar terrains as they would have inhabited during late Paleoindian times. The habitats of all animals for which there is evidence for procurement at Bull Creek and Ravenscroft are listed in Table 7-2, alongside information pertaining to their availability throughout the year as determined by seasonal behaviors. A few of the animals, such as small rodents, snails, and minnows are not believed to have been procured. These animals most likely died on-site of non-anthropogenic causes in the time span between the end of human occupation and site burial, per their recovery in the same strata as various intact anthropogenic activity areas. Or, alternatively, some of these taxa may have been brought to the site with other materials, such as if attached to vegetation (e.g., gastropods) or contained in the digestive tract of larger animals. They are included in the list primarily for their significance as proxies of topographic and climatic conditions during occupation.

Table 7-1. Niche habitats and seasonal activities of represented animals (table by author).

	Taxa	Common Name	Habitat	Seasonal Activity
Mammals	*Bison antiquus*	Bison	lowland plains	avail. depending on migration patterns
	Bison occidentalis	Bison	lowland plains	avail. depending on migration patterns
	Cervus canadensis	Elk	open plains	avail. depending on migration patterns
	Odocoileus sp.	Deer	woods, open plains	YR, more active in spring
	Antilocapra americana	Pronghorn	high plains	YR, more active in spring
	Ovis canadensis	Bighorn Sheep	highlands, canyons	YR
	Canis dirus	Canid cf. Dire Wolf	plains, woods, highlands	YR
	Canis sp.	Wolf-size	plains, woods, highlands	YR
	Canis latrans	Coyote-size	open plains	YR
	Taxidea taxus	Badger	open plains	less active in winter
	Lepus californicus	Jackrabbit	open plains	YR
	Sylvilagus floridanus	Cottontail Rabbit	open plains, shrubs	YR
	Cynomys ludovicianus	Black-Tailed Prairie Dog	open plains	YR
	Spermophilus sp.	Squirrel-size Mammal	riparian, near water	YR
	Dipodomys sp.	Kangaroo Rat	arid plains, sandy soils	YR
	Neotoma albigula	Wood Rat	open plains, woodland	YR
	Peromyscus maniculatus	Deer Mouse	open plains, woodland	YR
	Microtus pinetorum	Vole	open plains	YR
	Scalopus aquaticus	Common (Eastern) Mole	open plains	YR, burrow deeper in winter
Birds	*Grus canadensis*	Sandhill Crane	high plains, playas	spring / fall, along migratory route
	Aves	Small Bird	open plains, woodland	YR
Reptiles	*Crotalus sp.*	Rattlesnake	open plains, rocky areas	YR, less active in winter
		Non-pit Viper Snake	open plains, rocky areas	YR, less active in winter
	Trachemys scripta	Slider Turtle	in / near streams	YR, less active in winter
	Terrapene carolina	Box Turtle	open plains, near water	spring / summer
Amphibians	Anura	Frog / Toad	open plains, near water	spring / summer
Fish	Cyprinidae	Minnow	streams, rivers	YR
Mollusks	*Lampsilis teres*	Freshwater Mussel	streams, rivers	YR, follow fish migrations
Gastropods		Snail	terrestrial, near water	spring / summer

YR = year-round

In sum, the animals procured by late Paleoindian occupants in the Bull Creek valley were found in four, possibly five major eco-zones: open high plains, wooded prairie margins / riparian zones, fluvial or riverine zones, mesa / mountain canyonlands, and possibly plains playas. Playas are mentioned as being only potentially represented because sandhill cranes in modern history are more commonly found around playas and deeper lakes than along rivers and streams such as Bull Creek. Playas are commonly found in upland settings throughout the High Plains, including across the Southern Plains, and are known to have drawn human occupants to their shores throughout the early Holocene (LaBelle 2003, 2010). Bison, elk, pronghorn, jackrabbits and box turtles would have all been procured from the open high plains. Deer, badgers, cottontail rabbits, and slider turtles would have been procured from wooded prairie margin or riparian zones. Slider turtles could have also been found in riverine settings, alongside frogs / toads and minnows. Riverine procurement is also evidenced by the mussel shell knife recovered among the hunted bison remains at Ravenscroft. Bighorn sheep, indicated by protein residue analysis, would most likely have been procured in the mesa canyonlands west of the valley. The seasonal behaviors of these animal resources and the significance of those to analyzing the temporal and cyclical aspect of catchment are expanded upon following overview of the catchment ranges for lithic and floral resources.

Catchment Analysis: Lithics

The second dataset to provide site catchment insight is lithic material used to make stone tools. Analyzing the catchment of lithic artifacts involves identifying the geologic origins and geographic source locations of the represented lithic materials. These locations are proposed to most likely either have been travelled to directly by site occupants or to have been occupied by groups with whom the group in question had a trade relationship. Within the late Paleoindian archaeological deposits at Bull Creek and Ravenscroft, five distinct lithic material types have been identified: Dakota quartzite, Alibates chert, Edwards chert, Niobrara jasper, and obsidian. The geologic and geographic sources of these materials are presented in the table below.

Table 7-2. Details pertaining to represented lithic materials (table by author).

Name of Material	Rock Type	Source Location
Alibates Chert	agatized dolomite	Canadian River Valley, Texas Panhandle
Dakota Quartzite	silcrete quartzite	SE Colorado, NW Oklahoma, E and NE New Mexico, NW Texas
Edwards Chert	chert nodules in limestone	Edwards Plateau, Central Texas
Niobrara Jasper	chert in Smoky Hill Formation	Central Plains, esp. west-central Kansas and SW Nebraska
Obsidian	extrusive igneous	Jemez Mountains region, north-central New Mexico

Alibates chert and Dakota quartzite are unequivocally the most densely represented materials spanning late Paleoindian occupations in the Bull Creek valley. The only complete projectile point recovered from the bonebeds at Ravenscroft was shaped out of Dakota quartzite. Relatively small quantities of obsidian, Edwards chert, and Niobrara jasper were found, supporting the assumption that the source locations of these materials were most likely not included in the annual rounds of late Paleoindian Bull Creek valley occupants. Figure 7-1 displays the locations of each lithic material source on a map of the region encompassing the Bull Creek valley with the approximate amount of time it would take to walk from the valley to each respective location, without determent by inclement weather or other emergent circumstances.

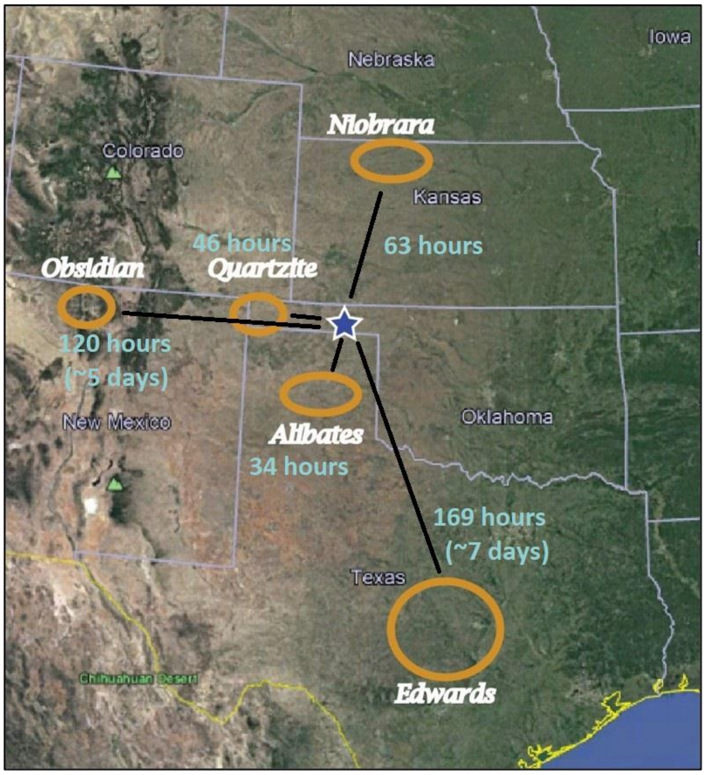

Figure 7-1. Source locations of lithic materials represented in late Paleoindian deposits in the Bull Creek valley (blue star).

Alibates chert is sourced in the Canadian River Valley region of the Texas Panhandle, approximately 100 km southwest of the Bull Creek valley. The Alibates flint quarries, now a national monument, show evidence of extensive quarrying activity dating back 13,000 years (Turner et al. 2011). Dakota Quartzite is a hard silcrete quartzite that varies in coloring between shades of red, pink, silver, purple, and brown. Outcrops of this stone are found 100 – 150 km due west of the Bull Creek valley in the Oklahoma Panhandle, and further into southeast Colorado, northeast New Mexico, and across the northwestern range of the Llano Estacado in northwestern Texas (Banks 1990). The quarrying locations of these two lithic material types are roughly equidistant from the Bull Creek valley.

Figure 7-2. Quarried Dakota quartzite boulders immediately east of Black Mesa, ~160 km west of Bull Creek valley.

Figure 7-3. View from an Alibates quarry at Alibates Flint National Monument, Texas.

Among a dense smattering of lithic debris in the lowest summertime occupational level at Bull Creek lay two re-worked halves of the same obsidian channel flake (see Chapter 4). EDXRF analysis determined the source of the obsidian to be within the Jemez Mountains region of northwestern Colorado (Bement et al. 2020a). Channel flakes are produced in the act of removing a concave flute from the base of a projectile point. The only cultural groups who produced fluted projectile points on the Southern Plains and as well in the nearby environs of the southwest are Folsom and Clovis. Therefore, it is evident that Bull Creek site occupants recycled this obsidian flake, which had been produced between one to three thousand years before their occupation of the valley. The question then arises of where the channel flake was found.

Clovis and Folsom lithic artifacts have been observed in the Bull Creek valley, yet none are formed of obsidian. Both Clovis and Folsom obsidian artifacts sourced from the same north-central New Mexican range have been documented in New Mexico (Steffen et al. 2009). Dakota quartzite— the most extensively used lithic material in the Component III summertime occupation— is sourced at the far west / northwestern edge of the Oklahoma panhandle, adjacent to and sharing eco-zones with New Mexico. Both Clovis and Folsom artifacts have been documented in this region (Bement and Carlson 2015; Carlson et al. 2014). It therefore appears more likely that the obsidian channel flake was picked up in the Black Mesa region rather than in the immediate vicinity of the Bull Creek occupation. Yet regardless of the exact place where a late Paleoindian Bull Creek occupant acquired the object, the fact remains that it was recycled following production and use by an earlier group. The object could have been scavenged from a ground surface or cached context, or possibly traded for with another group, as obsidian blades are of a significantly sharper quality than the quartzite or chert found closer to the Bull Creek valley. This recycled channel flake is considered alongside the camel phalanx blade handle to be a unique heritage resource.

Plant Resources

The inclusion of plant materials within catchment models as applied to Paleoindian archaeology is rare compared to the prevalent use of primarily lithics and secondarily fauna to form interpretations (MacDonald and Nelson 2019; LaBelle 2010; Hill 2010). This is largely due to the generally poor preservation of organic materials in such old contexts. However, enough evidence of botanical remains coinciding with the time and on-site location of late Paleoindian inhabitation in the Bull Creek valley has been recovered to allow for exploratory discussion of the significance various plants could have held.

