THESIS

COMMUNAL HUNTING IN THE COLORADO HIGH COUNTRY: ARCHAEOLOGICAL INVESTIGATIONS OF THREE GAME DRIVE SITES NEAR ROLLINS PASS, GRAND COUNTY, COLORADO

Submitted by

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ABSTRACT

COMMUNAL HUNTING IN THE COLORADO HIGH COUNTRY:

ARCHAEOLOGICAL INVESTIGATIONS OF THREE GAME DRIVE SITES NEAR

ROLLINS PASS, GRAND COUNTY, COLORADO

The pioneering efforts of James Benedict and Byron Olson demonstrated the importance of alpine communal game drives in the lives of prehistoric Native American populations living in northern Colorado. Their research resulted in numerous books and journal publications on alpine and sub-alpine sites from Rocky Mountain National Park southward to the Indian Peaks Wilderness. Unfortunately, their meticulous work on the spectacular sites at Rollins Pass remained unpublished. This thesis presents their data and additional data collected by the author, Jason LaBelle, and the Center for Mountain and Plains Archaeology at Colorado State University.

This thesis is an archaeological investigation of three alpine game drive sites (5GA35, 5GA36, and 5GA37) and a nearby lithic scatter (5GA4268). As of September 2015, 80 hunting blinds, 1,935 meters of walls, and 15 cairns and two additional cairn lines have been recorded between the three game drives. Diagnostic projectile points demonstrate Late Archaic through Late Prehistoric use. The chipped stone debitage assemblage is representative of late-stage production or maintenance of stone tools and only a limited amount of initial reduction occurred on-site. Raw material types for the artifact assemblage are dominated by Middle Park sources, namely Troublesome Formation chert, indicating groups moved into the alpine zone from the intermountain basins from the west. Spatial analysis of blind morphology and density show that groups were constructing game drives in such a way as to maximize the number of hunters near areas of wall convergence in the kill zone, the most critical location of the game drive. The relationship between features and artifacts suggests that artifacts found within 20 meters of blinds are directly related to the hunt itself while artifacts found outside this range may relate to pre-hunt or post-hunt activities. Protein residue analysis suggests that elk and/or deer may have been a target species at these sites. Spatial analyses of the relationship of artifacts to features indicate a limited amount of post-hunt processing occurred in the kill zone, while blinds served critical roles throughout all phases of the hunt. 5GA4268 is interpreted as a specialized processing site associated with 5GA35. Use wear analysis indicates that scraping hide was the dominant activity at 5GA4268. This thesis illustrates the merit of applying spatial analyses to feature and artifact attributes to gain a more holistic interpretation of human behaviors associated with alpine communal hunting sites.

ACKNOWLEDGMENTS

This thesis is the culmination of several years worth of work that would not have been possible without the support and inspiration of a number of individuals. First and foremost, I owe a great amount of gratitude and thanks to my advisor, Dr. Jason LaBelle, for introducing me to the fantastic archaeology of the Rollins Pass Project and for allowing me to become part of that research. Throughout my time at Colorado State University, he was a positive influence on my life, helping me grow both personally and professionally. His guidance, patience, and true love of archaeology inspired me to become the better archaeologist. His years of dedication to the Rollins Pass Project helped make this thesis possible. I would also like to thank my other committee members, Dr. Mary Van Buren and Dr. Randall Boone. Your comments were most helpful in finalizing this thesis.

Special thanks must be extended to the late Jim Benedict and Byron Olson for their tireless pursuit of archaeology in the Colorado high country. Their research laid the groundwork for future archaeological inquiry along the Front Range and their importance to this project cannot be understated. It has been an honor and a privilege to work on a legacy project started by Jim and Byron over 40 years ago and I can only hope that this research holds up to the lofty standards they set.

Thank you to the numerous field crews over the years who worked through oftentimes trying weather conditions to meticulously record the data presented in this thesis; your work is greatly appreciated.

Funding for this research came from several sources, to all of which I am grateful. The Karen S. Greiner endowment from the Department of Anthropology at Colorado State University funded use wear analysis which proved very enlightening to the project. The Ward F. Weakly Memorial Fund from the Colorado Council of Professional Archaeologists and the Alice Hamilton Scholarship Fund by the Colorado Archaeological Association funded protein residue analysis which offered great insight to the project and professional illustrations of selected artifacts. Thank you to Tyson Arnold for beautifully illustrating these artifacts. The graduate teaching assistantship offered by the Department of Anthropology at Colorado State University provided valuable financial support and experience during my first year. And last but not least, the Jim and Audrey Benedict Fund for Mountain Archaeology provided further financial assistance for this project. I would like to thank Jason LaBelle for affording me many opportunities to enhance my archaeological skills both in the lab and in the field which greatly enhanced my graduate school experience. I am greatly indebted to all the above for their support. Thank you.

I would like to extend a great deal of thanks to my parents, grandparents, and extended family for their support as I progressed through graduate school. I am grateful for your unwavering support and encouragement throughout the process. Thank you for instilling in me a desire to always perform to the best of my abilities and not settle for anything less. I would not have made it this far without you.

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CHAPTER 1 - INTRODUCTION

Northern Colorado today represents a melting pot of peoples and cultures from around the United States and throughout the world. Prehistoric northern Colorado was not so different. The area is accessible from many different geographic regions and, as such, served as an area of contact and cultural exchange between various Native American groups from the western Great Plains and groups living on the Colorado Plateau. With all these people moving back and forth across the landscape, it is no accident that the crest of the Continental Divide and surrounding landscape hosts a dense concentration of prehistoric sites of all types and ages (e.g. Benedict 1974, 1975a, 1975b, 1978a, 1985, 2000; Brunswig 2005; Cassells 1995; Hutchinson 1990; LaBelle and Pelton 2013).

Linear stone wall features in the Colorado Front Range were first reported in the literature as early as the 1930s and were originally interpreted as hunting sites, fortifications, or ceremonial structures (Husted 1963; Moomaw 1954; Olson 1970; Yelm 1935). Today, most of these features above treeline are interpreted as communal hunting sites, or game drives, and nearly 100 such sites have been identified. Traditional archaeological investigations of game drives focus on quantifying various morphological characteristics of game drives, including drive wall length or the number of cairns and blinds, excavating hunting blinds, lithic analysis, and radiocarbon and lichonometrically dating sites (Benedict 1975a, 1978a, 1996, 2000, 2009; Olson and Benedict 1970; Cassells 1995, 2000; Hutchinson 1990). These types of studies demonstrate an impressive array of regional and local adaptations to the generalized Colorado Front Range game drive and allow researchers to discuss the integral role high-elevation game drives played in the lives of prehistoric populations living in Colorado. Additional studies focus on blood residue analysis (Cassells 1995, 2000), animal ecology (Benedict 1996), and high elevation cultural ecology (Benedict 1992). These studies demonstrate the breadth of diversity of interdisciplinary approaches taken to studying game drive systems.

High elevation communal hunting sites in Colorado are defined by the presence of rock walls, blinds, and/or cairns spatially arranged to optimize the potential resource return of a hunt (Brink 2005; Brink et al. 2003). While certain aspects of these sites are well understood from previous studies, questions remain as to who built and utilized these systems, how these game drives functioned, and what activities and behaviors occurred on-site. These questions are situated within broader-context questions related to the causes that pushed these groups into adapting this strategy of resource acquisition and the broader social and cultural implications of this strategy. While this thesis does not attempt to solve these more broad questions, it does seek to add to the growing body of literature of the regional trends through the close examination of four sites.

Thesis Objectives and Organization

The subject of this thesis is four archaeological sites located above treeline near Rollins Pass, Grand County, Colorado: 5GA35, 5GA36, 5GA37 (hereafter collectively referred to as the game drive sites), and 5GA4268 (previously 5GA48). It must be noted here that the reader will see 5GA48 on all maps; 5GA48 has been recently reassigned as 5GA4268. In-text references to the site reflect this new site number, however, figure references have not been changed. The intent of this thesis is not to be a site report for the four sites being investigated. Instead, the primary goal is to present a narrative of alpine communal hunting at four sites through the application of two spatial scales of analysis: regional and local. Regional scale analyses place the four sites in a broader, regional context of the prehistoric use of the northern Colorado mountains and the adjacent intermountain basins to the west and Great Plains to the east while local scale analyses identify relationships within and between sites and how those relationships influenced the formation of the sites. Analysis at these two spatial scales presents a more holistic view of site use than would otherwise be possible.

Thesis Objectives

Three primary questions are explored in this thesis and are designed to provide both a guide for methodological and theoretical inquiry as well as an organizational framework for the thesis.

1. The first question addresses the pre-hunt planning stage leading to the use of the four sites. Analysis for this aspect of the hunt explores broader, regional contexts behind how and why prehistoric populations were utilizing these sites. Regional seasonal mobility patterns are explored in order to set up a series of expectations which are then tested using the available dataset. Chapter 5 addresses these questions related to the pre-hunt planning phase of a hunt.
2. The second question addresses the use of 5GA35, 5GA36, and 5GA37 as communal hunting sites. Analysis for this aspect explores the spatial relationship of site features and artifacts at a local level. The spatial relationship within and between sites is used to

elucidate how these game drives functioned. In addition to this spatial analysis of site features and artifacts, protein residue analysis was conducted on 15 stone tool samples to inform on the animals targeted during a hunt. Understanding the type(s) of animal(s) hunted provides additional information as to how a hunt was executed giving a more holistic interpretation of the sites. Chapter 6 addresses these questions related to the execution of a hunt.

3. The third question addresses post-hunt activities at the sites. Analysis for this aspect explores the use of 5GA4268 in addition to the game drives as specialized activity areas at a local scale. Combining the spatial component of artifacts together with their morphological characteristics, a more holistic understanding of the use of the sites begins to emerge. In addition to the combination of spatial and morphological data of artifacts, use wear analysis was conducted on 15 stone tool samples to inform on the types of activities performed or materials worked at the sites. Understanding these variables provides additional information as to the activities occurring on-site. Chapter 7 addresses these questions related to the post-hunt stage of site use.

Thesis Organization

As the intent of this thesis is to present a narrative of high elevation communal hunting through the lens of four sites, the organizational framework of this thesis is dictated by the natural progression of the stages of a hunt. In order to do this, background is first provided to give the reader a context for both the sites themselves and prehistoric communal hunting in general. The rest of this chapter is dedicated to providing background information to the sites, including their position within the physical environment and the history of research regarding them. Chapter 2 gives an overview of prehistoric communal hunting in general and alpine communal hunting more specifically. This chapter relies entirely on published research and is meant to place the research presented in this thesis within the larger context of prehistoric communal hunting.

Chapter 3 presents the theoretical and methodological tenets of this research. This chapter is divided into two sections, theory and methods. Chapter 4 provides data and interpretation of the lithic assemblage collected from the sites and also describes the feature assemblage recorded for the sites. Chapters 5, 6, and 7 form the heart of this thesis research. The questions addressed in each of these chapters are outlined above. These three chapters follow the natural progression of a hunt, from the pre-hunt planning stage through the execution of a hunt and finally to the post-hunt phase. Organized in this way, the chapters give the reader a natural storyline to follow regarding the use of the game drive sites and 5GA4268. These chapters rely on a combination of published research, previously collected data, and new research conducted by the author.

Chapter 8 summarizes the data presented in chapters 5-7 and concludes with a discussion on what the research for this thesis might mean for future directions for research on alpine communal hunting sites.

This organization of this thesis is modeled after the natural progression of a hunting episode to provide a tangible storyline which connects the readers to behaviors and activities of prehistoric hunters (Figure 1.1). This approach offers a unique perspective into the operation of

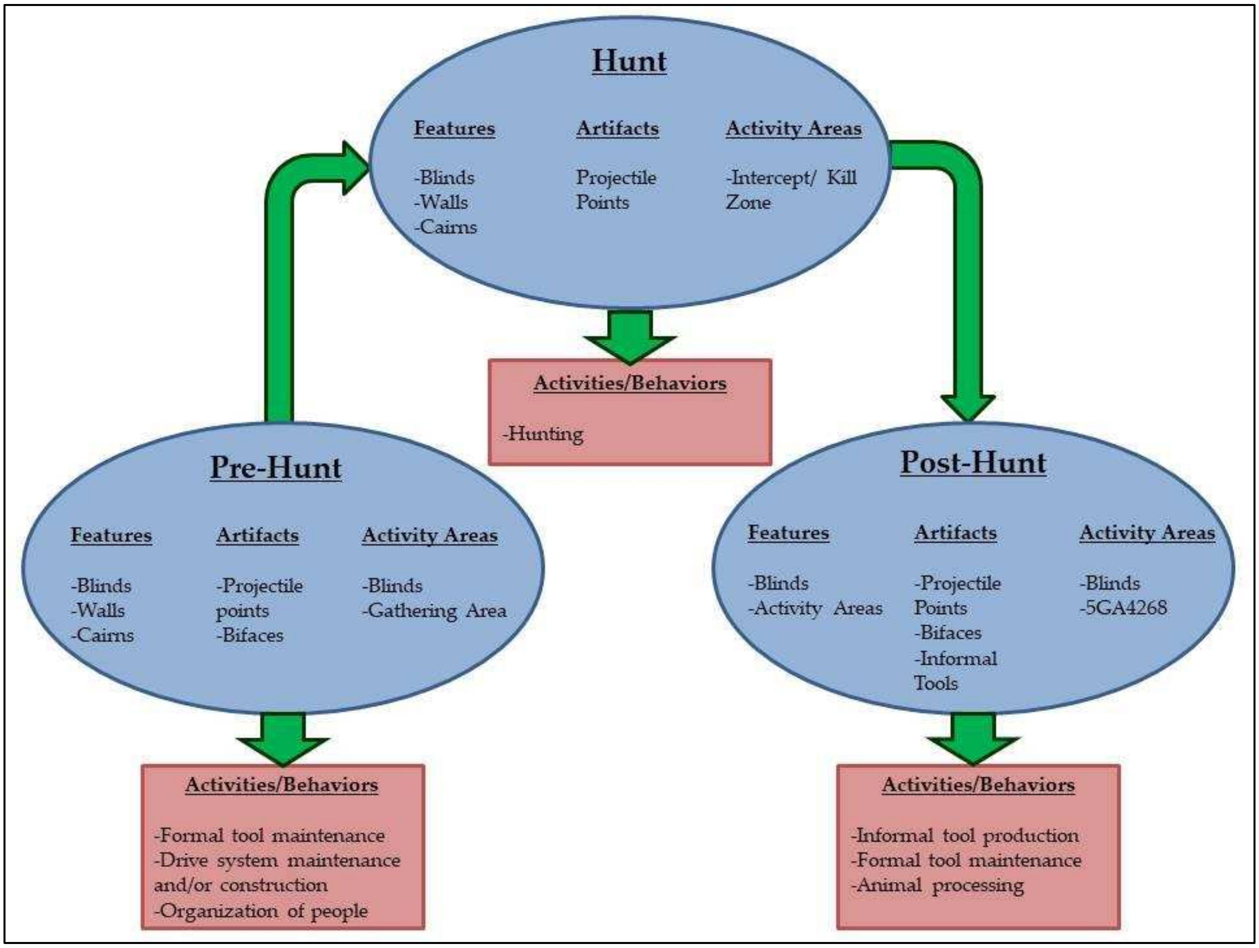


Figure 1.1: Organizational flowchart showing the relationship of various aspects of this thesis to each other.

alpine hunting sites and how they functioned within the larger system of seasonal mobility of hunter-gatherers in the region. Rather than describe the artifacts and features in isolation, this approach incorporates activities and behaviors associated with artifacts and ties those to specific geographic locations within the drive system to elucidate how certain features operated within the overall hunting episode. The artifacts and features were not used independently or in isolation from one another but, rather, served multiple functions throughout the entire hunting sequence. Many previous studies on alpine game drives focused on specific aspects of the drive systems, whether that is the features, the artifact assemblage, or the environment, but did not tie those aspects together to create a holistic description of the entire sequence of activities and behaviors which occurred during a hunting event. By examining sites from this perspective (that is, as pre-hunt, hunt, and post-hunt phases) the thesis seeks to parse out specific behaviors associated with each of these phases and demonstrate how their location within the drive structure holds potential for future archaeological analyses of high elevation hunting sites.

Physical Environment

Rollins Pass is located along the Continental Divide approximately 35 kilometers west southwest of Boulder, Colorado, as the crow flies (Figure 1.2). The pass divides the headwaters of the South Fork of Middle Boulder Creek (a tributary drainage of the South Platte River) to the east and Ranch Creek (a tributary drainage of the Colorado River) to the west (Helmuth and Helmuth 1994). The South Platte and Colorado River are two of the principal drainages in the state and, more broadly, the region. Until recently, Rollins Pass was an important route across the Continental Divide from the game rich, sagebrush basin in Middle Park to the west to the short-grass prairies to the east. This is attested to by the numerous prehistoric archaeological sites (Benedict 1969, 1971, 1973; LaBelle and Pelton 2013; Olson 1970, 1971; Olson and Benedict 1970) and historic Native American trails (Ives 1942; Toll 2003) identified in the vicinity of Rollins Pass as well as the construction of the Moffat Railroad in the early 1900s (e.g. LaBelle and Pelton 2013 and The Moffat Road 1996). The completion of the Moffat Tunnel in 1928 and recent road closures prevents crossing Rollins Pass by either method today, thus diminishing its importance as a route across the Continental Divide. However, the area remains a popular

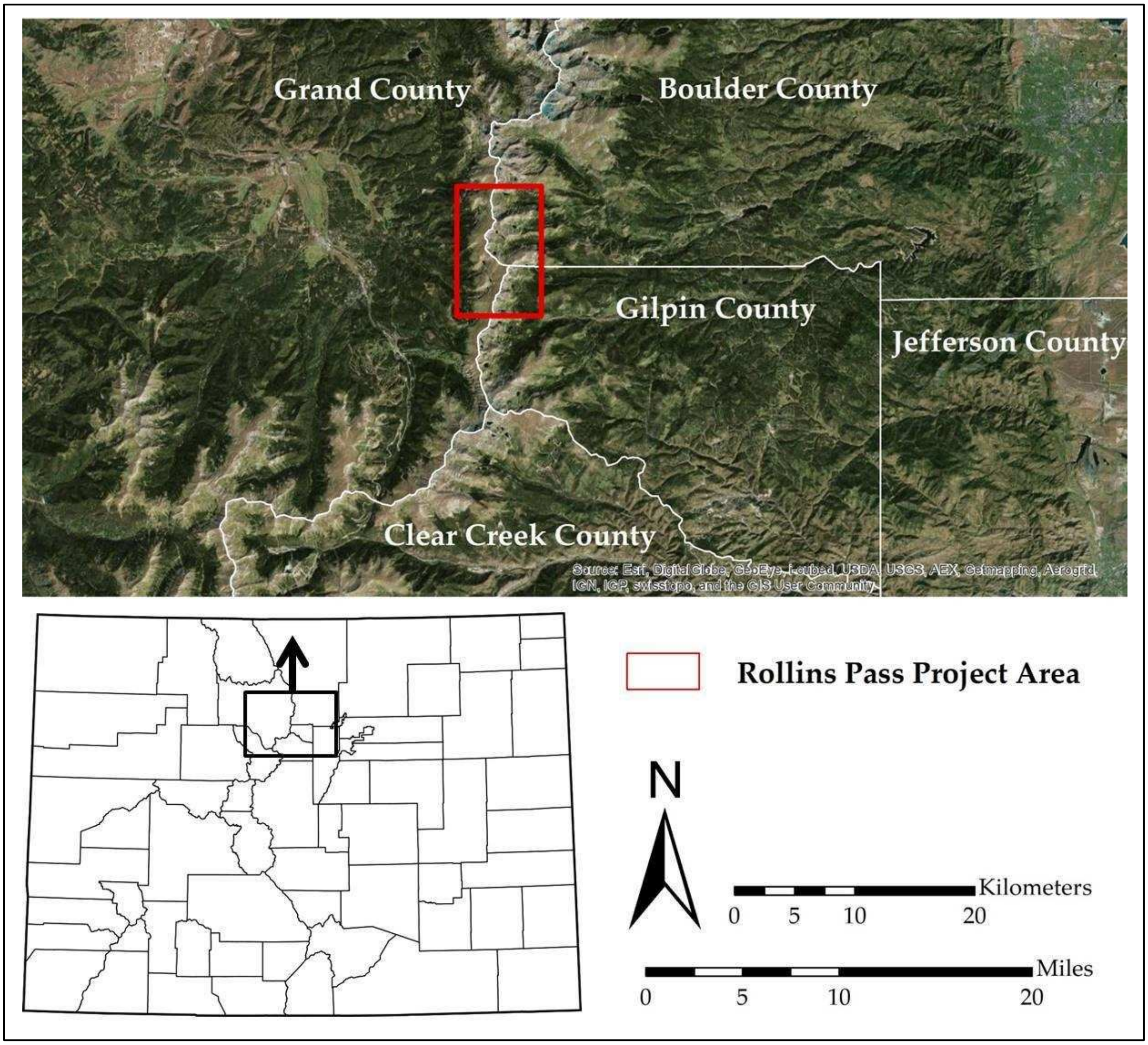


Figure 1.2: Rollins Pass project area in relation to modern political boundaries of Colorado.

recreational destination to outdoor enthusiasts from both the Front Range and Middle Park areas due to its relatively easy access and breathtaking scenery.

The four sites are located above modern treeline about one kilometer north of Rollins Pass in eastern Grand County, Colorado (Figure 1.3). The sites are situated on a sloping alpine ridge at elevations ranging from about 3,570 meters (11,700 feet) to 3,650 meters (12,000 feet) above sea level. To the west, the ridge continues to slope downward into the montane ecosystem below treeline and eventually into the sagebrush steppe ecosystem of Middle Park. To the southwest, the ridge drops precipitously into Corona Lake and the Ranch Creek basin (Figure 1.4a). To the east are rocky cirques with near vertical cliffs dropping into King Lake more than 150 meters (500 feet) below and the sub-alpine basin containing the headwaters of the South Fork of Middle Boulder Creek (Figure 1.4b). In the more immediate vicinity of the sites, local topography and environments range from gently sloping terrain with alpine vegetation characterized by short bunch grasses and flowering plants to steeper slopes containing large boulders and talus fields.

Wind is likely the most important climate component that influences the local environment in this alpine setting. Winds at this elevation are typically influenced by the strong Westerlies associated with the mid-latitude jet stream and can be quite extreme above treeline (Holtmeier 2003). Strong winds strip the snow from exposed tundra and redeposit it in sometimes great quantities in the upper reaches of the sub-alpine forest, cirques, lee-side drifts above timberline, and in small topographic depressions in the alpine tundra (Benedict 1985; Holtmeier 2003). Ultimately, this leads to wide disparities in soil moisture, length of the growing season, and the intensity of the winter freeze which results in the diversity of plant communities and taphonomic processes which are of great importance to archaeological studies (Benedict 1985; Holtmeier 2003).

Wind speed and direction are influenced by local topography; ridges and gullies with a relief of just five to ten meters can modify wind speed by ±60% (Holtmeier 2003). Local

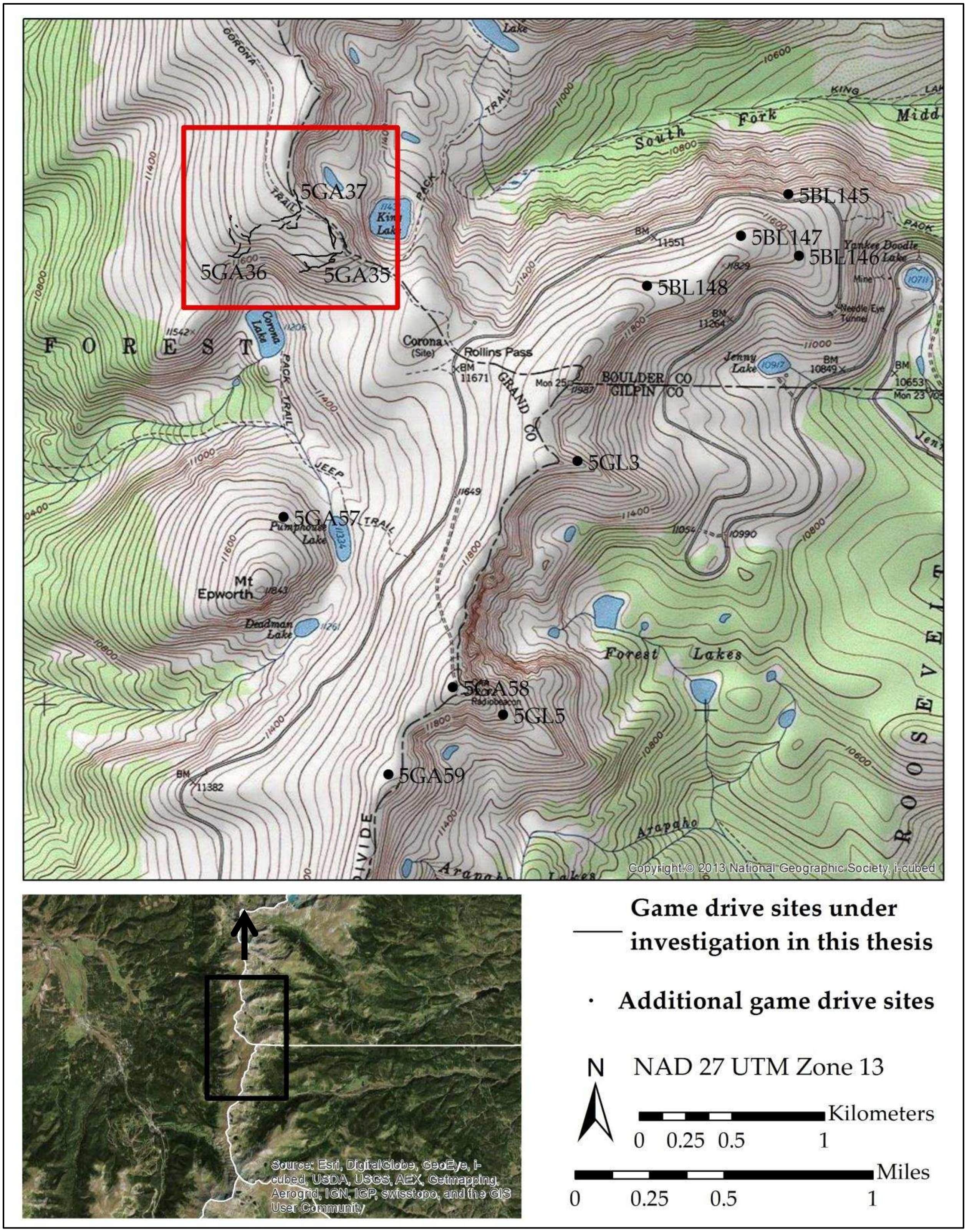


Figure 1.3: Spatial relationship of the sites under investigation in relation to additional game drive sites in the Rollins Pass complex and geographic features.

topography can also drastically alter prevailing wind directions, which in turn can have an impact on the placement of game drive systems. One example is the Devil's Thumb Pass game drives (5GA20 and 5BL103) described by Benedict (2000) in the Devil's Thumb valley, about five kilometers north of Rollins Pass. Here, a lee-side eddy of wind created by a cirque on the north side of the valley allowed hunters to drive game westward, upslope to the Continental Divide (and, thus, against the prevailing wind direction along the Continental Divide) (Benedict 2000). Although on-site wind speed observations were not recorded as part of the data set for this thesis, the mean annual wind speed on Niwot Ridge, located about 20 kilometers northeast of Rollins Pass in a similar environment, is 10.3 meters/second (about 23 miles per hour) (Holtmeier 2003). On-site observations of tree flagging, which can give generalized primary wind directions (Holtmeier 2003), suggest the wind at Rollins Pass is predominately from the west. Because of the constant wind and overall slow growth rate of plants in the alpine zone (Holtmeier 2003), deposition of sediment is minimal at the sites. A notable exception to this is

Figure 1.4: (A) Landscape of the west side of the Rollins Pass area facing north/northeast from the summit of Mt. Epworth showing the location of sites investigated in this thesis. Corona Lake is visible in the foreground. Image by Aaron Whittenburg. Image on file at the Center for Mountain and Plains Archaeology. (B) Landscape of the east side of the Rollins Pass area facing west. Rollins Pass is to the left of the prominent snowfield above King Lake, just out of image. Image by Aaron Whittenburg.

inside the hunting blinds, which act as natural traps for airborne sediment (and snow in the winter) and creates a more favorable depositional environment. Understanding the depositional environment is important for later discussions of site features and artifact samples.