The initial, comprehensive paleoenvironmental reconstruction of the Bull Creek valley (Bement et al. 2007) recorded a total of 34 pollen or phytolith samples identifiable at least to genera. These plants would have grown across the landscape at the same time as the late Paleoindian occupations. More recently, flotation of bulk sediment samples collected from areas of heavy artifact density within and adjacent to a small hearth at the Bull Creek site allowed for the recovery of at least three, possibly four plant genera: goosefoot (*Chenopodium*), amaranth (*Amaranthus*), sedge (*Cyperaceae*), and possibly a species of nightshade (*Solanaceae*) (Bement et al. 2020b). Bull Creek's human inhabitants lived among these trees, shrubs, grasses, and flowers each day, spanning generations; undoubtedly, this familiarity resulted in cultural value being ascribed to many of them, at the very least for the functionality of some in nutritional or other practical terms. Comparing the Bull Creek valley floral assemblage to other archaeological findings alongside ethnographic and historic records of Indigenous groups on the Plains compels discussion of plant-use possibilities among late Paleoindian groups.

The four plant genera identified at Bull Creek were found charred within a disturbed hearth area among many fragments of burned bones and microdebitage in the lowest summer occupational layer (CIII, dated to approximately ~9139 ± 21 RCYBP) (Bement et al. 2020b). The position of the charred botanical remains within a dense accumulation of other inarguably cultural artifacts of varying sizes, many burned and some extremely small (IE, microdebitage <1mm in size), significantly increases the likelihood of the plant remains having an anthropogenic reason for being there. The growth season of these plants—from summer to mid-fall—coincides with the other lines of evidence that suggest their procurement and therefore the occupational level they were found within occurred during those seasons.

The 2007 paleoenvironmental reconstruction by Bement et al. recorded Cheno-Am pollen as being among the three most consistently and abundantly detected plant categories throughout Bull Creek's pollen record, alongside *Poaceae* (grasses) and High-Spine *Asteraceae* (sunflowers). Cheno-Am is a category that subsumes both *Chenopodium* and *Amaranthus* plants, as pollen from the two plant genera are difficult to distinguish. Kindscher (1987:22;82), in a book on edible plants found and used by historically-documented tribes on the Plains, notes that *Chenopodium* and *Amaranthus* plants are found and eaten by humans on the Plains as well as worldwide and throughout the archaeological record, and when consumed, provide a large variety of vitamins, minerals, and fiber, with moderate caloric energy.

In the article documenting their recovery, we propose that the evident shift in this region from conducting large-scale bison hunts in the summer-to-fall seasons during the early Paleoindian period to the winter in the later Paleoindian period was connected to an increase in the value ascribed to harvesting wild *Chenopodium* and/or other plant resources (Bement et al. 2020b). During the time of the occupations in question, the regional climate was shifting from the cooler, more moist conditions associated with the Younger Dryas to the hotter and drier conditions which, in general, continue to present day. These changes supported the prolific spread of early stage successional plant species like *Chenopodium*, particularly in and around water sources and areas of increased ground-surface disturbance, such as sites of human occupation. The seeds of a single *Chenopodium* plant could provide up to 1,712 calories (Gingerich and Kitchel 2014; Scarry 2003), protein, and carbohydrates. Such a high nutritional yield in large quantity, alongside the plant's predictability, could have been sufficient enough for groups to devote part of their collective labor to procuring it and to re-schedule communal bison hunting events—which required efforts from the entire group— to the cold seasons when *Chenopodium* and other plants were unavailable (Bement et al. 2020b). Over time, *Chenopodium* could have become recognized among late Paleoindian groups in this region as a seasonally and spatially predictable, valuable source of food. However, the sample size for these plant resources at Bull Creek is low when compared to other, more recent archaeological sites in the Plains where Chenopodium retrieval is also evident. The disparity may be due to low retrieval rates, short-term occupation, and/or poor preservation. Additionally, no grinding stones or container technologies typically associated with the processing of small seed resources have been found in Paleoindian contexts in or near the Bull Creek valley. For these reasons, this hypothesis remains conjectural. At the very least, the potential evidence of and reason for *Chenopodium* retrieval and use at Bull Creek is of enough quantity and quality to deserve consideration and further study.

As mentioned before, the four plant genera recovered through flotation of sediments from the lowest, summer-to-fall occupation are *Chenopodium* (goosefoot), *Amaranthus* (amaranth), *Cyperaceae* (sedge), and possibly a species of *Solanaceae* (nightshade). Indigenous groups whose territories stretch across the Plains in more recent history and who are known to have traditionally gathered wild and possibly cultivated *Chenopodium* plants include the Dakota, Omaha, Kiowa, and Pawnee. The Pawnee reportedly used the leaves as green dye for arrows and bows (Kindscher 1987:80-81). *Amaranthus* plants are suggested by Kindscher to have potentially been of importance to peoples across the Plains region particularly in times of drought, while tribes elsewhere in the Great Basin and Southwest may have relied on their nutrition more regularly (1987:20). Kindscher also notes that *Amaranthus* seeds have been documented within archaeological deposits across the plains and might have occasionally been cultivated, but in most cases appear to have been harvested wild (1987:20).

The earliest pollen records indicate that juniper (*Juniperus*), willow (*Salix*) and walnut (*Juglans*) trees likely grew among the riparian vegetation along Bull Creek around ~11,070 RCYBP. Despite an evident phase of decline, the records show that juniper, oak (*Quercus*), and elm (*Ulmus*) continued to grow around the site during the late Paleoindian occupations studied here (Bement et al. 2007:44-46). The discovery of hackberry seeds across the site in every season of excavation thus far demonstrates the growth of hackberry trees in the area during occupation.

Evidence for the use of wood by Bull Creek inhabitants was found during excavations between 2009 to 2018 at the Bull Creek site in the form of up to 13 post-holes. These cylindrical shaped cavities in the late Paleoindian soil layer are believed to have filled in predominantly with sand following abandonment of the site and decomposition or removal of the wooden posts that would have stood within them. Future tests for detection of environmental DNA on the fill,

fill/cut boundary, and surrounding soil of post-holes may aid in identifying which specific wood was used.

In addition, wood would have been used to form shafts for projectile points. Multiple projectile points or fragments have been found in the Bull Creek valley sites, including at the Bull Creek site and at Ravenscroft. All of these projectile points were made as part of multiple-component hunting weaponry that consisted of knapped points fastened to wooden shafts, propelled by atlatls, also constructed of wood. The long and straight wood of willow trees or durable oak wood would have been ideal for use as shafts for such weaponry, and also as posts. Hackberry, elm, walnut, and juniper wood would have been significantly more difficult to work with, and therefore were more likely to have been used as firewood.

Numerous other plants that evidently grew around the site during late Paleoindian occupation are known to have potential value as food, medicinal applications, or other practical purposes among Plains groups later in time. Cattails (*Typhus angustifolia*) grew among the riparian vegetation that thrived along the creek beginning around ~11,070 RCYBP and continued to, in association with moist climatic conditions. Both the roots and seeds of cattails are edible. An explorer in 1809 observed the contents of an Arikara Medicine Man's bag and noted a significant amount of cattails, reportedly used to treat "burns or scalds", alongside- among other plants- a kind of artemisia, or sage (Kindscher 1992:244-45).

The earliest pollen sediment samples pre-date ~11,070 RCYBP by a short time and contain the highest volumes of pollen associated with the genus *Artemisia* observed of any period in the study, suggesting that the valley at that time was likely blanketed with sagebrush. Around ~11,070 RCYBP, sagebrush was out-populated by rabbitbrush, but still remained present. The samples indicate that sagebrush or related members of the *Artemisia* genus had returned to proliferation in the valley by approximately ~9300 RCYBP and continued to grow in the valley throughout the time when Bull Creek was occupied. Sagebrush seeds can be eaten raw or dried and ground. In the northern plains, the Lakota traditionally burned sage as a means of inducing "good influences" and protecting against "maleficent powers"; they also wove sage into bracelets for ceremonial use (Kindscher 1987:240; Kindscher 1992:48). Ethnobotanist Kelly Kindscher notes that all species of wild sage were used by tribes whose territories were in its growth range for medicinal and ceremonial purposes throughout known history, including the Blackfeet, Kiowa, Apache, Cheyenne, Comanche, and Arapaho (1992:46-52).

Second only to grasses in terms of volume of annual growth around the Bull Creek site are High-Spine *Asteraceae*, members of the sunflower family that thrive across the continent. When the Bull Creek site was occupied during the summertime in the late Paleoindian period, tall sunflowers likely stood and bloomed like they do today. The seeds of sunflowers can be eaten raw fresh or dried, boiled alone or diluted into soups or drinks, roasted, or ground into flour and baked into bread (Kindscher 1987:125). Plains tribes known in more recent history to value the consumption of sunflower seeds include the Kiowa, Dakota, Omaha, Ponca, Pawnee, Apache, Mandan, Arikara, and Hidatsa (Kindscher 1987:125-27).

Figure 7-4. Sunflower (High-Spine Asteraceae) growing on terrace above excavation.

Spanning the several thousand years represented by samples in the study during which there is the earliest evidence of human life in the Bull Creek valley, relatively high frequencies of *Poaceae* pollen indicate that the hills surrounding the creek were rolling grasslands. Further north on the Plains at the Two Deer site in Kansas, archaeologists documented evidence of wild grass consumption dating back to between 885 and 1060 A.D. (Kindscher 1987:230). The White Mountain Apache in Arizona are known to have traditionally eaten blue grama grass that grows near water and around the Bull Creek site today, and likely grew there during the late Paleoindian occupations as well (Kindscher 1987:230). There are many other documented cases in the archaeological and historic record of the harvesting of wild grasses and sometimes cultivating them as a traditional food source by tribes across and beyond the Great Plains.

Many tribal as well as some non-tribal peoples on and around the Plains continue to highly value the aforementioned plants and more, and still practice similar traditions today, demonstrating both the timeless value of plant resources and the resilience of Indigenous Plains culture.

Determining Timing and Seasonality

An archaeological catchment model gains the dynamism that qualifies it for use in interpreting past lifeways when temporality is brought into focus. To this effort, it is necessary to examine the seasonal behaviors of procured animals (hibernation, migration, and mating) and the seasons of peak growth and dormancy of potentially harvested plants. The relative seasonal availabilities of various flora and fauna within the Bull Creek site components indicate the times during the year in which the site and surrounding landscape were occupied, thus adding to the land-use model the cyclic, temporal dimension of occupants' experiences within the landscape space of occupation.

Components II and III, the two main levels of occupation at the Bull Creek site, each contain distinct faunal assemblages: the only animal taxa recovered in Component II is bison, whereas Component III contained all 28 of the taxa represented at the site thus far. Some of these animals, such as box turtles and frogs / toads, hibernate during the winter; therefore, their presence within the occupational deposit indicates occupation occurred during warmer seasons. Seasonality is also indicated by the respective developmental stages of young bison recovered from Component II and III. Neonatal bison in Component III indicate occupation during the late spring and summer months following the animals' birth. Fetal bison remains in the 5-to-6-month stage of development within Component II indicate procurement of both the fetuses and the other bison remnant in Component II during the winter.

The four recovered plant genera originated within the Component III summertime occupational level. The seasonality of the level is further confirmed by the fact that each kind of plant would have only been alive and ripe for harvest during warmer months.