History of Research

By virtue of their sheer numbers and highly visible nature to anyone traversing the Continental Divide in this area, the rocks walls, blinds, and cairns at Rollins Pass were first described almost 150 years ago. The first formal description of the rock features was by C.A. Deane in 1869, a government surveyor who believed the features were related to the Moundbuilding cultures further east (Anonymous 1869, in LaBelle and Pelton 2013). Four years later, in 1873, John Q.A. Rollins built the first wagon road across the pass and in doing so, ran across the features. He described the features and his incredible find of a weathered bow in a letter to the editor of the *Rocky Mountain News,* at the time the regional newspaper published in Denver (Rollins 1873, in LaBelle and Pelton 2013).

Scientific research on prehistoric sites at Rollins Pass began a century after the initial descriptions by C.A. Deane and John Rollins with the systematic mapping of 5GA35 by Byron Olson and James Benedict in 1969 (Benedict 1969; Olson and Benedict 1970). Initial mapping methods utilized a theodolite and aerial photography to pinpoint site features (blinds, walls, and cairns) on a map of the Rollins Pass area derived from aerial photography (Figure 1.5). Using approximately 850 survey shots, features were mapped and field sketched at a scale of 1:1,200 and later transferred to a 1:6,000 scale topographic base map (Olson and Benedict 1970).

Mapping of the sites was limited to the blinds, walls, and cairns identified during survey and did not include the geographic location of surface artifacts collected during survey of the sites. Subsequent research, led primarily by Olson, began the following year in 1970 and continued through the 1973 field season. In 1970, Olson and Benedict began a series of excavations at the Rollins Pass sites, with an emphasis on gaining detailed stratigraphic data on the blinds and a total recovery of artifacts (Olson 1971). In most cases, only half of each blind was excavated as this produced the maximum amount of information per time expenditure while preserving an undisturbed section for future research (Olson 1971). At 5GA35, four of the six excavated blinds were archaeologically productive (blinds 513, 541, 565, and 573) (Figure 1.6). Numerous artifacts were collected from both surface survey and excavation, including several projectile points, bifacial knives, a serrated blade, over 100 pieces of chipped stone debitage (see chapter 4 for further discussion of the lithic assemblage), and a single radiocarbon date was obtained from charcoal found in blind 573. The radiocarbon age of the charcoal sample (1-11,132) is 3,090 ±250 radiocarbon years before present (Olson 1971). Unfortunately, this meticulous work did not result in any final report or research publications; instead, the data and interpretations are reported in several reports to the National Forest Service and the Smithsonian Institute (Benedict 1969, 1971; Olson 1970, 1971; Olson and Benedict 1970) and also in several articles by Benedict related to his work on game drives and other alpine sites in the Indian Peaks Wilderness (Benedict 1992, 2005, 2009; Benedict and Olson 1978).

A second period of research at Rollins Pass was initiated in 2009 when Jason LaBelle and the Center for Mountain and Plains Archaeology (CMPA) at Colorado State University (CSU) began assessing the Olson site (5BL147) for potential reinvestigation (LaBelle and Pelton 2013).

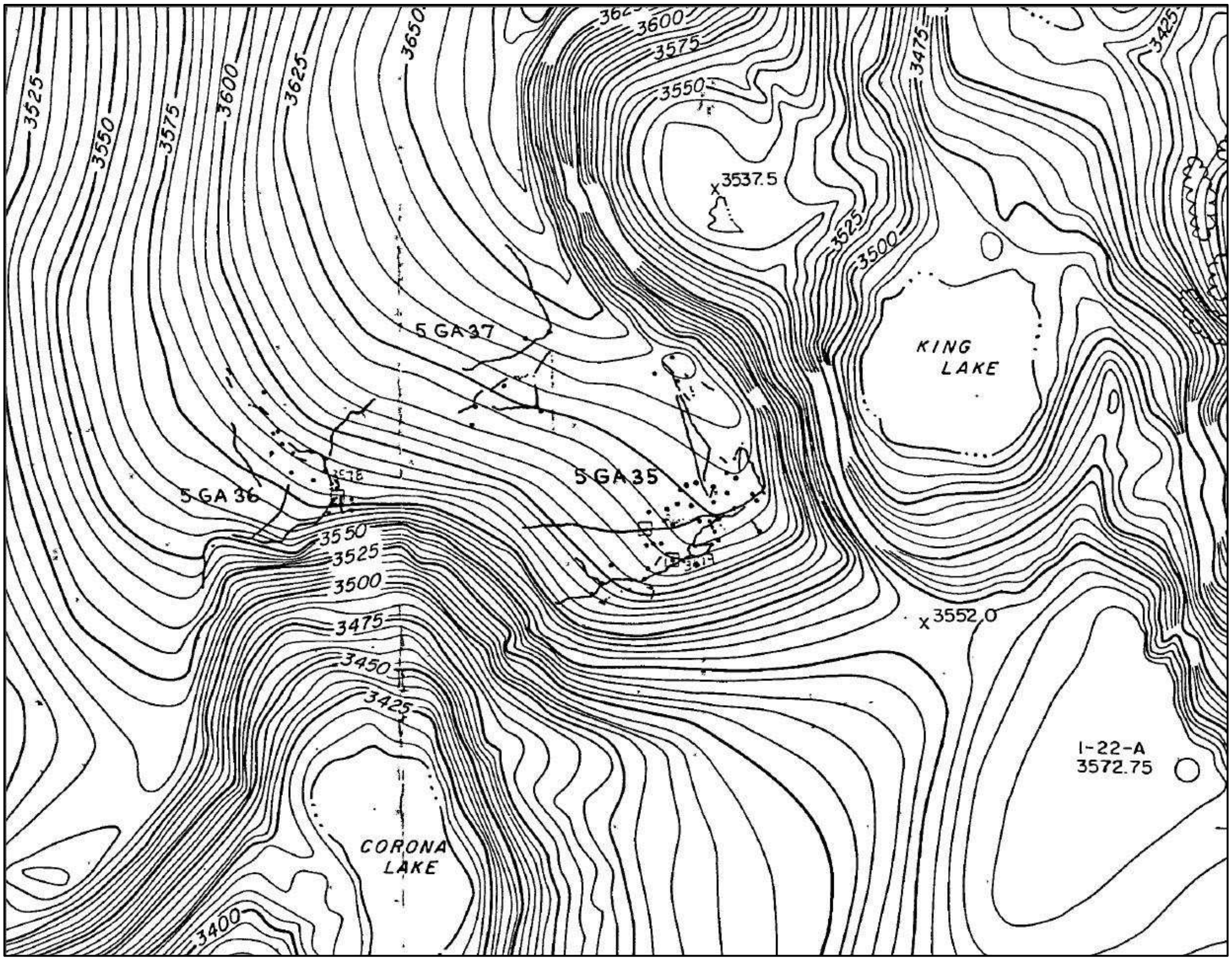


Figure 1.5: Scan of topographic map with the game drive sites overlaid created by Byron Olson and James Benedict. Original map and scan on file at the Center for Mountains and Plains Archaeology.

LaBelle and his crews primarily focused on systematically recording the Olson site during the 2010 field season but also expanded their research (2011-2015) to include other sites in the area. This research is on-going, with the latest field season (2016) focused on exploring the archaeological potential of the numerous permanent snow and ice patches in the area. Upcoming Master's theses by Kelton Meyer and Michelle Dinkel look to expand the knowledge of game drives and the use of non-hunting sites at Rollins Pass.

Periodic fieldwork at 5GA35, and 5GA36 began in 2011 and expanded to 5GA37 and 5GA4268 during later years. Fieldwork utilized the efforts of the CSU archaeological field school, CMPA student crews, and volunteers. Fieldwork during this period of research focused on intensive surface survey to gain an explicitly spatial understanding of the relationship between site features and artifacts. As such, recording the geographic coordinates of site features and artifacts using the Universal Transverse Mercator (UTM) coordinate system and morphometric measurements of site features comprised a majority of the fieldwork. Additional field methods are described in detail in the following chapter. As of September 2015, a total of 80 hunting blinds and nearly two kilometers of walls have been recorded between the three hunting sites in addition to the numerous artifacts collected from intensive surface survey (see chapter 4 for further discussion of the lithic assemblage).

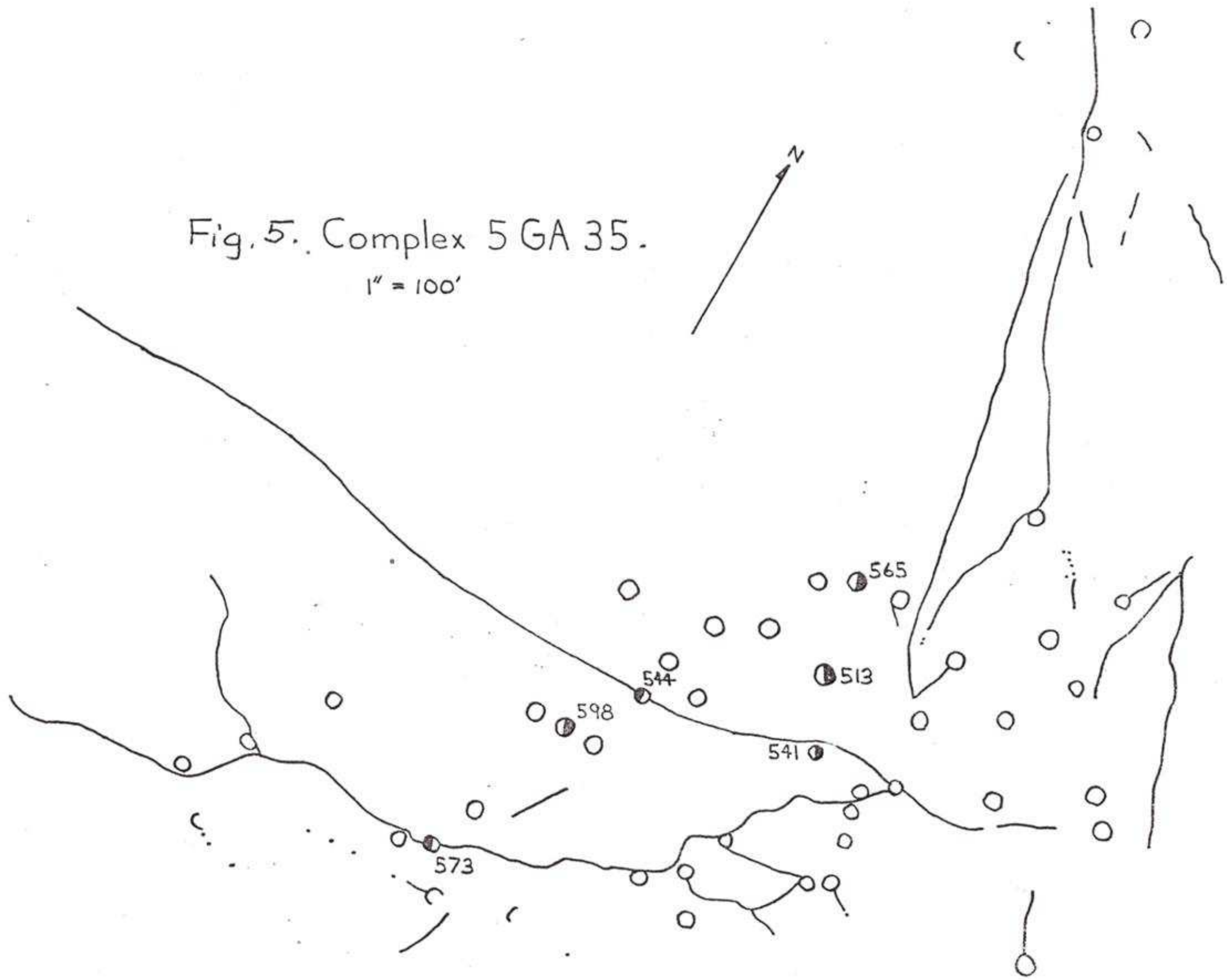


Figure 1.6: 1971 plan map of 5GA35 showing location of walls and blinds. Excavated blinds are numbered with the portion of the blind excavated shaded in. Image taken from Olson 1971. Original report and image scan on file at the Center for Mountain and Plains Archaeology.

CHAPTER 2 - PREHISTORIC COMMUNAL HUNTING AND COLORADO HIGH ELEVATION GAME DRIVES: AN OVERVIEW

Communal hunting is an effective means of procuring a large quantity of meat resources in a relatively short amount of time. That this hunting strategy was used by prehistoric hunter-gatherers for tens of thousands of years is a testament to its importance in the study of prehistoric lifeways. Communal hunting is characterized by the active cooperation of more than two hunters, oftentimes members of multiple social groups, in a preconceived plan such that hunters work together to harvest a large number of animals of the same species (Bamforth 2011; Driver 1990; Steele and Baker 1993). This is opposed to passive cooperation in which hunters work individually to harvest animals with the agreement not to interfere with the activities of the others (Driver 1990).

Successfully conducting a communal hunt relies on three independent but interrelated variables. First, the social organization of the groups must support the need for a large surplus of meat resources (Driver 1990). This may range from large, multi-family social gatherings with the need to feed many people in a short amount of time to smaller, multi-family congregations with the need to feed fewer people but over a longer period, such as through the winter months. The second variable is the behavioral and physiological nature of the prey animals (Driver 1990). Foremost, animal behavior needs to be predictable. This allows hunters to position themselves in locations where animals are expected to be as well as implement a specific hunting technique (Driver 1990). The physiological condition of the animals must also be such that there is a positive return on meat resources for the time and energy expended executing a hunt (Driver 1990). This potentially affects the seasonality of hunts or the specific species or sex of species that is hunted. Third, environmental conditions external to both humans and animals must be amenable to communal hunting (Driver 1990). Local topography is of great importance to a successful hunt. A large gathering area, relative to the herd size of the prey species, gives the hunters enough room to maneuver themselves and the animals into position. This gathering area must then lead into an intercept zone, an area with limited space where animals are more easily dispatched. These choke points can be natural, such as arroyos or cliffs, or constructed, like Arctic and Colorado high elevation game drives.