The five wintertime bison hunts evident at Ravenscroft alongside the density of bison bones among the wintertime faunal assemblage at Bull Creek together suggest that bison hunting was the primary energy-expensive communal subsistence activity during the colder months. Paleozoological evidence confirms that bison spread across the Great Plains following continental deglaciation at the end of the Pleistocene. Their large herds thrived across the Plains landscape for some 13,000 years until American hunters brought them to the edge of extinction in the late 1800s. Bison herd structure and behaviors during the Paleoindian period are predictively modelled based upon Native American observations and oral histories, the accounts of early European colonists, examination of archaeological contexts, and comparison to modern bison and other large herd mammals (Maxwell and Driver 2018). Certain behaviors are assumed to hold true among both ancient and modern herds regardless of the herd's location on the continent. Bison are highly social animals; during the rutting season, herds of cows, their calves, and immature bulls gather together with smaller herds of mature bulls seeking mates. Following the rut, the groups part ways and spend the rest of the year roaming separately.

Studies of modern bison have shown that herds of both residential (non-migrating) and migratory animals can be found in a given home range (Bruggeman et al. 2009; Epp 1988). Other studies make clear that predictions of herd locations and specific migration patterns must consider local topography and climates / microclimates as well as unpredictable natural forces such as predation and extreme weather events—no single, general model could suffice (Bamforth 1987).

Analyses of stable carbon isotopes in bison bone collagen alongside trace element analyses prove to be valuable in reconstructing bison herd ranges and migrations across the Southern Plains during Paleoindian times (Graves 2018). Carlson and Bement (2018) use the results of isotopic analysis on bone and teeth specimens from three, early Paleoindian bison hunting locales, referred to collectively as the Beaver River kill complex, to reconstruct environmental conditions and predict migratory patterns unique to the bison herds represented. The Beaver River bison hunting complex is located in northwestern Oklahoma approximately 120 km east of Bull Creek valley. Among each kill, at least 20 bison are represented, and all occurred during the late summer to early fall season. The earliest bison hunting event in both the complex and in the entire Great Plains region lay within the Jake Bluff arroyo. This event is held to represent the cultural transition among Clovis groups from hunting mammoths— which were nearly extinct by the site's ~10,821 ± 17 RCYBP date— to large-scale bison hunting, which became the largest mammal on the plains following the disappearance of mammoths. Analysis of stable carbon and nitrogen isotopes on bison bone specimens from the Jake Bluff arroyo suggest a hot, dry environment in comparison to the cooler, wetter conditions indicated by isotopic analysis of specimens from the later four kills. Results also suggest that the bison hunted in Jake Bluff were a residential herd, while the bison hunted in the three Cooper events (spanning ~60 radiocarbon years, from ~10,589 ± 16 to ~10,563 ± 19 and finally ~10,532 ± 19 RCYBP) were of a low to moderate level of mobility, and the bison hunted in the single Badger Hole event (dated to ~10,347 ± 16 RCYBP) had the highest mobility or widest ranging migration pattern. These results correspond to those of Graves (2018), who demonstrated wide variability among patterns of bison movements through the southern plains during the Folsom period.

Preliminary results of isotopic analyses on the bison represented in the hunting events at Ravenscroft and butchering features at Bull Creek suggest that the late Paleoindian Bull Creek valley groups were conducting large-scale wintertime kills of resident herds and opportunistic, small-scale hunts of migratory animals—akin to the Folsom herds— in the summer.

Interpreting Land-Use

It remains unclear how many times or for how long the Bull Creek camp site was occupied beyond the measure of at least once per apparent component. However, occupation in the Bull Creek valley of group(s) who shared- at the very least- cultural practices, is made evident by the five successive hunting events at Ravenscroft, conducted in the same manner, location and season over a span of roughly five centuries, alongside extensive bison butchering features at the contemporaneous Bull Creek site which confirm intensive wintertime bison procurement. This points towards generations of sociocultural continuity situated in the Bull Creek valley landscape.

For the people who lived in the Bull Creek valley during the late Paleoindian period, large-scale, wintertime bison hunting was the most highly productive communal activity of the year for which we have evidence. The activities leading up to and following the hunt would have required investments in time and energy from most group members, possibly even from multiple groups (Bamforth 2011), and resultingly provided food and other useful resources to support them all throughout the coming year. Large-scale bison hunting on the plains is believed to have begun towards the end of the Clovis period and developed into a heavily invested-in, annual ritual through the Folsom period (Bement 1999). Around one to two thousand years prior to the Ravenscroft hunts and late Paleoindian Bull Creek valley occupation, studies show that late

Clovis and Folsom groups in the same region practiced large-scale bison hunting during the late summer to early fall season of highly mobile, migrating herds. The recurring summer-to-fall seasonality of these hunts prevailed across the southern plains through the early to middle Paleoindian periods, but seasonally shifted to the winter during the later Paleoindian period. Further north on the plains, large-scale bison hunting predominantly occurred in the winter throughout the early, middle, and later stages of the Paleoindian period (Hill 2013).

Distinct components at the Bull Creek site that were occupied during both the summer and winter seasons demonstrate that groups adapted the means to live in the Bull Creek valley during any season of the year. The only resource not found locally was raw stone in sufficient quantity for sustained procurement and use; some cobbles could have been gathered from the Beaver River, which flowed approximately 10 km northwest of the sites, but this lithic material source would neither have been plentiful nor predictable enough to be relied upon. It is possible that these groups resided locally throughout the year and acquired the bulk of their Alibates chert and Dakota quartzite via trade with other groups who occupied those regions and perhaps came to join in on the wintertime bison hunts. However, the identification of big horn sheep protein residue on an expedient lithic flake tool from Bull Creek points towards direct travel to the mesa lands to the west, where the sheep and Dakota quartzite were found. I propose that the groups in question travelled westward during the spring season, where they were able to procure Dakota quartzite directly from any of the numerous outcroppings of the material dispersed across the area.

The predominance of Alibates chert in the wintertime occupation at Bull Creek conversely points towards procurement during the fall season, though the possibility that this material was acquired through trade is higher, as no resources beyond the chert were uncovered at the Bull Creek or Ravenscroft sites that could be directly linked to the lithic source region. However, many of the same animals identified via protein residue analysis on flakes at Bull Creek are found as well in the area around the Alibates chert quarries to the south. This could reflect travel to that area, use of the flakes and then transportation-to for repeated use at the Bull Creek site. Both propositions remain conjecture unless further evidence of trade or direct travel south to the Canadian River valley is recovered.

In summary, I propose the following hypothetical land-use model. The Bull Creek stream provided clean, flowing water throughout the year and attracted ample flora and fauna, making this area feasible for human occupation during any season. After cold temperatures and frosts rendered many plants and animals unavailable, one or multiple groups would have set out from the valley in pursuit of a female-dominated bison herd, and once targeted, strategically lured them to the landscape that would enable their entrapment and a successful hunt: lowland arroyos, like the two utilized at the Ravenscroft site. As the invention of bison corrals allowed the ancestors of the Blackfeet on the Northern Plains to no longer need to travel far in pursuit of the animals (Schultz 1966), I propose that the arroyos in the late Paleoindian-era Bull Creek valley provided permanent structures for bison hunting with much the same result in curtailing the need for long-distance pursuit of bison.

Primary processing of the hunted bison would take between two days to a week, depending on temperature and humidity. Labor would have likely been divided among all capable group members. Once primary processing concluded, portions of the carcasses and hides were brought elsewhere to a secondary processing occupation camp like the Bull Creek site. The secondary processing would be conducted there for a week or more, and included activities of hide-working, marrow extraction, potentially meat and/or hide smoking, and certainly more in which non-preservation or limited excavations have not made apparent.

At the terminus of the secondary processing activities and through the duration of winter, supplies of fresh meat and perhaps dried plant foods sustained the groups, subsistence-wise. Come spring, when conditions were more accommodating to travel, groups would have had the opportunity to venture westward towards the Black Mesa area, where abundant Dakota quartzite was found. Along the way, they could have stopped to camp at any of the numerous playas dotting the landscape, which would have provided water and drawn wildlife viable for opportunistic hunting. While in these areas, groups conducted small-scale hunts of local animals including (though certainly not limited to) bighorn sheep. Additionally, while in this area, it would have been possible to scavenge for artifacts left behind by previous groups, such as the re-worked obsidian channel flake previously described (Bement et al. 2020a). Upon returning to the Bull Creek valley in the summer, they refined the larger material cores into tools and Plainview-like projectile points like that found at Ravenscroft. During the warmer months, groups went into the High Plains areas surrounding the valley to hunt animals such as individual bison, elk, pronghorn, and rabbits. From the stream, occupants caught turtles and potentially frogs and fish, though there is no direct evidence for the latter two being consumed.

After the first frost, Chenopodium was ready for harvest. Possibly during early fall and before the peak of winter, groups could have travelled southward for direct quarrying or trade for Alibates chert, among other goods. With the onset of winter, preparations for the bison hunt would have begun again.

In sum, the result of applying catchment analysis to the late Paleoindian Bull Creek data is the delineation of a core area routinely visited by the inhabitants of the Bull Creek site over an annual or perhaps multi-year basis. Figure 7-5 provides a visualization of the spatial dimensions of land-use by late Paleoindian groups who occupied the Bull Creek valley. The areas where the lithic materials they utilized are outlined in orange (for walking times to each source, see back to Figure 7-1). In the valley, evidence shows that large-scale bison hunting was done on resident herds in the cold months, and on a small-scale of migrating animals in the warm months. The route of the migrating animals is shown in yellow, and the likely home range of the resident animals (determined by stable carbon and nitrogen isotope analysis) is outlined in black. The green circle encompassing the Bull Creek valley represents the broad catchment area for all fauna found at the Bull Creek site. As the figure demonstrates, the catchment areas for fauna (including both migratory and resident bison), Dakota Quartzite, and Alibates quartzite, overlap. I propose that this sum area was either a large part or the whole of the territory of the groups who occupied the Bull Creek valley during the late Paleoindian period.

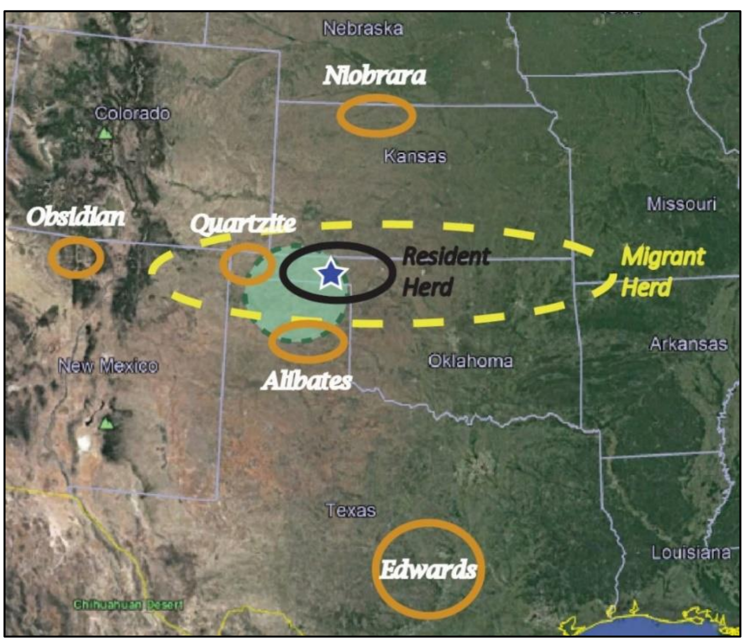

Figure 7-5. Preliminary model of late Paleoindian land-use in and around the Bull Creek valley.