In North America, the archaeological remains of communal hunting are reported across a widespread area, including the Great Basin, the Great Plains, the Canadian Arctic, and the Colorado Rocky Mountains, and across all periods (e.g. Bamforth 2011; Benedict 1975a; Brink 2005; Reeves 1978). Prehistoric hunters employed a number of strategies to conduct communal hunts. In some areas, hunters drove animals into arroyos which acted as natural impoundments (e.g. Wheat et al. 1972). In other areas, prehistoric populations constructed drive lines of cairns in order to funnel animals over a precipice (the stereotypical bison jump) (e.g. Brink 2008; Frison 1970; Johnston 2016; Reeves 1978). In other regions, hunters funneled game into constructed wooden pounds or used nets to trap game (e.g. Bupp 1981; Frison 1971; Frison et al. 1986). In the high Arctic and in the Colorado alpine zones, hunters constructed cairns, stone walls, and hunting blinds to harvest game (e.g. Benedict 1996; Brink 2005; Brunswig 2005; Cassells 1995, 2000). The technology of the killing implement (i.e. projectile point) is often less important than the technology or strategy employed in the actual hunt, as animals are typically encountered at close range or frequently confined and, as such, a tool as simple as a firehardened wooden spear would likely be sufficient to dispatch animals (Driver 1990). As such, this thesis focuses primarily on the strategies and behaviors related to communal hunting in the Colorado high country.

Perhaps the best example of communal hunting that is closely related to the Colorado game drives are the communal caribou hunting sites of the Canadian Arctic. The environment and game drive features in this region bear a close resemblance to those features found in the Colorado high country. Benedict (1996, 2005) noted the striking similarity in both form and function of drive systems in these two regions. Game drive systems in the Canadian Arctic, like the Colorado game drives, are composed of stone walls, blinds (called *talut)*, and cairns (called *inuksuit)* (Brink 2005). Much like the Colorado game drives, the drives systems of the Arctic are part of a generalized U- or V-shaped pattern that worked to funnel game into a predetermined area (Benedict 2005; Brink 2005). These systems incorporate the natural environment as much as possible to minimize the time and energy expended in constructing the drive system and to better facilitate the movement of caribou through the system. Continuous and discontinuous drive walls and lines of *inuksuit* commonly follow ridgecrest routes for increased visibility for both the caribou and the hunters (Benedict 2005).

Arctic game drives are typically less substantial than the Colorado systems, which tend to have numerous walls and more fully-circular blinds (Benedict 2005). A notable exception to this are the well-developed continuous rock walls at the West Ferguson No. 2 site on southern Victoria Island, where there are two converging walls of 42 meters and 17 meters in length which form the termination point of a system that is up to 250 meters in overall length (Brink 2005). The construction of *inuksuit* in the Arctic and cairns in Colorado are similar, with both relying on leaning- or stacked-slab cairns, simple rockpile cairns, or a single rock placed in a prominent location (Benedict 2005). *Inuksuit* tend to be much more numerous and play a larger role in the overall function of the Canadian game drive systems.

Colorado Alpine Game Drives

The alpine game drives of Colorado are comprised of a large gathering area, linear stone walls, cairns, and hunting blinds, and a predetermined intercept/kill zone where animals could be easily dispatched by waiting hunters (Figure 2.1). While each game drive is unique in the sense that each is tailored to the local environment, several common denominators exist which allow for a generalized discussion of the character of these drives. Game drives are typically found above treeline where alpine grazing areas attract herds of grazers, typically elk or bighorn sheep, and natural barriers minimize the need for manmade structures thus reducing the overall effort required of prehistoric hunters utilizing this hunting strategy. Large gathering areas occur upwind from the game drives and are an important facet of the game drive systems in that they are areas of high predictability and high expected rates of encounter. The predictability of the location of animals on the landscape is paramount to the success of the game drives. While game drives tend to occur along and near mountain passes that formed natural travel corridors for migrating game (e.g. Benedict 1985, 2000), they are also located where westward sloping alpine meadows are truncated by headwalls of cirques (e.g. Benedict ; Cassells 1995) , on ridges or ramps bordered by cliffs and/or unstable talus slopes (e.g. Benedict 1975a, 1978a, 1996; Benedict and Cassells 2000), or in high glacial valleys where lakes, streams,

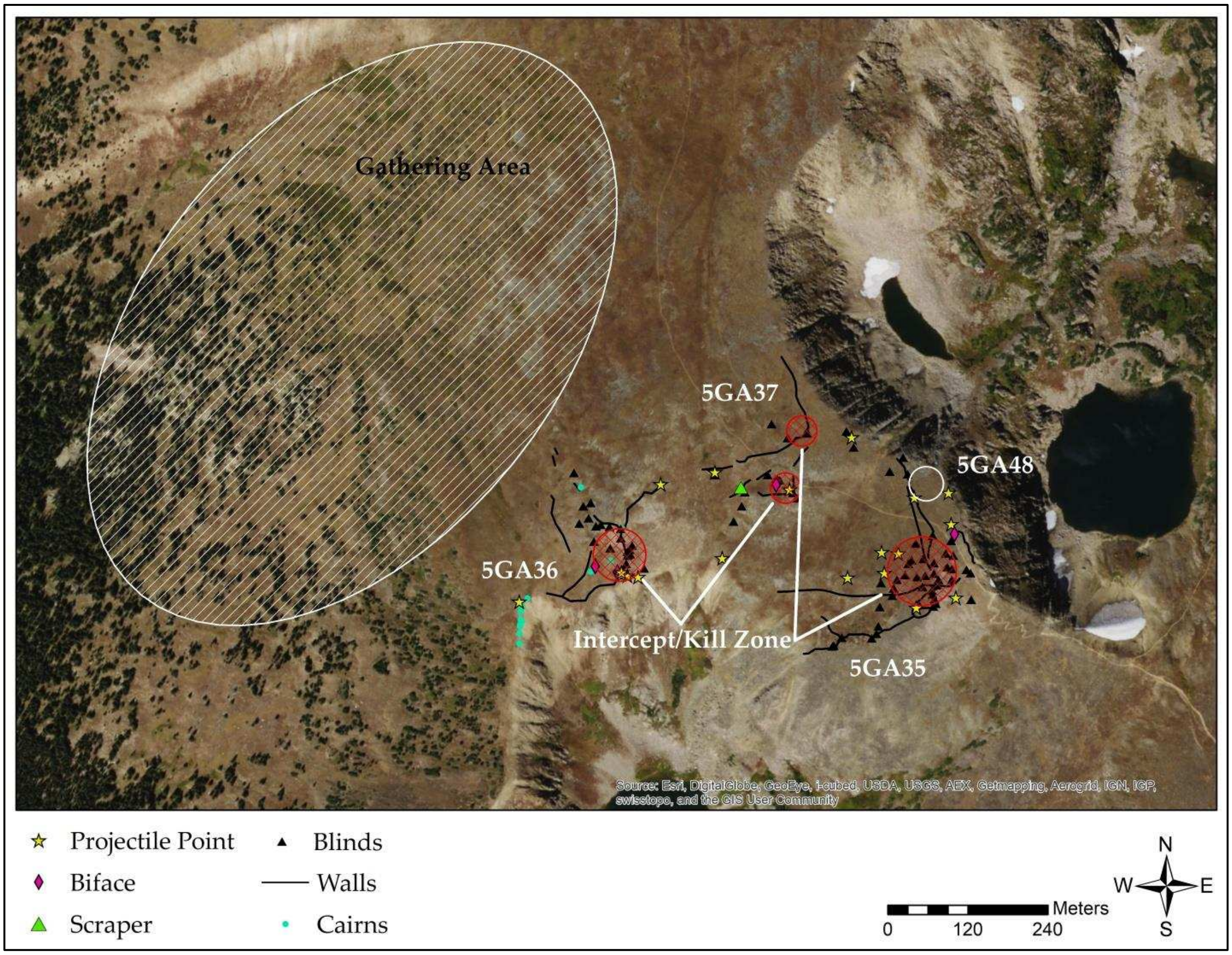


Figure 2.1: Map showing the location of various parts of a game drive system, using the three hunting sites presented in this thesis as an example.

and/or krummholz stands were utilized as barriers to movement (Benedict 1990, 2000). Game drives range in size from small expedient game drives built quickly in response to an encounter with animals with no intention of future use to large destination game drives built in response to expected and predictable animal movement and repeatedly reused and remodeled over time (Benedict 1996).

One of the most prominent features of game drives are the rock walls. Wall structures are low, continuous or discontinuous linear and/or sinuous features constructed from loosely piled rock which follow routes across the alpine tundra selectively chosen by hunters for maximum visibility and ease of construction (Figure 2.2a) (Benedict 1975a, 1978a, 1985, 1996, 2000; Benedict and Cassells 2000; Cassells 1995, 2000; LaBelle and Pelton 2013). Continuous drive walls vary in length from just a few meters long up to a kilometer long at some of the largest game drive sites (e.g. LaBelle and Pelton 2013). Drive walls generally form a V- or U-shaped pattern designed to funnel game into an increasingly constricted area. This constricted area where walls converge is the presumed kill zone of the drive system. While some of the largest and/or best preserved walls are nearly a meter high, most drive walls are much more subtle, consisting of discontinuous alignments only a few stones in height (Benedict 1996). It would be easy to imagine these walls having little to no influence on game movement given their low height. However, wall height may have been augmented by sticks and flagging to increase the effective height of the wall. This tactic is widespread in the Arctic (Speiss 1979); however, no direct evidence of sticks and/or flagging material has been found at any of the Front Range game drives. However, Hutchinson (1990) reports remnants of sticks or posts found at intervals of 2-3 meters along several drive walls of the Waterdog Divide site near Monarch Pass in the southern Sawatch Range of Colorado. Despite being outside of the Front Range, this is strong evidence that the same tactic may have been used in Front Range game drives but due to taphonomic issues and differential preservation have not been preserved.

In areas where continuous drive walls were unneeded, such as far from the kill zone or along cliff edges, cairns were often built to control game movement into the drive system. Cairn construction in the Front Range relies on several different techniques and includes leaning- or stacked-slab cairns, simple rockpile cairns, or a single rock placed in a prominent location

(Figure 2.2b) (Benedict 2005). Lines of cairns oftentimes augment wall structures by increasing the overall effective length of the drive (Benedict 1975a, 1996). In certain cases, such as the Flattop Mountain game drive (5LR6) in Rocky Mountain National Park, the lines of cairns are far more substantial than the walls themselves (Benedict 1996). Cairns can also be located along ridge lines where from below they can appear human-like in their silhouetted appearance, called ‘soldier stones’ in Alaska (Binford 1978) and function to prevent animals from moving upslope and over the ridge (Benedict 1975a).

In the exposed alpine tundra, where few natural features exist to conceal themselves from incoming game, hunters constructed blinds and shooting pits. Hunting blinds and shooting pits are circular, semi-circular, or oval shaped in their construction (Figure 2.2c). Blind sizes vary depending on the landscape and available construction material but tend to range from one to three meters in interior diameter. Blinds were typically excavated out of areas of loose rock forming a pit 50-110 centimeters in depth and ringed with varying levels of stone courses (Benedict 1975a, 1978, 1985, 1996, 2000; Benedict and Cassells 2000; Cassells 1995; LaBelle and Pelton 2013). In areas of loose rock such as small boulder fields and talus slopes, blinds were often excavated below ground surface and augmented by rocks piled along the peripheral walls to increase the overall depth; in open tundra meadows where excavation was more difficult, blinds oftentimes lack a defined central depression and are typically shallow (Benedict 1996). When available, natural features, such as large talus boulders, were incorporated into the blind structure to facilitate quicker and easier construction (Benedict 1996). Blinds and shooting pits tend to cluster in predetermined kill zones in areas of wall convergence (LaBelle and Pelton 2013; this thesis, see Chapter 6) but have been recorded in any

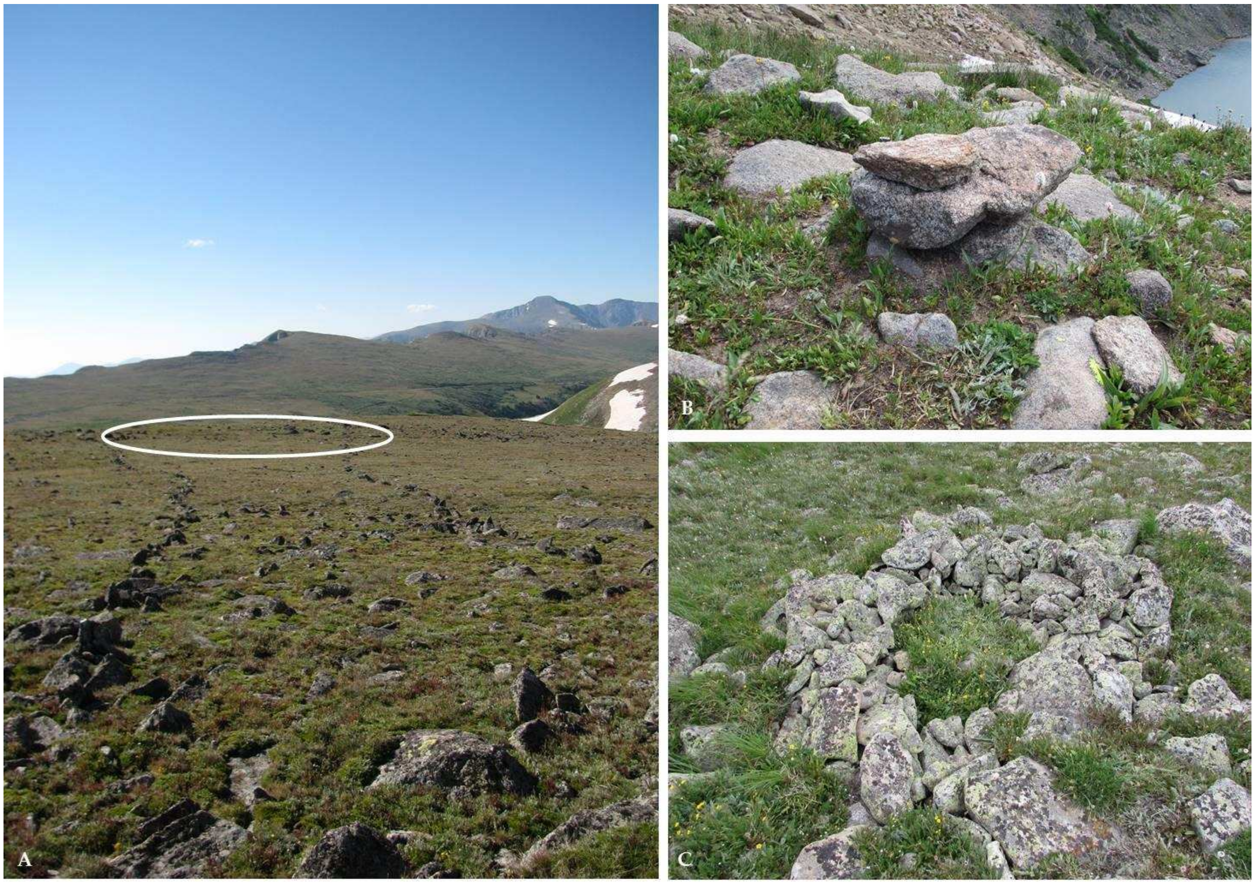


Figure 2.2: Examples of features typically associated with game drive structures in the Colorado Front Range. (A) Drive wall structures at 5GA35. It must be noted that these walls appear to be redundant in that they both serve the same function and were likely not used in conjunction with one another. Zone of wall convergence noted by the circle. Image by Aaron Whittenburg. (B) Simple stacked-stone cairn at 5GA36 consisting of two stones stacked on an in-situ stone. A steep talus slope begins about a meter behind the cairn and drops precipitously into Corona Lake, visible in the upper left of the image. Image by Aaron Whittenburg. Image on file at the Center for Mountain and Plains Archaeology (C) Hunting blind feature at 5GA36 showing circular construction and incorporation of natural features (large boulders). Image by Kelton Meyer. Image on file at the Center for Mountain and Plains Archaeology.

part of the drive system. Hunting blinds may have served more than the single purpose of concealing hunters from incoming game. Ethnographic evidence from the Mask site in the Canadian Arctic demonstrates that hunting blinds were used for eating and talking, playing cards, craft making, target shooting, and sleeping, in addition to watching for incoming game (Binford 1978). While some of these activities have no direct parallels to prehistoric activities viewed to date, it does provide evidence that hunting blinds in the Front Range may have served as activity areas for additional activities beyond those directly related to hunting (see Chapter 6 for further discussion).

Unlike other strategies for communal hunting that could take place more or less any time of year, game drives in the alpine regions of the Front Range were likely primarily a late-summer and autumn activity. Winter and early-spring weather precludes any prehistoric human activity in this area and even large animals tend to avoid these areas during this period. Spring and summer come slowly to the sub-alpine and alpine regions where snowmelt can continue well into July. Some game drives are built in areas that, today, do not become snow-free until late in the melt season due to a combination of elevation, aspect, and snow loading (Benedict 1996). Mid-summer through mid-fall is a spectacular time in the high country and is likely when prehistoric hunters most utilized the game drives. By this time, most areas would be snow free, forage is at its peak, and the physiological condition of animals makes hunting profitable (Benedict 1996; Driver 1990).

The use of game drives as a hunting strategy in the Front Range spans the periods from the Late Paleoindian to the Late Prehistoric. The intensity of use varies through time, as told by the radiocarbon and lichonometric record, but it appears game drive use gradually increased as time nears the modern era, reaching its zenith during the Early Ceramic Period during the Late Prehistoric period before dropping off drastically after the horse was reintroduced to Colorado from points south. Variations in the intensity of use of game drives is generally attributed to climatic shifts which affected distribution of flora in the region which, in turn, affected game animal populations and use of the alpine regions (Benedict 1999). Because game animals were the primary attraction of the alpine zones along the Front Range, their populations and distributions likely controlled the use of the alpine environment by prehistoric populations (Benedict 1999). Table 2.1 highlights select sites in northern Colorado and places them in a temporal context for the region. Dates in the following discussion are reported in uncalibrated radiocarbon years before present (rcyBP) and calibrated calendar dates (B.P.). Calibrated dates were obtained using CALIB 7.1 (Stuiver and Reimer 1993; Stuiver et al. 2017).

Direct evidence for Paleoindian use of game drives in the Front Range is limited and associations between dates and cultural artifacts are tenuous, at best. The oldest provisional evidence for game drive use comes from two dates from the Devil's Thumb Valley game drive (5BL3440) and both are from a single charcoal grain. The two dates are tightly clustered at 9570 ±80 rcyBP (11,080-10,920 B.P.) and 9550 ±80 rcyBP (11,080-10,930 B.P.) and come from the wall and floor, respectively, of an excavation unit (Benedict 2000). The latter date came from a cluster

Table 2.1: Regional prehistoric chronology for the South Platte River Basin and select sites from northern Colorado. Game drive sites are bolded. Adapted from Chenault 1999.

Stage	Period	Calibrated Date Range	Select Sites
Paleoindian (12,000 – 5500 B.P.)	Clovis	12,000 – 11,000 B.P.	Barger Gulch; Caribou Lake; Dent**; Devil's Thumb Valley (?);** Gordon Creek; Lindenmeier; LoDaisKa; Twin Mountain
	Folsom	11,000 – 10,000 B.P.	
	Plano	10,000 – 7500 B.P.	
Archaic (7500 – 1800 B.P.)	Early Archaic	7500 – 5000 B.P.	**5BL66; 5GA35; Flattop Mountain;** Granby; **Hungry Whistler;** Magic Mountain; **Trail Ridge;** Vail Pass; Yarmony
	Middle Archaic	5000 – 3000 B.P.	
	Late Archaic	3000 – 1800 B.P.	
Late Prehistoric (1800 – 410 B.P.)	Early Ceramic	1800 – 800 B.P.	Kinney Spring; Lyndsay Ranch; **Murray;** Roberts Ranch; **Olson; Sawtooth;** Scratching Deer; Valley View
	Middle Ceramic	800 – 410 B.P.	
Protohistoric (410 – 90 B.P.)	Late Ceramic	410 – 90 B.P.	**5GA35 (?); 5BL148 (?)**

of *in situ* flakes near the center of what is described as a lithic workshop (Benedict 2000). While the proximity of the charcoal to the lithic workshop provides strong evidence of association, the charcoal cannot be definitively assigned as having a cultural origin (Benedict 2000). Additionally, three Paleoindian projectile points were collected nearby that are attributed to the Foothills-Mountain tradition (Benedict 2000). Better evidence for Late Paleoindian use of game drives comes from charcoal dated 7650 ±190 rcyBP (8640-8280 B.P) from a basin hearth at 5BL70 on Mount Albion (Benedict and Olson 1978). 5BL70 is interpreted as a butchering site associated with the Hungry Whistler site (5BL67) but itself is not a game drive site (Benedict and Olson 1978). Paleoindian-style projectile points have been found at other game drive sites as well, most notably the Flattop Mountain game drive (Benedict 1996), although their special association with game drive use is oftentimes difficult to establish.

Game drive use in the Front Range becomes more apparent during the Archaic period (7550-1800 B.P./A.D. 150). Regionally, this period is defined by the broadening of the resource base by prehistoric populations to include the traditional larger game animals as well as small game animals and an increased emphasis on plant resources (Tate 1999). Point typologies commonly associated with Archaic use of game drives include Mount Albion, Coney-Lake corner-notched, Pelican Lake, and numerous unassigned medium to large dart types. The oldest unequivocal evidence comes from a charcoal sample from a hunting blind at 5BL66 and dates to 6175 ±65 rcyBP (7170-6990 B.P.) (unpublished data presented in Benedict 1996). Further evidence for early Archaic use of game drives comes from other sites in the Mount Albion area, most notably the Hungry Whistler site (5BL67), the type site for the Mount Albion complex, and 5BL70. Hungry Whistler has four radiocarbon dates associated with it ranging from 5800 ±125 rcyBP (6740-6460 B.P.) to 5300 ±130 rcyBP (6210-5940 B.P.), while 5BL70 has two additional dates of 5650 ±145 rcyBP (6570-6300 B.P.) and 5300 ±130 rcyBP (6570-5940 B.P.) (Benedict and Olson 1978). Evidence of continued use throughout the Archaic period exists at several game drives throughout the Front Range, most notably at the Olson game drive (5BL147), the Flattop Mountain game drive (although overwhelmingly represented by Mount Albion), the Trail Ridge game drive (5LR15), and 5GA35.

Game drive use in the Front Range reached its zenith during the Late Prehistoric period (A.D. 150-1540). Regionally, this period is defined by increasing cultural complexity, semi-sedentism by some groups, the introduction of pottery to northern Colorado, and, perhaps most important to game drives, the introduction and eventual transition to bow and arrow technology (Gilmore 1999). Point typologies commonly associated with Late Prehistoric use of game drives includes Hogback corner-notched, Prairie and Plains side-notched, and Plains tri-notched. Nearly all of the previous discussed sites have at least a small Late Prehistoric component, but certain sites are well known for their size and are worth highlighting. The Sawtooth game drive (5GA55/5BL523) has seven reported radiocarbon dates ranging from 1,365 ±65 rcyBP (A.D. 610-690) to 255 ±60 rcyBP (A.D. 1460-1700) (Cassells 1995, 2000). These dates also coincide with lichenometric studies conducted on the drive walls of the game drive, which show periodic wall building episodes from 1,760 to 800 rcyBP (Cassells 1995, 2000). The Flattop Mountain game drive has 15 reported radiocarbon dates ranging from 4,310 ±80 rcyBP (4980-4820 B.P.) to 220 ±50 rcyBP (AD 1740-1800) (Benedict 1996). Although some dates are Archaic in age, the majority date to the Late Prehistoric. The Murray game drive (5BL65) has two reported radiocarbon dates of 970 ±100 rcyBP (A.D. 985-1170) and 670 ±150 rcyBP (A.D. 1210-1430) along with 22 (out of 25 total) projectile points attributed to the Hogback phase (Benedict 1975a). Lichenometric studies were also undertaken at the Murray site by Benedict (1967) to establish a lichen-growth curve for the Front Range and while the site cannot be directly dated by the growth curve, as it serves as a control point for the curve, extrapolation from data from a rock glacier in Arapaho Cirque suggests an age of 1,000-900 rcyBP for the wall (Benedict 1975a). Late Prehistoric projectile points are also the dominant type found at the Olson site; 19 of the 23 projectile points from the assemblage are Late Prehistoric, including Hogback points, Plains and Prairie side-notched points, and Plains tri-notched points (LaBelle and Pelton 2013).

There is limited evidence for Protohistoric (or Late Ceramic) (A.D. 1540-1860) use of alpine game drives in Colorado. A few of the radiocarbon dates listed above do fall within this period, but the radiocarbon calibration curve for this period is not reliable for tight dating and drawing conclusions from these dates would be premature. An overall lack of ethnographic evidence strongly suggests that this hunting strategy was largely abandoned by the time Euroamericans penetrated the Colorado mountains, possibly due to the introduction of the horse. However, the account of John Q.A. Rollins' (Rollins 1873, in LaBelle and Pelton 2013) finding a wooden bow laying among rocks near features at Rollins Pass suggests an occupation and possible use of the sites predating 1873 by several centuries at most (LaBelle and Pelton 2013). Additionally, a small glass bead was recovered from within a blind at 5BL148 and indicates a post-1835 occupation of the site, possibly around 1850 based on von Wedell's (2011) glass bead chronology (LaBelle and Pelton 2013).

CHAPTER 3 - THEORY AND METHODS

This chapter describes the theory and methods used to gather, analyze, and interpret the data presented in the following chapters. The chapter begins by describing the theoretical perspective that guided the analysis and conclusions presented in the following chapters. The methods used to gather and analyze the data are then described. Together, these form the basis upon which the rest of the thesis is built.

Theoretical Perspective

Human behavioral ecology is the study of human behavior and its diversity through the application of models and concepts derived from evolutionary ecology. The overarching tenet of human behavioral ecology (HBE) is to discover how the development of modern human behaviors reflects the species' history of natural selection (Cronk 1991). As such, HBE attempts to explain the behavioral differences of both contemporary and archaeological populations as a consequence of environmentally contingent responses of individuals attempting to maximize their fitness (Hames 2001). Drawing parallels to the biological aspect of natural selection, behaviors which enhance the fitness of individuals, dictated by environmental constraints, are selected for over behaviors that are maladaptive to a specific environment. The underlying Darwinian assumption of HBE is that natural selection has created organisms to respond to local environmental conditions in the most fitness-enhancing ways (Smith and Winterhalder

1992). In this way, HBE is the study of human behavior from an adaptive perspective (Nettle et al. 2013).

High elevation game drives along the Continental Divide in Colorado's Front Range represent a sophisticated and intensive form of food resource procurement for native populations. Game drives exist at or above timberline along exposed ridges adjacent to passes over the Continental Divide and far from any location where year-round habitation is possible. Because the construction of game drives denotes a significant investment of time and energy by native populations, it is important for the archaeological interpretation of the area to better understand the reason for such time and energy investment in constructing a human-made environment to procure food resources.

The broad research question regarding game drives asks what is the underlying impetus for native populations to invest time and energy in constructing game drives far from year-round habitation locations, such as the Great Plains, and in such extreme environments often encountered above tree-line in the Front Range. This broad question speaks to the ongoing debate among regional archaeologists as to the complex, multifaceted, and ever-changing relationship between mountains and people. Understanding this relationship may help elucidate the reasons behind the seemingly intensive use of mountain environments by early populations. Human behavioral ecology is a useful method for evaluating such reasons. It can be used to provide a baseline of assumptions and predictions about the use of game drives in the procurement of food resources, against which various hypotheses can be tested. The baseline is not of interest; it is the deviation from this baseline that is interesting.

Historical Background

Human behavioral ecology grew as an extension of the emphasis of behavioral ecology on evolutionary biology and animal behavior in the 1960s and 1970s (Borgerhoff Mulder and Schacht 2012; Cronk 1991). Human behavioral ecology draws upon theory and methods developed in three different fields of research to explain adaptive variation in human behavior (Smith and Winterhalder 1992). From evolutionary biology, HBE incorporated models anchored in the basic principles of Darwinian natural selection. From economics, HBE adopted the concepts of optimization theory and game theory. From anthropology, HBE borrowed ethnographic research methods. Human behavioral ecology developed as a reaction to the foundation laid by cultural ecologists such as Julian Steward (1955) who had reestablished the relationship between society and environment as a legitimate subject of study (Cronk 1991; Smith 1983). The early goals of HBE were to set the cultural ecological work of Steward and others on sounder theoretical footing by allying it with neo-Darwinian approaches to behavior (Winterhalder and Smith 2000). Archaeologists adopted HBE to study hunter-gatherer subsistence, resource transport, and subsistence-related changes in technology (Bird and O'Connell 2006) through the use of optimal foraging strategy and prey choice models (Hames 2001).