CHAPTER EIGHT

DISCUSSION AND CONCLUSIONS

It has long been recognized that interpretations of Paleoindian lifeways on the Great Plains and beyond are historically focused on the hunting of mammoths and bison and the associated production of projectile points, and far less often pay heed to the needs and activities of group members who would not have partaken in large animal hunting (Dahlberg 1981). This is largely due to differential preservation of organic materials and ephemeral activity areas, though some neglect in interpretation is also to blame. One fact of critical significance to interpretations of the early Holocene archaeological record which is oft ignored or unemphasized is the necessity that groups would have experienced for predictable, secure sources of food, in order to support the nutritional needs of elders, child-bearing women, and children (Hollenbach 2010). A year-round supply of water, alongside diverse and predictable fauna and flora, made the Bull Creek valley an ideal setting for status as a central place for late Paleoindian groups to return to during any season of the year.

As described in Chapter 6, ample evidence of hide-working and marrow extraction were documented at the Bull Creek occupation site. Ethnohistorically, among Indigenous peoples in and around the Great Plains, both hide-working and marrow extraction were, and in some cases continue to be, activities primarily done by women (Scheiber 2005; Frink and Weedman 2005; Baillargeon 2010). Such tribes include the Blackfeet (Ewers 1945), the Northern Cheyenne (Grinnell 1966), the Assiniboine (Lowie 1909), the Crow (Lowie 1935), the Pawnee (Weltfish 1965), and the Chiricahua Apache (Opler 1965). In all accounts, the procurement of animal hides and other byproducts is as important, if not more, as the procurement of meat (Reilly 2015). In societies across the world and throughout time, identities associated with cultural practices often come to mean just as much as the practices themselves (Kelly 2007). On the Plains, many other traditions—including bison hunting the mechanics of hide-working—continued for millennia. Although the application of ethnohistorically known genders and gender roles to archaeological contexts entails risk of inaccuracy, I argue that recognition of persistent patterns in the social division of labor should still be made. If this analogy holds, then, marrow extraction and hide-working may be considered to represent women at Bull Creek, and the area of the site excavated thus far would appear to have been occupied primarily by women.

Kelly (1995) observed that gathering activities among present-day foraging groups were nearly universally undertaken by women, elders, and children. If the three, possibly four charred plant genera found at the Bull Creek occupation is in fact evidence of plant resource gathering, and if late Paleoindian groups are held to be comparable to contemporary foragers, then this would appear to further illuminate the presence and actions of such individuals in the Bull Creek valley. Given this line of reasoning, then, the late Paleoindian period Bull Creek valley appears to have been populated by the following individuals: able-bodied adults who conducted the wintertime, intensive bison hunting and associated flintknapping activities— men, potentially alongside women without infants and not in the later stages of pregnancy or otherwise gendered individuals— and child-bearing women, elderly, and children, who likely participated in the post-hunt butchering alongside other archaeologically-invisible activities.

Concluding Thoughts

"There is no separateness between I and here. It is who I am, and I am who it is."

Penny Rimbaud

This thesis is largely a response to the call made by Hollenbach (2010), who encouraged researchers to "find creative ways" to apply the archaeological data in our hands, however limited, for the purpose of developing a more holistic understanding of early American peoples' lifeways as situated within varying landscapes. Through conducting a catchment analysis on the various artifact types recovered in late Paleoindian cultural deposits in the Bull Creek valley—fauna, flora, and lithics—I was able to map onto the landscape where groups would have had to go to procure them. Determining the seasonality of occupations against the backdrop of a timeline provided through radiocarbon dating gave insight into the seasons of the year and regularity with which the foraging and collecting activities were undertaken. The results are the preliminary sketch of late Paleoindian land-use in the Bull Creek valley presented at the end of Chapter 7.

The first human groups to occupy the Southern Great Plains region during the early Holocene adapted to environmental conditions associated with the dramatic shift from the end of widespread cold temperatures and glaciation during the terminal Pleistocene, to atmospheric warming during the early Holocene. Melting glaciers brought increased precipitation, allowing flora and fauna to thrive in spaces previously uninhabitable. Bison herds multiplied, spreading across the plains, while the majority of megafauna around them gradually disappeared. Highly-mobile Clovis hunters developed both a strategy of large-scale bison herd hunting and the cultural ritual of multi-group hunt aggregations, which would hold pivotal importance across the southern and northern plains for thousands of years to come (Bement and Carter 2010). A shift toward decreasing territory size and increasing sociocultural differentiation is evident during the late Paleoindian period (Hurst 2010). During this time, groups would have likely become more intimately familiar with local ecologies and rooted to particular landscapes, developing ways of surviving in these areas throughout the year. Evidence of late Paleoindian occupation in the Bull Creek valley through different seasons of the year by the same or otherwise closely connected sociocultural groups attests to this broad cultural shift.

In contrast to notions of Paleoindian groups on the Plains relying solely on megafauna, archaeological research in the Bull Creek valley shows that groups during the late Paleoindian period additionally took advantage of numerous animal and possibly plant species. The evidence at Bull Creek for the gathering of chenopodium and other edible plants alongside their demonstrable nutritional value leads to the proposition that the proliferation of these plants in riverine valleys such as that surrounding Bull Creek could have been a significant factor in drawing groups to occupy that area during warmer months of the year, when both plant and animal communities were most thriving. Perhaps the late Paleoindian inhabitants of the Bull Creek valley resembled the Omaha tribe, who decided their bison hunting route based upon the location of plant foods (Kindscher 1987); perhaps they repeatedly returned to the valley throughout the year where their large-scale hunts were seasonally scheduled not in continuous pursuit of large mammals, but for the plant resources available there. The possibility that chenopodium and other plants were collected at Bull Creek is in line with Hill's (2007) suggestion that the exploitation of plants and small game intensified during the late Paleoindian period. This idea is also akin to the suggestions of Hollenbach (2010), who hypothesizes that it was factors tied to gathering activities that determined group mobility in northwest Alabama during the early Holocene.

Though preliminary, this land-use model demonstrates that the Bull Creek valley was a persistent place on the cultural landscape of Southern Plains foraging groups during the late Paleoindian period. Evidence so far shows that numerous generations of a socioculturally-cohesive group returned to the valley during different seasons of the year multiple times over a span of several centuries. This model is not just a reconstruction of an anonymous group(s)' subsistence adaptations, but an attempt at identifying real individuals on the landscape they inhabited through describing their activities and surroundings with as much justice to their lived experiences as possible. Understanding the details of these groups' relation to the land surrounding them is the closest we can archaeologically come to understanding their identities, one of the pivotal goals of archaeology and anthropology.

Future Research Directions

The consistency of the Bull Creek valley's late Paleoindian faunal assemblage with other post-megafaunal-extinction assemblages throughout the Southern Plains lends support to the comparison of these results to other contemporaneous sites in the Southern Plains and its peripheries (Johnson 1987; Carlson and Bement 2017). The potential applicability of this model to surrounding areas is further supported by findings across the Oklahoma panhandle and adjacent portions of Texas and Kansas of lanceolate-shaped projectile points acutely similar to those found at the Bull Creek and Ravenscroft sites. This demonstrates a degree of sociocultural continuity among groups that did not manifest randomly but through social relations over space and through time. Comparison of these results to other contemporaneous sites in the Southern

Plains could result in the formation of a land-use model applicable across a much broader landscape than this one, which is centered in the Bull Creek valley. Use of a geographic information system, as utilized by Hollenbach (2010), is also suggested for future research.

Research by Pitblado (2003) on late Paleoindian occupations in the southern Rocky Mountains northwest of the study area, and by Hollenbach (2010) on late Paleoindian land-use to the southeast, in Alabama, both show stark differences in adaptive strategies from contemporaneous occupations on the Plains. Together they highlight the distinctiveness of late Paleoindian lives on the Southern Plains. More comparisons of a refined late Paleoindian, Southern Plains land-use model to similar models from surrounding regions could further illuminate the details of the broader North American social landscape during the early Holocene.

BIBLIOGRAPHY

Adovasio, J. M., D. C. Hyland, and O. Soffer

1998 Perishable Technology and Early Human Populations in the New World. Paper Prepared for the 31st Annual Chacmool Conference "On Being First: Cultural Innovation and Environmental Consequences of First Peoplings", Calgary.

Albert, Lois E.

1984 Survey of Archaeological Activity in Oklahoma. In *Prehistory of Oklahoma*, edited by Robert E. Bell. Academic Press, Inc., Orlando.

Amick, Daniel S.

1999 *Folsom Lithic Technology: Explorations in Structure and Variation*. International Monographs in Prehistory: Archaeological Series 12, Ann Arbor.

Andrefsky Jr., William

1998 *Lithics: Macroscopic Approaches to Analysis*. Cambridge University Press, New York.

Andrews, B.N., J.M. Labelle, and J.D. Seebach

2008 Spatial Variability in the Folsom Archaeological Record: A Multi-Scalar Approach. American Antiquity 73:464-490.

Antevs, E.

1955 Geologic-climatic dating in the west. American Antiquity 20:317-335.

Arauza, Hanna M., Alexander R. Simms, Leland C. Bement, Brian J. Carter, Travis Conley, Ammanuel Wolderguay, William C. Johnson, and Priyank Jaiswal

2015 Geomorphic and sedimentary responses of the Bull Creek Valley (Southern High Plains, USA) to Pleistocene and Holocene environmental change. Quaternary Research 85:118-132.

Baillargeon, Morgan

2010 *North American Aboriginal Hide Tanning: The Act of Transformation and Revival*. Mercury Series No 146, Canadian Museum of Civilization Corporation. Hull, Quebec, Canada.

Baker, W.E., T.N. Campbell, and G.L. Evans

1957 The Nall Site: Evidence of Early Man in the Oklahoma Panhandle. *Bulletin of the Oklahoma Anthropological Society* 5:1-20.

Ballenger, Jesse A.M.

1999 Late Paleoindian Land Use in the Oklahoma Panhandle: Goff Creek and Nall Playa. Plains Anthropologist 44(168):189-207.

Ballenger, Jesse A.M., Vance T. Holliday, Andrew L. Kowler, William T. Reitze, Mary M. Prasciunas, D. Shane Miller, and Jason D. Windingstad

2011 Evidence for Younger Dryas global climate oscillation and human response in the American Southwest. Quaternary International 242(2):502-519. DOI:10.1016/j.quaint.2011.06.040

Bamforth, Douglas B.

1985 The Technological Organization of Paleo-Indian Small Group Bison Hunting on the Llano Estacado. *Plains Anthropologist* 30:243-258.

1986 Technological Efficiency and Tool Curation. *American Antiquity* 51:38-50.

2002 High-tech Foragers? Folsom and Later Paleoindian Technology on the Great Plains. Journal of World Prehistory 16:55-98.

2011 Origin Stories, Archaeological Evidence, and Post-Clovis Paleoindian Bison Hunting on the Great Plains. American Antiquity 76(1):24-40.

Banks, L.D.

1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest.* Oklahoma Anthropological Society Memoir 4.

Basso, Keith H.

1996 *Wisdom Sits in Places: Landscape and Language Among the Western Apache.* University of New Mexico Press, Albuquerque.

Bell, Robert E. (ed.)

1984 *Prehistory of Oklahoma*. Academic Press, Inc., Orlando.

Bement, Leland C.

1999 *Bison Hunting at Cooper Site: Where Lightning Bolts Drew Thundering Herds*. University of Oklahoma Press, Norman.

2003 Constructing the Cooper Model of Folsom Bison Kills on the Southern Plains. Great Plains Research 13:27–41.

2009 Clovis Sites, Gut Piles, and Environmental Reconstructions in Northwest Oklahoma. Plains Anthropologist 54(212):325-331.

Bement, Leland C., and Brian J. Carter

2010 Clovis Bison Hunting on the Southern Plains of North America. American Antiquity 75:907-933.

2015 From Mammoth to Bison: Changing Clovis Prey Availability at the End of the Pleistocene. In *Clovis: On the Edge of a New Understanding*, ed. A.M. Smallwood and T.A. Jennings. Texas A&M University Press, College Station.

Bement, Leland C. and Kent J. Buehler
1994 Preliminary Results from the Certain Site: A Late Archaic Bison Kill in Western Oklahoma. Plains Anthropologist 39(148):173-183.

Bement, Leland C., and Kristen Carlson
2018 On the Significance of Cutmark Distributions at the Badger Hole Folsom Bison Arroyo Trap, Southern Plains, USA. PaleoAmerica 4(1):31-42.

Bement, Leland C., and Scott D. Brosowske
1998 Pedestrian Survey of Playa Lake Environments in Beaver and Texas Counties, Oklahoma: Project 40-97-12040.021. Oklahoma Archeological Survey Archeological Resource Survey Report 39.
1999 Paleoindian Bison Hunting Along the Beaver River: Harper County, Oklahoma. Oklahoma Archeological Survey Archeological Resource Survey Report 40.
2001 Streams in No Man's Land: A Cultural Resource Survey in Beaver and Texas Counties, Oklahoma. Oklahoma Archeological Survey Archeological Resource Survey Report 43.

Bement, Leland C., Andrew S. Madden, Brian J. Carter, Alexander R. Simms, Andrew L. Swindle, Hanna M. Alexander, Scott Fine, and Mourad Benamara
2014 Quantifying the distribution of nanodiamonds in pre-Younger Dryas to recent age deposits along Bull Creek, Oklahoma Panhandle, USA. Proceedings of the National Academy of Sciences of the United States of America 111(5):1726-1731.

Bement, Leland C., Brian J. Carter, R.A. Varney, Linda Scott Cummings, and J. Byron Sudbury
2007a Paleo-environmental reconstruction and bio-stratigraphy, Oklahoma Panhandle, USA. Quaternary International 169-170:39-50.

Bement, Leland C., Dakota Larrick, Richard E. Hughes, and Kristen Carlson
2020a Evidence for Late Paleoindian Scavenging of Early Paleoindian Obsidian, Oklahoma Panhandle. PaleoAmerica. DOI: 10.1080/20555563.2019.1709323

Bement, Leland C., Kristen Carlson, and Brian J. Carter
2018 Late Paleoindian Occupation at Bull Creek: Comparing and Contrasting Seasonal Site Structure and Resource Procurement Strategies in the Oklahoma Panhandle. (DRAFT) For inclusion in *Open Air Sites of the Terminal Pleistocene and Early Holocene*, ed. K. Carlson and L. Bement (In Press). Submitted for consideration to University Press of Colorado.

Bement, Leland C., Kurt Schuster, and Brian J. Carter
2007b Archeological Survey for Paleo-Indian Sites along the Beaver River: Beaver County, Oklahoma. Oklahoma Archeological Survey Archeological Resource Survey Report 54.

Bement, Leland C., Kent J. Buehler, and Brian J. Carter
2012 Ravenscroft: A Late Paleoindian Bison Kill in the Oklahoma Panhandle. Oklahoma Anthropological Society Bulletin 60.

Bement, Leland C., Richard R. Drass, Linda Scott Cummings, and Dakota Larrick
2020b Breaking a Preservation Barrier: Recovery of Charred Seeds in a 10,270 Year-Old Hearth on the High Plains of North America. PaleoAmerica. DOI: https://doi.org/10.1080/20555563.2020.1846884

Binford, Lewis R.
1968 Post-Pleistocene Adaptation. In *New Perspectives in Archaeology*, edited by S. R. Binford and L. R. Binford, pp. 313-341. Aldine, Chicago.
2001 *Constructing frames of reference: an analytical method for archaeological theory building using hunter-gatherer and environmental data sets*. University of California Press, Berkeley.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45(1):4-20.

Boldurian, Anthony T.
1981 An analysis of a Paleoindian lithic assemblage from Blackwater Draw locality no. 1 in eastern New Mexico. Master's thesis, Eastern New Mexico University, Portales.
1991 Folsom mobility and organization of lithic technology: a view from Blackwater Draw, New Mexico. *Plains Anthropologist* 36:281-95.

Boldurian, Anthony T., and John L. Cotter
1999 *Clovis Revisited: New Perspectives on Paleoindian Adaptations from Blackwater Draw, New Mexico*. The University Museum, Philadelphia.

Borgerhoff-Mulder, Monique, Samuel Bowles, Tom Hertz, Adrian Bell, Jan Beise, Greg Clark, Ila Fazzio, Michael Gurven, Kim Hill, Paul L. Hooper, William Irons, Hillard Kaplan, Donna Leonetti, Bobbi Low, Frank Marlowe, Richard McElreath, Suresh Naidu, David Nolin, Patrizio Piraino, Rob Quinlan, Eric Schniter, Rebecca Sear, Mary Shenk, Eric Alden Smith, Christopher von Rueden, and Polly Wiessner
2009 Intergenerational Wealth Transmission and the Dynamics of Inequality in Small-Scale Societies. Science 326:682-688.

Bradley, Bruce A., Michael B. Collins, and Andrew Hemmings
2010 *Clovis Technology*. International Monographs in Prehistory, Ann Arbor.

Brink, Jack
2008 *Imagining Head-Smashed-In: Aboriginal Buffalo Hunting on the Northern Plains*. Athabasca University Press, Edmonton.

Buehler, Kent J.
2003 Human and Naturally Modified Chipped Stone Items from the Burnham Site. In *The Burnham Site in Northwestern Oklahoma: Glimpses Beyond Clovis?* edited by D. Wyckoff, J. Theler, and B. Carter. Sam Noble Oklahoma Museum of Natural History Oklahoma Anthropological Society, Memoir 9.

Byington, E.S.
1912 Arkansas and Oklahoma Notes. The Archaeological Bulletin 3(3):81-82. Council Grove, Kansas.

Calef, G.W., and J. Van Camp
1987 Seasonal Distribution, Group Size and Structure, and Movement of Bison Herds. In *Bison Ecology in Relation to Agricultural Development in the Slave River Lowlands*, NWT, edited by H.W. Reynolds and A.W.L. Hawley, pp. 15-20. Occasional Paper No. 63, Canadian Wildlife Service, Edmonton.

Cannon, M.D., and D.J. Meltzer
2004 Early Paleoindian foraging: examining the faunal evidence for large mammal specialization and regional variability in prey choice. Quaternary Science Reviews 23(18/19):1955-1987.

Carlson, Kristen, and Leland C. Bement
2017 The Bull Creek Site: Late Paleoindian Encampment in the Oklahoma Panhandle. In *Plainview: The Enigmatic Paleoindian Artifact Style of the Great Plains*, edited by Vance T. Holliday, Eileen Johnson, and Ruthann Knudson. University of Utah Press, Salt Lake City.
2018 *The Archaeology of Large-Scale Manipulation of Prey: The Economic and Social Dynamics of Mass Hunting*. University Press of Colorado, Louisville.

Carlson, Kristen, Leland C. Bement, Brian J. Carter, Brendan J. Culleton, and Douglas J. Kennett
2017 A Younger Dryas signature in bison bone stable isotopes from the Southern Plains of North America. Journal of Archaeological Science: Reports (21):1259-1265. DOI: https://doi.org/10.1016/j.jasrep.2017.03.001

Chenault, Mark L.
1999 Paleoindian Stage. In *Colorado Prehistory: A Context for the Platte River Basin*, pp. 51-90. Colorado Council of Professional Archaeologists, Denver.

Clark, John E. and Michael B. Collins
2002 *Folsom Technology and Lifeways*. Special Publication 4: Lithic Technology. Department of Anthropology, University of Tulsa.

Clark, Peter U., Jeremy D. Shakun, Paul A. Baker, Patrick J. Bartlein, Simon Brewer, Ed Brook, Anders E. Carlson, Hai Cheng, Darrell S. Kaufman, Zhengyu Liu, Thomas M. Marchitto, Alan C. Mix, Carrie Morrill, Bette L. Otto-Bliesner, Katharina Pahnke, James M. Russell, Cathy Whitlock, Jess F. Adkins, Jessica L. Blois, Jorie Clark, Steven M. Colman, William B. Curry, Ben P. Flower, Feng He, Thomas C. Johnson, Jean Lynch-Stieglitz, Vera Markgraf, Jerry McManus, Jerry X. Mitrovica, Patricio I. Moreno, and John W. Williams

2012 Global climate evolution during the last deglaciation. PNAS 109(19):E1134-E1142. DOI: https://doi.org/10.1073/pnas.1116619109

Conley, Travis O.

2010 Buried Soils of Late Pleistocene to Holocene Ages Accented in Stacked Soil Sequences from the Southern High Plains of the Oklahoma Panhandle. Master's thesis, Department of Plant and Soil Sciences, Oklahoma State University, Stillwater.

Dahlberg, Frances (ed.)

1981 *Woman the Gatherer*. Yale University Press, New Haven and London.

Dary, David

1989 *The Buffalo Book: The Full Saga Of The American Animal*. Ohio University Press/ Swallow Press, Athens.

David, Bruno and Julian Thomas

2008 Landscape Archaeology: Introduction. In *Handbook of Landscape Archaeology*, edited by B. David and J. Thomas. Left Coast Press, Inc., Walnut Creek.

Dent, Richard J.

2007 Seed Collecting and Fishing at the Shawnee Minisink Paleoindian Site: Everyday Life in the Late Pleistocene. In *Foragers of the Terminal Pleistocene in North America*, edited by R.B. Walker and B.N. Driskell, pp. 116-131. University of Nebraska Press, Lincoln, London.

Doerr, H., and Morris, J.

1960 The Oklahoma Panhandle — A Cross Section of the Southern High Plains. Economic Geography 36(1):70-88.

Drass, Richard R.

1999 Redefining Plains Village Complexes in Oklahoma: The Paoli Phase and the Redbud Plains Variant. Plains Anthropologist 44(168):123-133.

1998 The Southern Plains Villagers. In *Archaeology on the Great Plains*, edited by W. Raymond Wood, pp. 415-447. University Press of Kansas, Lawrence.

Echo-Hawk, Roger C.

2000 Ancient History in the New World: Integrating Oral Traditions and the Archaeological Record in Deep Time. American Antiquity 65(2):267-290.

Ewers, J.C.
1958 *The Blackfeet: Raiders on the Northwestern Plains*. University of Oklahoma Press, Norman.