Human Behavioral Ecology and the Acquisition of Food Resources

Behavioral ecology explanations for patterns of human behavior focus on both function and adaptation and are concerned primarily with the fitness implications of certain behaviors (Bird and O'Connell 2006). This approach identifies potential behaviors, assesses fitness related costs and benefits of the potential behaviors, and ultimately creates a hypothesis about which behavior is most likely to be adopted given a certain set of environmental constraints (Bird and O'Connell 2006). One arena in which this behavioral ecology approach plays out is in the acquisition of food resources among hunter-gatherers.

Human behavioral ecology approaches to the acquisition of food resources operate from a series of models and hypotheses that can then be tested empirically (Smith and Winterhalder 1992). These models and hypotheses serve as predictions which identify the basic qualities of adaptive solutions given a set of environmental features (Winterhalder 1981). To observe these qualities, HBE models emphasize generality and strive to be as simple as possible (Smith and Winterhalder 1992; Winterhalder and Smith 2000). To achieve generality, models identify the essential components of adaptive strategies (Borgerhoff Mulder and Schacht 2012). In doing so, HBE models analyze the complex behavioral phenomenon of humans in a reductionist fashion (Smith and Winterhalder 1992). In using this reductionist strategy, human behavioral ecologists partake in the phenotypic gambit, the proposition that natural selection will favor behavioral variants that most efficiently solve fitness-related tradeoffs (Bird and O'Connell 2006). To do this, various aspects of human behavior are reduced to discrete categories of analysis. Once reduced to discrete categories, researchers can use these models to predict optimal behavioral strategies of human actors given a specific set of environmental conditions (Borgerhoff Mulder and Schacht 2012).

Optimization theory in human behavioral ecology combines neoclassical economic concepts of optimization with postulates of synthetic evolutionary theory (Smith and Winterhalder 1992; Winterhalder 1981). Optimization models are built around a hypothetical actor, allowing researchers to generate testable hypotheses about the potential behavioral variation of the actor when faced with differing environmental constraints and/or goals (Cronk 1991). The balance of cost and benefit inherent in optimization theory underlies all ecological thought in anthropology (Bettinger 1991). This is especially evident in optimization models regarding hunter-gatherers, which rely heavily on the Darwinian conception of natural selection (Bamforth 2002). While HBE's view of behavior as a balance of costs and benefits is applicable to many domains of human behavior, archaeology has focused on optimization models regarding diet and foraging behavior (Bettinger 1991). The most widely applied optimization model of foraging behavior is optimal foraging theory.

Optimal foraging theory (OFT) specifies a general set of decision rules for human actors based on cost-benefit considerations of food acquisition which most benefit the overall fitness of that individual (Smith 1983). The underlying assumption of OFT is that hunter-gatherers have a goal to maximize their net return while foraging because it ultimately maximizes their fitness and, thus, behave accordingly in predictable ways (Hames 2001). Seen from a Darwinian perspective, in the direct and indirect competition for resources of a particular environment, individuals with the most efficient techniques for acquiring energy and resources are at an evolutionary advantage because they can produce more offspring (Winterhalder 1981). In this way, OFT is anchored by an assumption derived from views of adaptations via natural selection: that foraging behavior has been shaped by natural selection to respond to changing environmental conditions in ways that yield the greatest benefit to the fitness of the individual (Smith 1983). Inherent in OFT models is the assumption that the successful acquisition of food resources is directly related to the overall fitness of an individual.

Optimal foraging theorists are primarily concerned with the forager's choice of food items or with the range and variety of items harvested within a given environment (Winterhalder 1981). This has been termed the optimal diet (Winterhalder 1981). Optimal foraging theory gives researchers a set of fundamental hypotheses that predict which food resources foragers will pursue during a search, how far they will travel for resources, and how long they will stay in these resource patches before moving on to another location (Borgerhoff Mulder and Schacht 2012; Hames 2001). These hypotheses provide data on the optimal hunter-gatherer foraging expedition within an environment. These data then form baseline predictions that can be directly tested against observed archaeological patterns of behavior (Smith 1983). Hill and Kaplan (1992) describe the two types of data that can be derived from OFT models: qualitative and quantitative. Qualitative data predicts directional tendencies in prey choice by showing that diet breadth will expand or contract depending on encounter rates of the most profitable species (Hill and Kaplan 1992). In other words, if profitable species are encountered at a high rate, hunter-gatherers will restrict their diet to those profitable species; likewise, low encounter rates result in an expansion of diet breadth to fulfill the nutritional needs of the individual. Quantitative data predict the number of species a forager will pursue given a specific environment and provide a rank-order of prey species within that environment (Hill and Kaplan 1992). These two types of data combine to form an optimal diet in a given environment and provide the researcher a foundation to build optimal foraging models. One such model that results directly from qualitative and quantitative data is the prey choice model.

Prey choice models and hypotheses are derived from four categories related to food acquisition: the goal of the forager, currency, constraints, and the decision or trade-off of the forager (Bird and O'Connell 2006; Winterhalder and Smith 2000). As mentioned earlier, the goal of the forager in OFT models is to maximize the rate of resource return; the same is true for prey choice models (Hames 2001). The currency with which these models operate is generally the energy derived from the acquired resource usually in calories (Bird and O'Connell 2006). Constraints in prey choice models are environmental limitations on resource patches and prey types within a foraging range (Bird and O'Connell 2006). The decision of the forager in prey choice models will be to either procure a prey type upon an encounter or to bypass it in search of a more profitable item (Bird and O'Connell 2006). Prey choice models are derived directly from optimization theory and optimal foraging theory. They represent the optimal behavior expected in a given environment that is the most beneficial for the acquisition of food resources and, thus, most beneficial to the reproductive fitness of the individual.

Conclusion

The application of human behavioral ecology to the study of high elevation game drives in the Colorado Front Range may help explain their existence and use. It provides a set of baseline assumptions which can then be tested against archaeological data. It is not necessarily the degree to which the data agree with the baseline assumptions that is important, but rather it is the deviation from the assumptions which is of most interest.

Human behavioral ecology approaches to hunter-gatherer forager behaviors argue that selective forces, in the Darwinian sense, will select for individual behaviors which are most suited to the acquisition of food resources in a particular environment, thus increasing the overall fitness of the individual. From this approach, the use of game drives, and the high country in general, represents the most efficient human behavioral adaptation for the acquisition of food resources. The optimization of the foraging strategy is a key component of human behavioral ecology. The implication of human behavioral ecology for human behaviors related to the use of the high country is that, despite the difficulty of access and the relatively short habitation time, it is still cost-effective for human groups to exploit the mountain resources during the summer months rather than stay in the low elevations where they presumably spend the winter months.

Prey choice models provide a rank-list order of plant and animal resources that would be procured when encountered. Generally, plants and animals higher on the list would be procured more often and in higher numbers than those lower on the list. Archaeological data can be used to test this baseline assumption. If the optimization prey choice model holds, archaeological assemblages from the Colorado Front Range should contain a higher proportion of the most desirable floral and faunal remains. The implication for interpretations of the construction and use of game drives is that drive systems should be constructed to take advantage of the most profitable animals. It would be expected that the construction of game drives would increase the encounter rate with high ranking animals and, thus, increase the overall fitness of the individuals involved in such endeavor.

The strength of human behavioral ecology is its ability to provide a set a fundamental models and hypotheses which can be tested using archaeological data. Human behavioral ecology argues that humans act in the most rational way possible, thus optimizing their foraging effort. Obviously, this is rarely the case. It is the deviations from these optimization models that can be most informative to archaeological interpretation, not the models themselves. As such, using HBE to provide baseline predictions about human foraging behavior is a worthwhile endeavor for the study of the function of game drives in the Front Range.

Methods of Analysis

This section discusses the primary field methods used for data collection in the field during the two primary periods of fieldwork. Methods for laboratory analyses are discussed in their respective sections.

Olson and Benedict

Byron Olson and James Benedict initiated systematic research at Rollins Pass when they began recording a variety of game drive sites in the area, including 5BL145, 5BL146, 5BL147, and 5BL148, all located on an east/west trending finger ridge immediately south of Rollins Pass, in addition to the three under investigation in this thesis (Benedict 1969, 1971; Olson and Benedict 1970). Reports written for the Forest Service and the Smithsonian Institution do not distinguish field methods utilized between the sites; it is assumed that the described field methods were applied to all sites they investigated at Rollins Pass. This research included site mapping, surface survey and collection, and excavation.

Mapping efforts began in 1969 with the preparation of a topographic base map prepared photogrammetrically from aerial photographs and ground-control surveys (Benedict 1969). The resulting base map included a 16.3 kilometer^2 area along the Continental Divide around Rollins Pass (Olson and Benedict 1970). The following field season, Olson and Benedict began mapping site features (blinds, walls, and cairns) identified during survey. Using photogrammetricallyplotted ground control panels as instrument stations, Olson and Benedict used approximately 850 survey shots to produce a theodolite survey of the site features (Olson and Benedict 1970). Features were mapped and field sketched at a scale of 1:1,200 and later transferred at a reduced scale to the 1:6,000 topographic base map. A subset of the resultant map can be seen above in Figure 1.5. Mapping of the sites was limited to features and did not include the geographic coordinates of artifacts recovered during surface survey of the sites.

Methods of surface survey are not well described in the reports. It is likely that surface survey was systematic (as evidenced by the number of artifacts collected and features recorded at the sites) but the specifics of survey are unknown. Surface artifacts were recorded and collected and most are curated at the Center for Mountain and Plains Archaeology at CSU (a few artifacts are missing; see discussion in the following chapter). Surface artifacts are primarily projectile points, although scrapers, bifaces, chipping debris, and sandstone grinding slabs have also been surface collected. As mentioned above, the geographic location of artifacts was not recorded (other than to the general site). However, Olson and Benedict (1970:19) do mention that "with few exceptions, artifacts have been widely scattered, rather than occurring in concentrations".

One of the major undertakings of Olson and Benedict's research during this period was the excavation of six hunting blinds at 5GA35. Excavation techniques were specialized, adapted to the tundra environment and its preservation, yet flexible enough to be applied to the features of the sites (Olson and Benedict 1970). Excavation procedures minimized disturbance to the tundra and insured a maximum preservation of the site; all blinds were backfilled after excavation and restored as close as possible to their original condition and walls were rebuilt where disturbed (Olson and Benedict 1970). Before excavation, each blind was photographed from several angles and described on a standard form which included maximum interior and exterior diameter, interior and exterior blind height, blind wall preservation, and the geomorphic environment (Olson and Benedict 1970). A stake was then placed in the center of the blind along an upslope-downslope bisecting line to serve as a reference point for future measurements. One-half of each blind was excavated by natural stratigraphic units and by arbitrary 2.5 centimeter levels within these units (Olson and Benedict 1970). The hand drawn plan map shown in Figure 1.5 shows the portion of the blind that was excavated (depicted by shading). In addition, all features encountered within the blind, such as hearths, were treated as separate stratigraphic units (Olson and Benedict 1970). All material removed during excavation was dry screened and retained for backfilling.

Artifacts and features encountered during excavation were mapped in place and their stratigraphic context was recorded on standard forms. Artifacts and chipping debris were bagged by unit and level. When charcoal was encountered, its occurrence and character were recorded and its distribution mapped. Bulk charcoal samples were collected for radiocarbon dating and for the analysis of carbonized plant remains, taking care to avoid contamination by cinders from the old Rollins Pass railroad (Olson and Benedict 1970). When large rocks were encountered during excavation, they were mapped and observations on their weathering characteristics were made before removal.

At the base of the occupation level, the exposed floor was described and a stratigraphic profile was drawn along the established baseline. For each stratigraphic unit, textural samples and Munsell soil colors were recorded. The profile was extended through the walls of the blind, necessitating the trenching of walls and small areas outside the blind (Olson and Benedict 1970). In the preparation of the profile drawing, all wall rocks were mapped in place, noting their basal depths and stratigraphic positions (Olson and Benedict (1970). This insured each rock could be replaced as near its original location as possible when excavation and recording was complete.

After fieldwork and the initial reporting to the Smithsonian Institution and the United States Forest Service, these sites were never formally published. LaBelle and Pelton (2013) have since published on the Olson site (5BL149) and this thesis presents data on 5GA35, 5GA36, and 5GA37. Unfortunately, a majority of the paperwork and fieldnotes associated with Olson and Benedict's research at Rollins Pass, with the exception of a few maps, has been lost to time.

Center for Mountain and Plains Archaeology

Ongoing research at 5GA35, 5GA36, and 5GA37 conducted by LaBelle and the Center for Mountain and Plains Archaeology focuses on intensive surface survey to gain an explicitly spatial understanding of the sites. Survey was conducted to re-map the sites using modern GPS technology and gather NAD27 UTM coordinates for features and artifacts and also to expand the artifact collection to gain a better understanding of the use of the sites. This survey includes revisiting and re-recording features previously recorded by Olson and Benedict and recording new features and artifacts using updated forms. To aid in relocating blinds and walls originally recorded by Olson and Benedict, a subset of the original 1:6,000 topographic map (see Figure 1.5) was uploaded and digitized in *ArcGIS 10.4*. Each feature, both relocated features and new features, was recorded using an updated standard form which included geographic coordinates, morphometric measurements, including maximum and minimum interior width, maximum exterior width, depth, orientation of maximum width, orientation of opening (if present), and pit shape, and an extensive comment section, including discussions about associated artifacts, contents of pit fill, connection to walls, cairns, or other blinds, lichen growth, viewshed, etc. Select walls were re-mapped using GPS tracking and new walls were recorded in a similar fashion. Not all previously recorded walls were recorded in this way as it was found that Olson and Benedict's mapping efforts were highly accurate. All artifacts found during survey were recorded and all projectile points, other chipped stone tools, and any artifacts in association with a blind were collected. All other artifacts (mostly debitage) were field recorded but not collected. For collected artifacts, geographic coordinates and preliminary measurements of size were recorded, and an overview photograph of the artifact location was taken. For non-collected artifacts, geographic coordinates, field measurements of size, raw material type, presence of cortex, and evidence of burning were recorded.