Faith, T., and T.A. Surovell
2009 Synchronous Extinction of North America's Pleistocene Mammals. Proceedings of the National Academy of Sciences USA 106(20):641-20,645.

Ferring, C. Reid
1990 The 1989 Investigations at the Aubrey Clovis Site, Texas. Current Research in the Pleistocene 7:10-12.
2001 The Archaeology and Paleoecology of the Aubrey Clovis Site (41DN479) Denton County, Texas. Index of Texas Archaeology: Open Access Gray Literature from the Lone Star State 2001 (Article 37).

Frink, Lisa, and Kathryn Weedman (ed.)
2005 *Gender and Hide Production*. Alta Mira Press, Walnut Creek.

Frison, George C.
1991 *Prehistoric Hunters of the High Plains.* 2nd ed. Academic Press, New York.

Frison, George C., and B. Bradley
1980 *Folsom Tools and Technology at the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Frison, George C., and George M. Zeimans
1980 Bone Projectile Points: An Addition to the Folsom Cultural Complex. American Antiquity 45(2):231-237.

Garcia, John, Frank R. Ervin, and Robert A. Koelling
1966 Learning with prolonged delay of reinforcement. Psychonom. Sci. 5(3):121-122.

Gero, J.M., and M.W. Conkey (ed.)
1991 *Engendering Archaeology*. Wiley-Blackwell, Hoboken.

Gilchrist, Roberta
1999 *Gender and Archaeology: Contesting the Past*. Routledge Press, New York.

Gilmore, Kevin
2006 Ritual Landscapes, Population, and Changing Sense of Place During the Late Prehistoric Transition in Eastern Colorado. In *Landscape Perspectives on the Archaeology of the High Plains,* edited by Laura Scheiber and Bonnie Clark. University Press of Colorado, Boulder.

Gilmore, Melvin
1977 *Uses of Plants by the Indians of the Missouri River Region* (1919). University of Nebraska Press, Lincoln.

Graves, Adam C.
2008 Protohistoric Bison Hunting in the Central Plains: A Study of Faunal Remains from the Crandall Site (14RC420). Plains Anthropologist 53(208):531-550.
2010 Investigation of Resource Structure and Human Mobility: An Example from Folsom-Aged Bison Kill Sites on the U.S. Southern Great Plains. Dissertation on file at the University of Oklahoma, Norman.
2018 Microanalytical Evidence of Folsom-Aged Communal Hunting on the US Southern Great Plains. In *The Archaeology of Large-Scale Manipulation of Prey: The Economic and Social Dynamics of Mass Hunting,* ed. K. Carlson and L.C. Bement. University Press of Colorado, Boulder.

Grayson, D.K.
1991 Late Pleistocene mammalian extinctions in North America: taxonomy, chronology, and explanations. Journal of World Prehistory 5:193-232.

Grayson, D.K., and D.J. Meltzer
2002 Clovis hunting and large mammal extinction: a critical review of the evidence. Journal of World Prehistory 16: 313-359.

Grayson, D. K. and M.D. Cannon
1999 Human paleoecology and foraging theory in the Great Basin. In *Models for the Millennium: Great Basin Anthropology Today,* edited by C. Beck. University of Utah Press, Salt Lake City.

Grinnell, George Bird
1966 *When Buffalo Ran*. University of Oklahoma Press, Norman.

Harrison, B.R., and H.C. Smith
1975 Excavations at Lake Theo Site, PPHM-A917, Briscoe County, Texas. *Panhandle-Plains Historical Reviews* 48:70-106.

Harrison, B.R., and K.L. Killen
1978 *Lake Theo: A Stratified, Early Man Bison Butchering and Camp Site, Briscoe County, Texas*. Panhandle-Plains Historical Museum, Special Archeological Report 1.

Haynes, Gary
2002 *The Early Settlement of North America: The Clovis Era*. Cambridge University Press, New York.
2013 Extinctions in North America's Late Glacial Landscapes. Quaternary International 285:89-98.

Hesse, Brian and Paula Wapinish
1985 *Animal Bone Archeology: From Objectives to Analysis.* Taraxacum Inc., Washington D.C.

Hester, James J., Ernest L. Lundelius Jr., and Roald Fryxell
1972 Blackwater Draw Locality No. 1: A Stratified, Early Man Site in Eastern New Mexico. Fort Burgwin Research Center, Ranchos de Taos, New Mexico.

Hill, Jr., Matthew E.
2005 Long-term and Regional Changes in Use of Bison. Poster presented at 70th Annual Society for American Archaeology Conference, Salt Lake City.
2008 New Investigations of the Cody-Age Finley and Scottsbluff Bison Bone Beds. Current Research in the Pleistocene 25:90-93.
2007 Causes of Regional and Temporal Variation in Paleoindian Diet in Western North America. Unpublished PhD Dissertation, University of Arizona, Tucson.
2010 Regional Differences in Great Plains Paleoindian Occupational Intensity and Duration. In *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways*, edited by Stance Hurst and Jack L. Hofman, pp. 73-95. University of Kansas Publications in Anthropology 25, Lawrence.
2013 Sticking it to the Bison: Exploring Variation in Cody Bison Bonebeds. In *Paleoindian Lifeways of the Cody Complex*, edited by Edward J. Knell and Mark P. Muniz, pp. 93-117. University of Utah Press, Salt Lake City.

Hill, M.E., M.G. Hill, and C. Widga
2008 Late Quaternary Bison Diminution on the Great Plains of North America: Evaluating the Role of Human Hunting Versus Climate Change. Quaternary Science Reviews 27: 1752-1771.

Hill, Matthew G., David J. Rapson, Thomas J. Loebel, and David W. May
2011 Site Structure and Activity Organization at a Late Paleoindian Base Camp in Western Nebraska. American Antiquity 76(4):752-772.

Hofman, Jack L.
1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S.R. Holen, pp. 335-355. University of Kansas, Lawrence.
1993 An Initial Survey of the Folsom Complex in Oklahoma. Oklahoma Anthropological Society Bulletin 41:71-105.
1989 Hunters and Gatherers. In *From Clovis to Comanchero: An Overview of the Southern Great Plains*, by J.L. Hofman, R.L. Brooks, J.S. Hays, D.W. Owsley, R.L. Jantz, M.K. Marks, and M.H. Manheim, pp. 71-90. Arkansas Archeological Survey Research Series 35, Fayetteville.
1994 Paleoindian Aggregations on the Great Plains. Journal of Anthropological Archaeology 13(4): 341-370.
2010 Allen Complex Behavior and Chronology in the Central Plains. In *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways*, edited by S. Hurst and J. Hofman. University of Kansas Publications in Anthropology 25.

Hofman, Jack L., and Russell W. Graham
1998 The Paleo-Indian Cultures of the Great Plains. In *Archaeology of the Great Plains*, edited by W. Raymond Wood. University Press of Kansas, Lawrence.

Hofman, Jack L., Brian J. Carter, and M. Hill
1992 Folsom occupation at the Waugh Site in northwestern Oklahoma. Current Research in the Pleistocene 9:22-25.

Hofman, Jack L., Robert L. Brooks, Joe S. Hays, Douglas W. Owsley, Richard L. Jantz, Murray K. Marks, and Mary H. Manhein
1989 From Clovis to Comanchero: Archaeological Overview of the Southern Great Plains. Arkansas Archaeological Society Research Series No. 35.

Hollenbach, Kandace D.
2007 Gathering in the Late Paleoindian: Archaeobotanical Remains from Dust Cave, Alabama. In *Foragers of the Terminal Pleistocene*, ed. by Renee B. Walker and Boyce N. Driskell, pp. 132-147. University of Alabama Press, Tuscaloosa.
2009 *Foraging in the Tennessee Valley, 12,500 to 8,000 Years Ago*. University of Alabama Press, Tuscaloosa.
2010 Modeling Resource Procurement of Late Paleoindian Hunter-Gatherers: A View from Northwest Alabama. In *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways*, edited by Stance Hurst and Jack Hofman, pg. 13-26. University of Kansas Press, Lawrence.

Hollenbach, Kandace D., and Asa R. Randall
2007 Ethnography, Analogy, and the Reconstruction of Paleoindian Lifeways. In *Foragers of the Terminal Pleistocene in North America*, edited by Renee B. Walker and Boyce N. Driskell. University of Nebraska Press, Lincoln & London.

Holliday, Vance T.
1997 *Paleoindian Geoarchaeology of the Southern High Plains*. University of Texas Press, Austin.
2001 Stratigraphy and geochronology of upper Quaternary eolian sand on the Southern High Plains of Texas and New Mexico, United States. Geological Society of American Bulletin January 2001.

Holliday, V.T., D. Meltzer, and R. Mandel
2011 Stratigraphy of the Younger Dryas Chronozone and Paleoenvironmental Implications: Central and Southern Great Plains. Quaternary International 242:520-533.

Holliday, Vance T., Eileen Johnson, and Ruthann Knudson (ed.)
2017 *Plainview: The Enigmatic Paleoindian Artifact Style of the Great Plains*. University of Utah Press, Salt Lake City.

Hurst, Stance
2010 Discovering Identity-Based Foraging Territories on the Southern Plains 10,200-8,000 RCYBP. In *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways*, ed. S. Hurst and J. Hofman. University of Kansas Press, Lawrence.

Hurst, Stance and Eileen Johnson
2016 Gearing Up at the Adair-Steadman (41FS2) Folsom Site. PaleoAmerica 2(3):252-260.

Hurst, Stance and Jack L. Hofman (ed.)
2010 *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways*. University of Kansas Press, Lawrence.

Janetski, Joel C.
2002 Modeling Folsom Mobility. In *Folsom Technology and Lifeways*, edited by J.E. Clark and M.B. Collins. Routledge, Abingdon-on-Thames.

Jennings, Thomas A.
2015 Clovis Adaptations in the Great Plains. In *Clovis: On the Edge of a New Understanding*, edited by A.M. Smallwood and T.A. Jennings. Texas A&M University Press, College Station.
2012 Clovis, Folsom, and Midland components at the Debra L. Friedkin site, Texas: context, chronology, and assemblages. Journal of Archaeological Science 39(10):3239-3247.

Jodry, Margaret Ann Brierty
1999a Folsom Technological and Socioeconomic Strategies: Views from Stewart's Cattle Guard and the Upper Rio Grande Basin, Colorado. Dissertation at American University, D.C.
1999b Paleoindian Stage. In *Colorado Prehistory: A Context for the Rio Grande Basin*, edited by M.A. Martorano, T. Hoefer III, M.A. Jodry, V. Spero, and M.L. Taylor, pp. 45-114. Colorado Council of Professional Archaeologists, Denver.

Johnson, Eileen (ed.)
1987 *Lubbock Lake: Late Quaternary Studies on the Southern High Plains*. Texas A&M University Press, College Station.

Johnson, Eileen
1997 Late Quaternary bison utilization at Lubbock Lake on the southern High Plains. In *Southern Plains Bison Procurement and Utilization from Paleoindian to Historic,* edited by L.C. Bement and K.J. Buehler. Plains Anthropologist Memoir 29:45-61.

Johnson, Eileen and Leland C. Bement
2006 Bison Butchery at Cooper, a Folsom Site on the Southern Plains. Journal of Archaeological Science 36:1430-1446.