Intensive survey was undertaken in 25x25 meter blocks which utilized UTM coordinates to create a grid system for the sites and surrounding terrain (Figure 3.1). Grids were selected for survey (shown in dark blue) based on their proximity to known features or activity areas or in high potential areas away from the sites. This methodology provides both positive and negative data regarding where artifacts are located within and near the sites and, thus, more strongly supports arguments about where activities are or are not occurring. Crew members were instructed to survey using one to two meter intervals, resulting in roughly 15 passes through each survey block. Survey notes were recorded for each block, noting the presence of any cultural features and/or artifacts (blinds, walls, cairns, tools, chipping debris, etc.), environmental features (naturally moist area, game trail, hiking trail, etc.), general

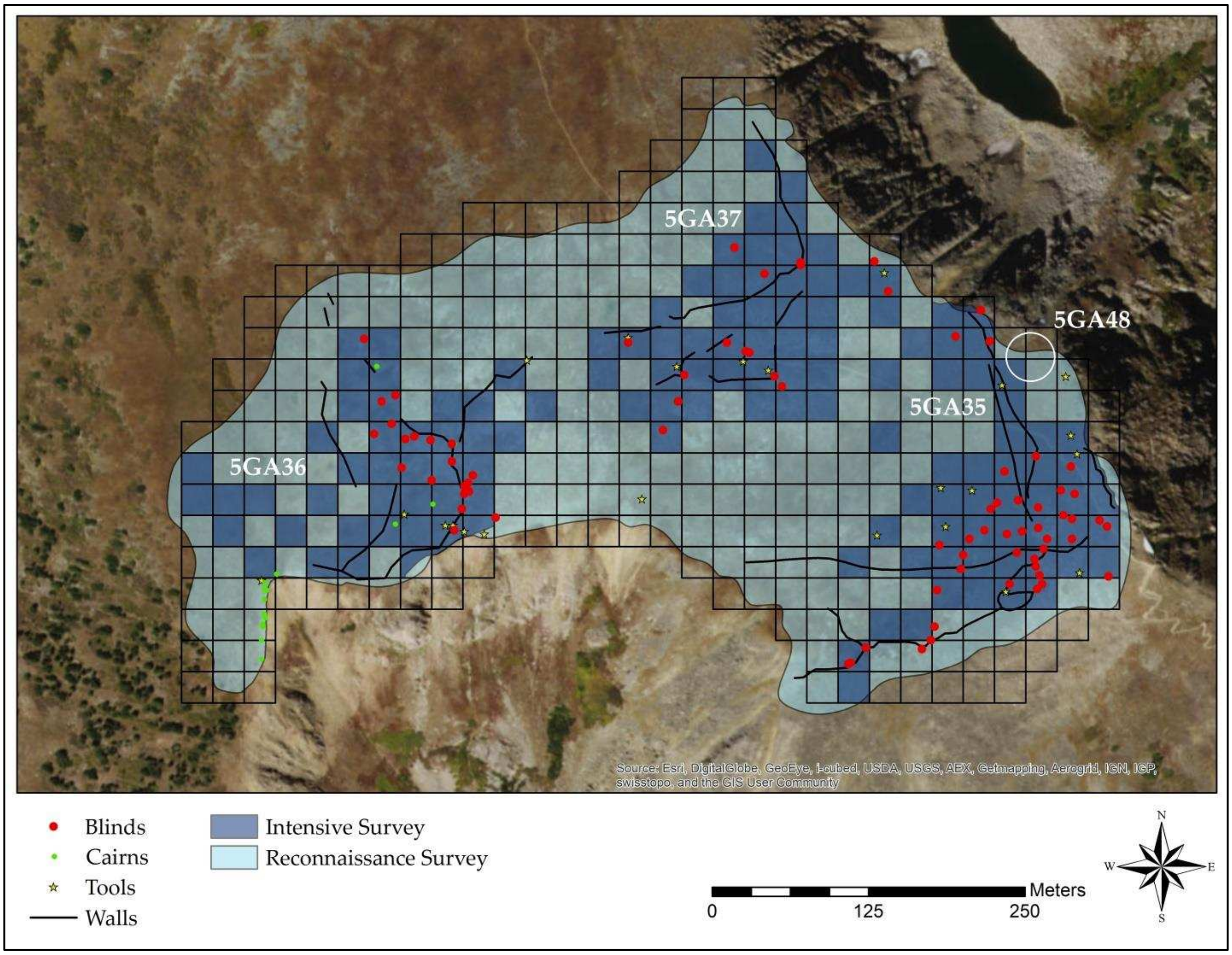


Figure 3.1: Map of survey coverage as of September 2015.

environmental characteristics (density of ground cover, presence of talus/boulder fields, slope, aspect, etc.), and a sketch map was drawn. The light blue area shown on the map (Figure 3.1)has been surveyed at a reconnaissance level, oftentimes undertaken while walking between sites. Features and artifacts encountered during this survey were recorded using the standard forms outlined above but did not necessarily mean that area would be more intensively surveyed.

CHAPTER 4 - THE ARTIFACT AND FEATURE ASSEMBLAGE

This chapter describes the artifact and feature assemblage from the sites. The object of this chapter is to describe and describe the assemblages so as to allow for additional questions to be addressed in later chapters. One of the primary goals of this chapter is to establish a chronology for the sites under investigation. While studying site chronology is not the primary goal of this thesis, it does place the game drive sites within the context of other game drives in the Front Range. Analysis of non-diagnostic artifacts is used in later chapters to address questions regarding site use.

The artifact assemblage is composed of material surface collected and excavated by Olson and Benedict in the late 1960s and early 1970s (Benedict 1971; Olson 1971; Olson and Benedict 1970) and material surface collected by Jason LaBelle and the Center for Mountain and Plains Archaeology beginning in 2011. Figure 4.1shows the location of the blinds excavated by Olson and Benedict and there spatial relationship to other features of the drive system. The results of those excavations are presented in Table 4.1. Except where applicable, the excavated artifacts have been grouped with the surface artifacts for analysis. The artifact assemblage consists entirely of chipped stone artifacts; no bone has been collected from any of the sites. One piece of possibly modified wood was collected from 5GA35 in 2014; however, its cultural origin is questionable and, thus, has not been included in any additional analyses. A summary of artifacts by site can be found in Table 4.2. Complete tool and debitage data can be found in Appendixes A and B, respectively.

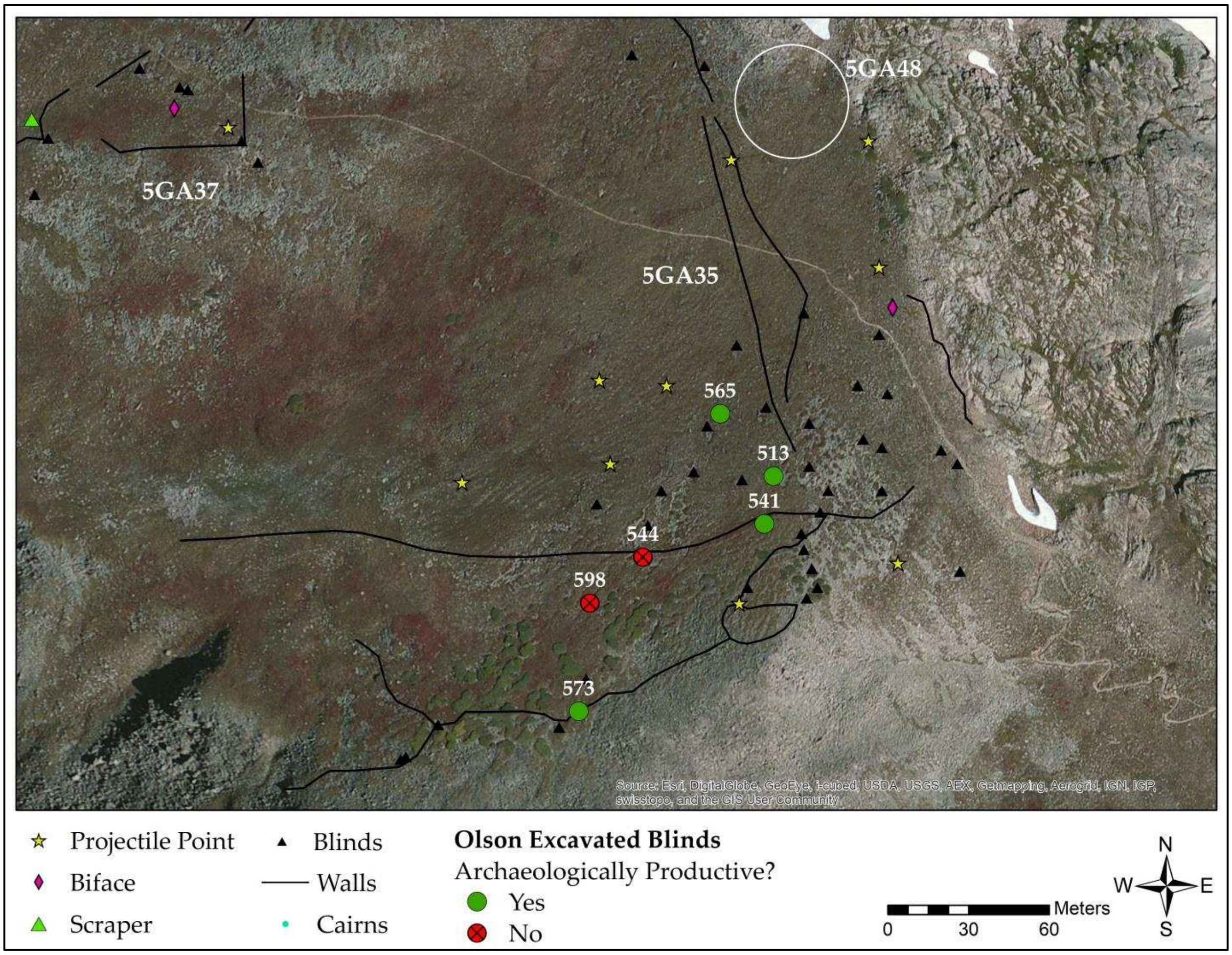


Figure 4.1: Overview map showing the location of blinds excavated by Olson and Benedict (1970).

Table 4.1: Quantity of artifacts excavated at 5GA35 by Olson and Benedict (1970). Note the missing total for pit 513; chipping debris is mentioned in the report but was either never collected, has been mislabeled since collection, or is no longer in the collection.

Pit ID	Projectile Points	Bifaces	Other Tools	Chipping Debris	Totals	Features
513	0	0	0	Yes	**?**	Possible hearth
541	1	0	0	0	**1**	None
544	0	0	0	0	**0**	None
564	0	1	0	0	**1**	None
573	3	0	1	178	**182**	None
598	0	0	0	0	**0**	None
Total:	**4**	**1**	**1**	**178+**	**184+**	

Table 4.2: Summary of artifact assemblage by site.

		5GA35	5GA36	5GA37	5GA4268	Total
Projectile Points	*Surface*	11	6	3	3	**23**
	Excavated	4	0	0	0	**4**
	Subtotals:	**15**	**6**	**3**	**3**	**27**
Bifaces	*Surface*	2	1	2	1	**6**
	Excavated	1	0	0	0	**1**
	Subtotals:	**3**	**1**	**2**	**1**	**7**
Scrapers	*Surface*	0	0	1	5	**6**
	Excavated	1	0	0	0	**1**
	Subtotals:	**1**	**0**	**1**	**5**	**7**
Other Tools	*Surface*	0	0	0	1	**1**
	Excavated	1	0	0	0	**1**
	Subtotals:	**1**	**0**	**0**	**1**	**2**
Utilized/Edge Modified Flakes	*Surface*	1	1	0	58	**60**
	Excavated	0	0	0	0	**0**
	Subtotals:	**1**	**1**	**0**	**58**	**60**
Debitage	*Surface*	22	0	1	71	**94**
	Excavated	178	0	0	0	**178**
	Subtotals:	**200**	**0**	**1**	**71**	**272**
Totals:		**221**	**8**	**7**	**139**	**375**

Projectile Points (n=27)

Twenty-seven projectile points and point fragments have been collected from the four sites from both excavated and surface contexts, a fairly modest number given the overall size and apparent length of use of the sites. Similarly sized sites such as the Olson site (n=44) (LaBelle and Pelton 2013) and the Flattop Mountain game drive (n>100) (Benedict 1996) have produced drastically more projectile points. Alternatively, the Sawtooth game drive, described by Benedict (1990) as "one of the most complex and extensive game-drive systems in the Colorado Front Range" (Benedict 1990: 59), has only 17 reported projectile points (Cassells 1995, 2000). A host of reasons can account for the wide variation in reported projectile point numbers, including intensity and/or repetition of prehistoric use of sites, looting by modern populations, or the artifacts still being buried, etc. Despite the relatively low number of projectile points, the four sites show five distinct typologies, demonstrating use from the early Archaic through Late Prehistoric periods (Table 4.3).

Table 4.3: Projectile point chronology organized by regional sequence and references.

Typology Name	Era	Projectile Form	Regional Date (calibrated)	Reference
Mount Albion	Early Archaic	Dart	4800 - 4200 BC	Benedict 1978a, 1978b, 1996, 2012; Olson 1978
Duncan/Hanna	Middle/Late Archaic	Dart	3400 - 1000 BC	Benedict 1981, 1990; Cassells 1995, 2000; Morris et al. 1985
Pelican Lake	Late Archaic	Dart	1250 BC – AD 230	Todd et al. 2001; Taylor 2006
Corner-Notched Hogback	Late Prehistoric	Arrow	AD 600 – 1000	Nelson 1971; Benedict 1975a, 1975b, 1996
Plains Side-Notched	Late Prehistoric	Arrow	AD 1100 – 1800	Gilmore 1999; Kehoe 1966; Kornfeld et al. 2010; Peck and Ives 2001

Table 4.4 shows the temporal trend for the occupation and use of each of the game drives and 5GA4268. Broadly, the data show a slight preference for use during the Archaic with 12 projectile points assigned to that period while the Late Prehistoric saw diminishing use, with eight projectile points assigned to that period. This apparent trend goes against the general trend described in Chapter 2, where it was shown that use of game drives reached its zenith during the Late Prehistoric period. It is also opposite of the pattern seen at the nearby Olson site (5BL147), where the Late Prehistoric period is heavily represented; however, the site shows use since the Early Archaic (LaBelle and Pelton 2013). More specifically, the data show that 5GA35 shows evidence of use through all represented periods. This is perhaps unsurprising, as the site

is the largest of the three drive sites at this location (features are discussed below) and likely saw several periods of construction or reconstruction of site features. Site 5GA36 shows sporadic use since the Early Archaic. Sites 5GA37 and 5GA4268 are represented by only a single projectile point and show possible Archaic use (5GA37) and use during the Late Prehistoric (5GA4268). The temporal trends for the sites also indicate they were likely not used simultaneously or contemporaneously but, rather, functioned as individual drives as the need arose. Because of overall low sample size, it is difficult to draw conclusive conclusions from this data regarding the temporal use of the sites. Low sample sizes are more easily influenced by abnormalities of the sample which may be attributed to a host of post-depositional processes, including but not limited to differential taphonomic processes affecting site formation and artifact collection by modern people.