Johnson, Eileen, Vance T. Holliday, Frank Asaro, Fred Stross, and Helen Michel
1985 Trace Element Analysis of Paleoindian Obsidian Artifacts from the Southern High Plains. Current Research in the Pleistocene 2:50-53.

Johnson, Matthew
2010 *Archaeological Theory: An Introduction.* 2nd ed. Wiley-Blackwell, Hoboken.

Johnson, Kenneth S.
2008a Geologic Map of Oklahoma. Educational Publication 9. Oklahoma Geological Survey, Norman.
2008b Geologic History of Oklahoma. Educational Publication 9. Oklahoma Geological Survey, Norman.

Keeley, L.H.
1999 Use of plant foods among hunter gatherers: A cross-cultural survey. In *Prehistory of Agriculture*, edited by P.C. Anderson, pp. 6-14. The Institute of Archaeology, Los Angeles.

Kelly, Robert L.
1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institution Press Washington, DC.
2007 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Percheron Press, New York.

2013 *The Lifeways of Hunter-Gatherers*. Cambridge University Press, Cambridge.

Kennett, D.J., J.P. Kennett, A. West, C. Mercer, S.S. Que Hee, L. Bement, T.E. Bunch, M. Sellers, W.S. Wolbach
2009 Nanodiamonds in the Younger Dryas Boundary Sediment Layer. Science 323:94.

Kindscher, Kelly
1987 *Edible Wild Plants of the Prairie: An Ethnobotanical Guide*. University Press of Kansas, Lawrence.
1992 *Medicinal Wild Plants of the Prairie: An Ethnobotanical Guide*. University Press of Kansas, Lawrence.

Kohler, T. A., Smith, M. E., Bogaard, A., Peterson, C. E., Betzenhauser, A., Feinman, G. M., Oka, R. C., Pailes, M., Prentiss, A. M., Stone, E. C., Dennehy, T. J., & Ellyson, L. J.
2018 Deep inequality: Summary and conclusions. In *Ten Thousand Years of Inequality: The Archaeology of Wealth Differences,* pp. 289. University of Arizona Press.

Kornfeld, Marcel, George C. Frison and Mary Lou Larson
2010 *Prehistoric Hunter-Gatherers of the High Plains and Rockies*. Left Coast Press, Walnut Creek, California.

LaBelle, Jason M.
1997 "Uncle Bill" and Panhandle Paleoindians. Paper presented at the 55th Plains Anthropological Conference, Boulder.
1998 Rediscovering the Nall Site (34CI143): Late Paleoindian Archaeology on the Central/Southern Plains. Paper presented at the 56th Plains Anthropological Conference, Bismarck.
1999a Preliminary report on fieldwork at the Nall site. In *Summary of the scope of field and laboratory work, and preliminary results, 1998– 1999,* edited by D.J. Meltzer, pp. 1– 42. Quest Archaeological Research Fund Annual Report. Southern Methodist University, Dallas.
1999b Recent fieldwork at the Nall site (34CI134): A large late-Paleoindian campsite in the Oklahoma Panhandle. Current Research in the Pleistocene 16:48-50.
2000 Summer 1999 fieldwork at the Nall site. In *Summary of the scope of field and laboratory work, and preliminary results, 1999– 2000,* edited by D.J. Meltzer, pp. 1– 38. Quest Archaeological Research Fund Annual Report. Southern Methodist University, Dallas.
2010 ReOccupation of Place: Late Paleoindian Land Use Strategies in the Central Plains. In *Exploring Variability in Early Holocene Hunter-Gatherer Lifeways,* edited by S. Hurst and J.L. Hofman, pp. 37-72. University of Kansas Publications in Anthropology 25. Lawrence, Kansas.

LaBelle, Jason M., and S.R. Holen
2009 Evidence for Multiple Paleoindian Components at the Lindenmeier Site, Larimer County, Colorado. Current Research in the Pleistocene 25:67-69.

LaBelle, Jason M., Vance T. Holliday, and David J. Meltzer
2003 Early Holocene Paleoindian Deposits at Nall Playa, Oklahoma Panhandle, U.S.A. Geoarchaeology: An International Journal 18(1):5-34.

Larrick, Dakota, Kristen Carlson, and Leland C. Bement
2019 Discard, Stockpile, or Commemorative Cairn? Interpreting the Bison Skull Pile at the Ravenscroft Late Paleoindian Bison Kill, Oklahoma Panhandle. Poster presented at the 84th SAA Annual Meeting, Albuquerque.

Lee, R. B., and R. Daly
1999 Introduction: Foragers and Others. In *The Cambridge Encyclopedia of Hunters and Gatherers*, edited by R. Lee and R. Daly, 1–19. Cambridge University Press, Cambridge.

Lee, Richard B. and Irven DeVore (ed.)
1973 *Man the Hunter*. Aldine Publishing Company, Chicago.

Lenski, Gerhard E.
1966 *Power and Privilege: A Theory of Social Stratification*. McGraw-Hill, New York.

Leonhardy, F.
1966 *Domebo: A Paleo-Indian mammoth kill in the prairie-plains*. No. 1 Great Plains Historical Association, 1966.

Levy, Jerrold
2001 Kiowa. In *Handbook of North American Indians (Vol. 13, Part 2 of 2: Plains),* ed. W.C. Sturtevant and R.J. DeMallie. Smithsonian Institution, Washington.

Lewis, Patrick J., Eileen Johnson, Briggs Buchanan, and Steven E. Churchill
2009 The impact of changing grasslands on Late Quaternary bison of the Southern Plains. Quaternary International 217:117-130.

Libby, W.F.
1961 Radiocarbon Dating. Science 133(3453):621-629. Retrieved April 20, 2021, from http://www.jstor.org/stable/1706593

Lowie, Robert H.
1909 *The Assiniboine*. Anthropological Papers of the American Museum of Natural History Vol. IV, Part I. Order of the Trustees, New York.
1935 *The Crow Indians*. Farrar & Rinehart, New York.

Lyman, R.L., and M.J. O'Brien
2001 The Direct Historical Approach, Analogical Reasoning, and Theory in Americanist Archaeology. Journal of Archaeological Method and Theory 8(4):303-342.

MacDonald, Douglas H., and Matthew R. Nelson
2019 Paleoindians of Yellowstone Lake: Interpreting Late Pleistocene- Early Holocene hunter-gatherer land-use in the greater Yellowstone ecosystem. Plains Anthropologist 64(249): 23-50.

Malainey, Mary E., and Barbara L. Sheriff
1996 Adjusting Our Perceptions: Historical and Archaeological Evidence of Winter on the Plains of Western Canada. Plains Anthropologist 44(158):333-357.

Mallouf, R.J. and R.D. Mandel
1997 Horace Rivers: A Late-Plainview Component in the Northeastern Texas Panhandle. *Current Research in the Pleistocene* 14:50-52.

Mandel, R.D. (ed.)
2000 *Geoarchaeology of the Great Plains: A Historical Perspective*. University of Oklahoma Press, Norman.

Mangerud, J., S.T. Andersen, B.J. Berglund, and J.J. Donner
1974 Quaternary stratigraphy of Norden, a proposal for terminology and classification. Boreas 3(3):109-126. DOI: https://doi.org/10.1111/j.1502-3885.1974.tb00669.x

Marcher, Melvin B.
1979 Major Sources of Water in Oklahoma. Compiled map, U.S. Geological Survey, Educational Publication 1.

Marlowe, F.
2005 Hunter-Gatherers and Human Evolution. Evolutionary Anthropology 14:54-67.

Martin, P.S.
2005 *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America.* University of California Press, Berkeley.

Maxwell, David, and Jonathan Driver
2018 Are Models of Ancient Bison Population Structure Valid? In *The Archaeology of Large-Scale Manipulation of Prey: The Economic and Social Dynamics of Mass Hunting,* ed. K. Carlson and L. Bement, pp. 96-120. University Press of Colorado, Louisville.

McConnell, Ruth
2010 The Chemistry of Hide Tanning. In, *North American Aboriginal Hide Tanning: The Act of Transformation and Revival*, edited by Morgan Baillargeon, pp. 133-139. Mercury Series No 146, Canadian Museum of Civilization Corporation. Hull, Quebec, Canada.

McKay, Michael W. and Leland C. Bement
2005 Exploring Southwestern Oklahoma: Pedestrian Survey of the Quartz Mountain District in Greer, Jackson, and Kiowa Counties. The University of Oklahoma, Oklahoma Archeological Survey, Archaeological Resource Survey Report 50.

Meltzer, D.J.
2015 *The Great Paleolithic War: How Science Forged an Understanding of America's Ice Age Past*. University of Chicago Press, Chicago.
2009 *First People in a New World: Colonizing Ice Age America*. University of California Press, Berkeley.
2004 Modeling the Initial Colonization of the Americas: Issues of Scale, Demography, and Landscape Learning. In *Settlement of the American Continents: A Multi-disciplinary Approach to Human Biogeography*, edited by C.M. Barton, G.A. Clark, D.R. Yesner, and G.A. Pearson, pp. 123-137. The University of Arizona Press, Tucson.
2006 *Folsom: New Archaeological Investigations of a Classic Paleoindian Bison Kill*. University of California Press, Berkeley and Los Angeles.

Meltzer, D.J., and V.T. Holliday
2010 Would North American Paleoindians have Noticed Younger Dryas Climate Changes? Journal of World Prehistory 23:1-41.

Metcalf, Jessica L., Chris Turney, Ross Barnett, Fabiana Martin, Sarah C. Bray, Julia T. Vilstrup, Ludovic Orlando, Rodolfo Salas-Gismondi, Daniel Loponte, Matías Medina, Mariana De Nigris, Teresa Civalero, Pablo Marcelo Fernández, Alejandra Gasco, Victor Duran, Kevin L. Seymour, Clara Otaola, Adolfo Gil, Rafael Paunero, Francisco J. Prevosti, Corey J. A. Bradshaw, Jane C. Wheeler, Luis Borrero, Jeremy J. Austin, and Alan Cooper
2016 Synergistic roles of climate warming and human occupation in Patagonian megafaunal extinctions during the Last Deglaciation. Sci. Adv. 2(6). DOI: 10.1126/sciadv.1501682

Morphy, H.
1993 Colonialism, History and the Construction of Place: The Politics of Landscape in Northern Australia. In *Landscape: Politics and Perspectives*, edited by Barbara Bender, pp. 205–243. Berg, Providence.
1995 Landscape and the Reproduction of the Ancestral Past. In *The Anthropology of Landscape: Perspectives on Place and Space*, edited by E. Hirsch and M. O'Hanlon, 184–209. Clarendon Press, Oxford.

Muhammad, Faisal S.
2017 The Ravenscroft II Site: A Late Paleoindian Winter Bison Kill Event in the Oklahoma Panhandle. Master's thesis, Department of Anthropology, University of Oklahoma, Norman.

Newlander, Khori
2018 Imagining the cultural landscapes of Paleoindians. Journal of Archaeological Science Reports 19:836-845.

Nowak, Michael and Heather J. Gerhart
2002 Archaeological Investigations in Southeastern Colorado. Department of Anthropology at Colorado College. Colorado College Publications in Archaeology No. 22.

Opler, Morris E.
1965 *An Apache Life-Way*. Cooper Square Publishers, New York.

Orians, G.H., and N.E. Pearson
1979 On the Theory of Central Place Foraging. In *Analysis of Ecological Systems*, edited by D. J. Horn, G. R. Stairs, and R. D. Mitchell, 155–177. Ohio State University Press, Columbus.

Perreault, Charles, and P. Jeffrey Brantingham
2011 Mobility-driven cultural transmission along the forager–collector continuum. Journal of Anthropological Archaeology 30(1):62-68.

Peteet, D.
1995 Global Younger Dryas? Quaternary International 28:93-104.

Pitblado, Bonnie L.
2003 *Late Paleoindian Occupation of the Southern Rocky Mountains*. University Press of Colorado, Boulder.

Quigg, Michael J.
1986 Ross Glen: A Besant Stone Circle Site in Southeastern Alberta. Archaeological Survey of Alberta Manuscript Series No. 10. Edmonton.
1978 Winter Bison Procurement in Southwestern Alberta. Plains Anthropologist Memoir 14, Part 2, 23(82):53-57.

Reilly, Aileen
2015 Women's Work, Tools, and Expertise: Hide Tanning and the Archaeological Record. Unpublished Master's Thesis, Department of Anthropology, University of Alberta.

Rose, Steven P.R.
1991 How chicks make memories: the molecular cascade from c-fos to dendritic remodeling. Trends in Neurosciences 14(9):390-397.
1992 *The Making of Memory*. Bantam Books, Uxbridge.

Saltré, Frédérik, Joël Chadoeuf, Katharina J. Peters, Matthew C. McDowell, Tobias Friedrich, Axel Timmermann, Sean Ulm, and Corey J. A. Bradshaw
2019 Climate-human interaction associated with southeast Australian megafauna extinction patterns. Nat Commun 10, no. 5311. DOI: https://doi.org/10.1038/s41467-019-13277-0

Santos-Granero, F.
1998 Writing History into the Landscape: Space, Myth, and Ritual in Contemporary Amazonia. American Ethnologist 25(2):128-148.

Sassaman, K.E.
2004 Complex hunter–gatherers in evolution and history: a North American perspective. Journal of Archaeological Research 12(3):227-280.

Schaedel, R.P.
1995 The temporal variants of proto-state societies. In *Alternative Pathways to Early States*, edited by N. N. Kradin and V. A. Lynsha, pp. 47-53. Dal'nauka, Vladivostok.

Scheiber, Laura L.
2005 Late Prehistoric Bison Hide Production and Hunter-Gatherer Identities on the North American Plains. In *Gender and Hide Production*, edited by Lisa Frink and Kathryn Weedman, pp. 57-75. Alta Mira Press, Walnut Creek.

Schultz, James Willard
1966 *Blackfeet and Buffalo: Memories of Life Among the Indians*. University of Oklahoma Press, Norman.

Scott, E.
2010 Extinctions, Scenarios, and Assumptions: Changes in Latest Pleistocene Large Herbivore Abundance and Distribution in Western North America. Quaternary International 217:225-239.

Sellards, E.H.
1952 *Early Man in America: A Study in Prehistory*. University of Texas Press, Austin.

Simpson, Caryl Wood
1976 Trinchera Cave: A rockshelter in Southeastern Colorado. Unpublished M.A. Thesis, Department of Anthropology, University of Wyoming, Laramie.

Smith, Eric Alden, Robert L. Bettinger, Charles A. Bishop, Valda Blundell, Elizabeth Cashdan, Michael J. Casimir, Andrew L. Christenson, Bruce Cox, Rada Dyson-Hudson, and Brian Hayden
1983 Anthropological Applications of Optimal Foraging Theory: A Critical Review [and Comments and Reply]. Current Anthropology 24(5):625-651.

Smith, Eric Alden, Monique Borgerhoff Mulder, Samuel Bowles, Michael Gurven, Tom Hertz, and Mary K. Shenk
2010 Production Systems, Inheritance, and Inequality in Premodern Societies: Conclusions. Current Anthropology 51:85-94.

Stanford, Dennis J.
2013 *Across Atlantic Ice: The Origin of America's Clovis Culture*. University of California Press, Berkeley.

Stiger, Mark
2006 A Folsom Structure in the Colorado Mountains. American Antiquity 71(2):321-51.

Stucky, R.
1974 Personal communication to Roger Saunders. Manuscripts on file at the Oklahoma Museum of Natural History, Norman.

Sudbury, J.B.
2010 Quantitative phytolith analysis: the key to understanding buried soils and to reconstructing paleoenvironments. Unpublished Ph.D. Dept. of Plant and Soil Sciences, Oklahoma State University, Stillwater.

Surovell, Todd A.
2009 *Toward a behavioral ecology of lithic technology: cases from Paleoindian archaeology*. University of Arizona Press, Tucson.

Surovell, Todd A., Joshua R. Boyd, C. Vance Haynes Jr, and Gregory W. L. Hodgins
2016 On the Dating of the Folsom Complex and its Correlation with the Younger Dryas, the End of Clovis, and Megafaunal Extinction. PaleoAmerica 2(2):81-89. DOI:10.1080/20555563.2016.1174559

Taçon, P. S.
1999 Identifying Ancient Sacred Landscapes in Australia: From Physical to Social. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by W. Ashmore and A. B. Knapp, 33–57. Blackwell, Malden.

Teteak, Steven M.
2018 Protein Residue Analysis of Eleven Lithic Tools and Two Sediment Samples from the Bull Creek Site (34BV176), Oklahoma Panhandle. Laboratory of Archaeological Sciences, California State University, Bakersfield.

Thurmond, Peter J.
1989 Late Paleoindian Utilization of the Dempsey Divide on the Southern Plains. Plains Anthropologist, Memoir 25, pp. 35-131.

Thurmond, J. Peter, and Don G. Wyckoff
1998 Late-Pleistocene Dunes along the Dempsey Divide, Roger Mills County, Oklahoma. Current Research in the Pleistocene 15:139-143.

Todd, L., D. Rapson, and J. Hofman
1996 Dentition studies of the Iron Mill and Other Early Paleo-Indian Bison Bone Beds. In *The Mill Iron Site*, edited by George Frison. University of New Mexico Press.

Turner, Ellen S., Thomas R. Hester, and Richard L. McReynolds
2011 *Stone Artifacts of Texas Indians*. Taylor Trade Publishing, Plymouth.

Turpin, Solveig A.
2004 Cyclical Nucleation and Sacred Space: Rock Art at the Center. In *New Perspectives on Prehistoric Art*, edited by G. Berghaus. Praeger, Westport, Connecticut.

Vehik, Susan C.
2001 Hunting and Gathering Tradition: Southern Plains. In *Handbook of North American Indians (Vol. 13, Part 1 of 2: Plains)*, ed. W.C. Sturtevant and R.J. DeMallie. Smithsonian Institution, Washington.
2002 Trade and Political Development on the Southern Plains. American Antiquity 67(1):37-41.

Verbicky-Todd, Eleanor
1984a Communal Buffalo Hunting Among Plains Indians. Archaeological Survey of Alberta 24. Alberta Culture Historical Resource Division Alberta.
1984b Communal buffalo hunting among the Plains Indians: an ethnographic and historic review. Alberta Culture, Historical Resources Division.

Wantanabe, Hitoshi
1968 Subsistence and Ecology of Northern Food Gatherers with Special Reference to the Ainu. In *Man the Hunter*, edited by R. Lee and I. DeVore, pp. 69-77. Aldine, Chicago.

Waters, Michael R., and Thomas W. Stafford Jr.
2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. Science, New Series 315(5815):1122-1126.

Waters, Michael R., Thomas W. Stafford Jr., and David L. Carlson
2020 The age of Clovis—13,050 to 12,750 cal yr B.P. Science Advances 6(43). DOI: 10.1126/sciadv.aaz0455

Waters, M.R., C.D. Pevny, D.L. Carlson, W.A. Dickens, A.M. Smallwood, S.A. Minchak, E. Bartelink, J.M. Wiersema, J.E. Wiederhold, H.M. Luchsinger, D.A. Alexander, and T.A. Jennings
2011 *Clovis Workshop in Central Texas: Archaeological Investigations of Excavation 8 Area at the Gault Site*. Texas A&M University Press, College Station.

Weltfish, Gene
1965 *The Lost Universe*. Basic Books, New York and London.

Wendland, W.
1978 Holocene Man in North America: The Ecological Setting and Climatic Background. Plains Anthropologist 23:273-287.

Wetherell, M.M., B.K. McHorse, and E.B. Davis
2017 Spatially explicit analysis sheds new light on the Pleistocene megafaunal extinction in North America. Paleobiology 43(4): 642-655. DOI:10.1017/pab.2017.15

Wheat, J.
1972 The Olsen-Chubbock Site: A Paleo-Indian Bison Kill. American Antiquity Memoir 26, 37(1):180.

White, R.W.
1987 The Muncy Site in the Oklahoma Panhandle: Indian Cultural Evidence Over a Long Time Span. *Bulletin of the Oklahoma Anthropological Society* 36:39-103.

Wilmsen, Edwin N.
1970 *Lithic Analysis and Cultural Inference: A Paleoindian-Case*. University of Arizona Press, Tucson.
1974 *Lindenmeier: A Pleistocene Hunting Society*. Harper & Row Publishers, New York, Evanston, San Francisco, London.

Wilmsen, Edwin N., and Frank H.H. Roberts, Jr
1978 Lindenmeier, 1934-1974: Concluding Report on Investigations. Smithsonian Contributions to Anthropology No. 24. Smithsonian Institution Press, Washington D.C.

Winterhalder, Bruce
1981 Optimal foraging strategies and hunter-gatherer research in anthropology: theory and models. In *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*, edited by Bruce Winterhalder and Eric Alden Smith, pp. 13-35. University of Chicago, Illinois.
2001 The Behavioural Ecology of Hunter Gatherers. In *Hunter-Gatherers: An Interdisciplinary Perspective*, edited by C. Panter-Brick, R. H. Layton and P. Rowley-Conwy. Cambridge University Press, Cambridge.

Winterhalder, Bruce and Eric Alden Smith
1981 Hunter-gatherer foraging strategies. In *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*. University of Chicago, Illinois.

1992 Evolutionary Ecology and the Social Sciences. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder, pp. 3–24. Aldine de Gruyter, Hawthorne.

Wood, Raymond W.
1998 *Archaeology on the Great Plains*. University Press of Kansas, Lawrence.

Wyckoff, Don G.
1984 The Foragers: Eastern Oklahoma. In *Prehistory of Oklahoma*, edited by Robert E. Bell, pp. 119-160. Academic Press, Inc., Orlando.

Wyckoff, Don G., J. Theler, and B.J. Carter
2003 The Burnham Site in Northwestern Oklahoma: Glimpses Beyond Clovis? Oklahoma Anthropological Society Memoir 9, Sam Noble Museum of Natural History, Norman.

Wylie, Alison
1985 The Reaction Against Analogy. Advances in Archaeological Methods and Theory 8:63-1 11.

Zedeño, Maria Nieves
2008 The Archaeology of Territory and Territoriality. In *Handbook of Landscape Archaeology*, edited by B. David and J. Thomas. Left Coast Press, Inc., Walnut Creek.

Zedeño, Maria Nieves, Jesse A.M. Ballenger, and John R. Murray
2014 Landscape Engineering and Organizational Complexity among Late Prehistoric Bison Hunters of the Northwestern Plains. Current Anthropology 55(1):23-58.