Table 4.4: Temporal trends for occupation and use of the game drives and 5GA4268.

	Typology						
Site	**Mount Albion**	**Duncan/ Hanna**	**Pelican Lake**	**Unassigned Archaic**	**Hogback Corner-notched**	**Plains Side-notched**	**Unassigned Late Prehistoric**
5GA35	3	3	2	0	3	1	0
5GA36	1	0	2	0	1	0	0
5GA37	0	0	0	1	0	0	1
5GA4268	0	0	0	0	1	0	1
Totals:	**4**	**3**	**4**	**1**	**5**	**1**	**2**

Mount Albion (n=4)

The Mount Albion typology is represented by four dart points from two sites; three from 5GA35 and one from 5GA36 (Figure 4.2). With the exception of specimen 35.99, all dart points

Figure 4.2: Projectile points diagnostic of the Mount Albion typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

in this category compare to other Mount Albion sites throughout the Indian Peaks and Rocky Mountain National park. Variations in size, blade shape, and symmetry are primarily the result of repeated reuse and resharpening or from secondary use as hafted butchering tools (Benedict 1978a). All four dart points are missing the tip and this was likely the cause of discard. Specimen 35.89 is an all but complete dart point made from a light brown petrified wood. The base is convex with an expanding stem and the blade form is ovate. Specimen 35.91 is a near complete dart point made from Troublesome Formation chert. The base is convex with a slightly expanding stem and the blade form is triangular. The specimen is missing a portion of both ears and notches as the result of snap fractures. Specimen 35.99 is a large dart point made from a tan quartzite. The base convex with a slightly expanding stem; the corners of the base are broken. The specimen has straight, serrated blade edges. No Mount Albion projectile points reported from northern Colorado exhibit blade serration; therefore it is tentatively assigned as Mount Albion, mainly due to the morphology of the base. Specimen 36.6 is a midsection and partial base of a dart point made from Troublesome Formation chert. The specimen is corner-notched with an expanding stem and a triangular blade form. This projectile point is tentatively classified as Mount Albion.

Duncan/Hanna (n=3)

The Duncan/Hanna typology is represented by three dart point bases from 5GA35 (Figure 4.3). The specimens are represented by only the basal portion and two specimens completely lack any identifiable notches or ears to conclusively assign these to this typology. They roughly compare to McKean complex points found at other sites in the Indian Peaks (Benedict 1981, 1990; Cassells 1995, 2000) and along the Front Range (Morris et al. 1985). It is noted that the specimens are considerably smaller than other examples of this type found elsewhere but are otherwise comparable in morphology to other examples of this type. Specimen 35.81 is a dart point base made from petrified wood. It has a concave base with an apparent expanding stem. Notch and blade morphology are unknown. Specimen 35.82 is a dart point base made from a tan chert. The base is concave with an expanding stem. Blade edges appear to be straight but heavy reworking has drastically reduced the overall length. Specimen

35.92 is a dart point base made from a red chert. It has a concave base and an apparent expanding stem. Notch and blade morphology are unknown. Specimens 35.81 and 35.92 may have been discarded after being broken in the haft; 35.82 appears to have been discarded after extensive reworking.

Figure 4.3: Projectile points diagnostic of the Duncan/Hanna typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

Pelican Lake (n=4)

The Pelican Lake typology is represented by four dart points, two each from 5GA35 and 5GA36 (Figure 4.4). The dart points compare to other nearby sites at Rollins Pass (LaBelle and Pelton 2013), sub-alpine campsites in the Rawah Wilderness, and from the western Great Plains (Todd et al. 2001). Specimens are distinguished from similar (arrow point) looking forms by a greater than 10 millimeter notch width and greater than 20 millimeter shoulder width (Shott 1997). Specimen 35.85 is a dart point made from Troublesome Formation chert. The base it partially broken but it appears to be straight in morphology with an expanding stem. Blade shape is triangular with serrations. The tip is snapped off and was likely the reason for discard. Specimen 35.88 is a near complete dart point made from Troublesome Formation chert. The base is straight with a greatly expanding stem. Blade shape is triangular with light serrations. The tip is snapped off and was likely the reason for discard. Specimen 36.3 is a complete dart point made from a white chert. The base is straight with an expanding stem. Blade shape is triangular with possible light serrations. Given its completeness, this dart point was likely lost. Specimen 36.4 is a near complete dart point made from a red Middle Park chert. The base is straight to slightly convex with an expanding stem. Blade shape is triangular with possible light serrations. The tip and one ear are snapped off and likely the reason for discard.

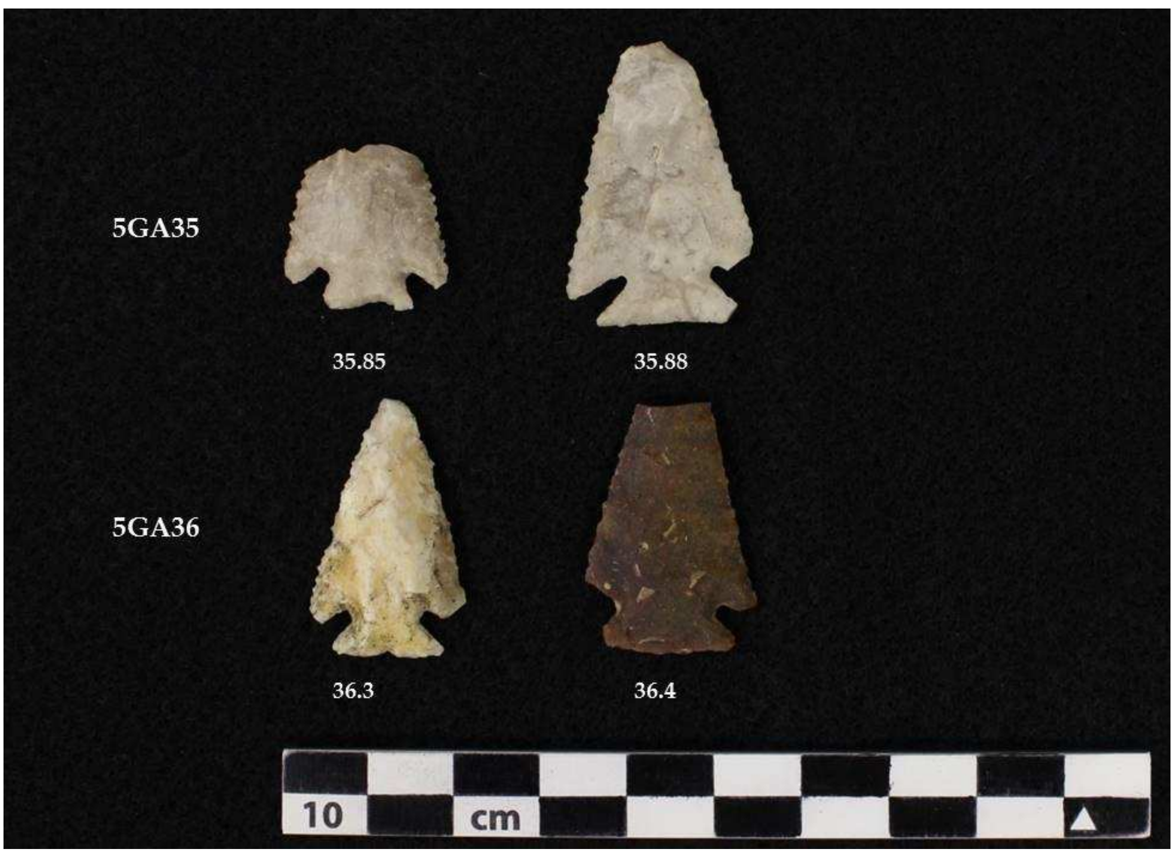


Figure 4.4: Projectile points diagnostic of the Pelican Lake typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

Unassigned Archaic (n=1)

Specimen 37.3 is an unassigned Archaic dart point made from Troublesome Formation chert (Figure 4.5). The width of the neck and shoulders strongly suggests the specimen is a dart point (Shott 1997), but the missing base makes assigning a specific typology difficult. Base morphology is indeterminate. The stem appears to be expanding. Blade shape is triangular. The specimen is missing the tip and a majority of the base and was likely discarded for this reason.

Figure 4.5: Projectile point of an unassigned Archaic type. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

Hogback Corner-notched (n=5)

The Hogback corner-notched typology is represented by five arrow points, three from 5GA35 and one each from 5GA36 and 5GA4268 (Figure 4.6). The arrow points compare to numerous other sites in the Rollins Pass area (LaBelle and Pelton 2013), Indian Peaks (Benedict 1975a, 1975b), Rocky Mountain National Park area (Benedict 1996), and nearby western Great Plains (Nelson 1971). Specimen 35.83 is an arrow point base made from petrified wood. The base is convex with a slightly expanding stem. The specimen is snapped just above the shoulders. This break was likely the reason for discard. Specimen 35.96 is a near complete arrow point made from Troublesome Formation chert. The base is straight with an expanding stem. Blade shape is triangular. The tip and lateral portion of the base are snapped off and was likely the reason for discard. Specimen 35.100 is an arrow point made from a brown chert. The base is straight with an expanding stem. Blade shape is triangular. The tip and one lateral portion of the base are snapped off and was likely the reason for discard. Specimen 36.7 is an arrow point made from Troublesome Formation chert. The base is straight with an expanding stem. Blade

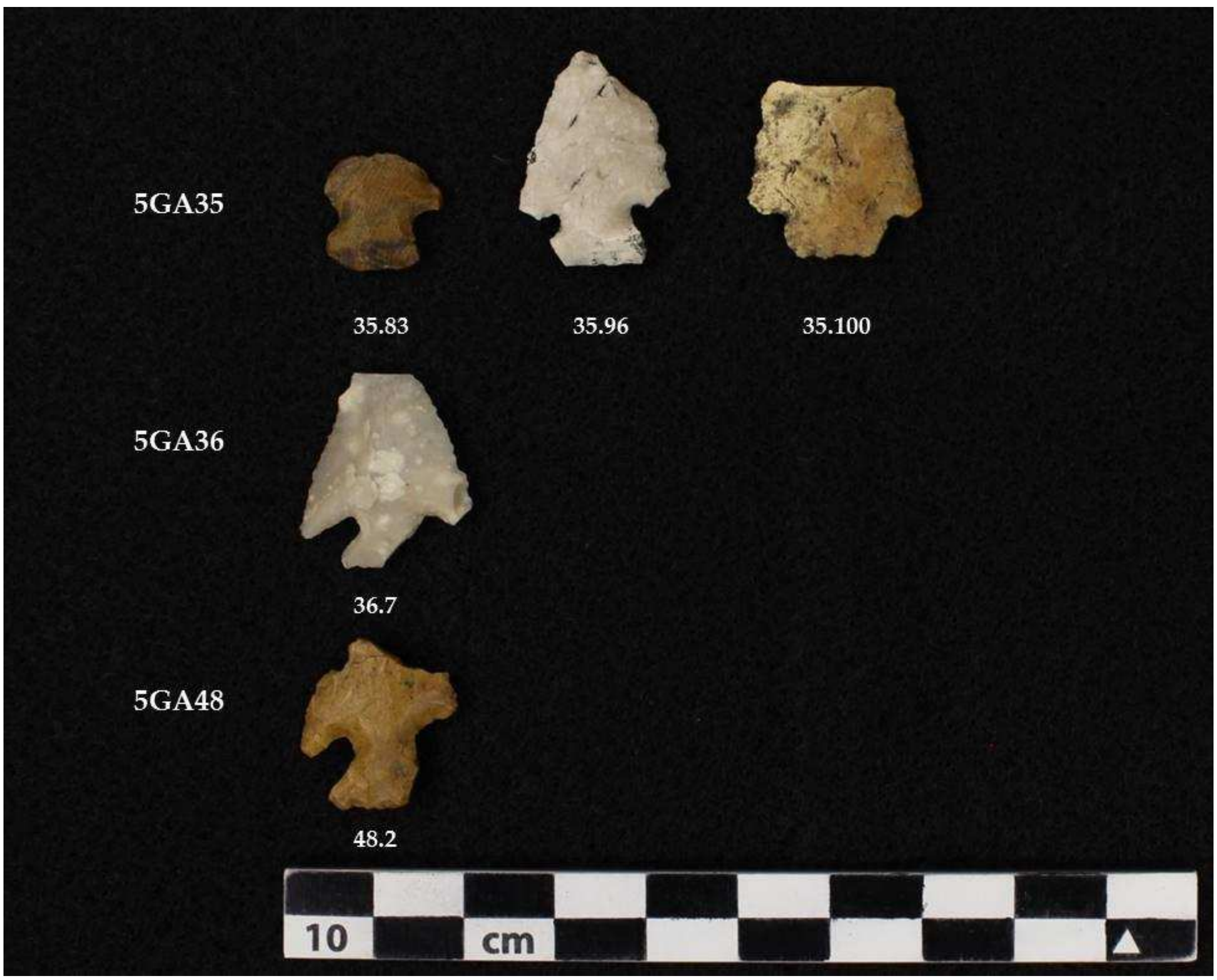


Figure 4.6: Projectile points diagnostic of the Hogback corner-notched typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

shape is triangular. The specimen is missing the tip and one lateral portion of the base and was likely the reason for discard. Specimen 48.2 is an arrow point made from Middle Park chert. The base is straight with an expanding stem. Blade shape appears to be triangular to ovate although the specimen is snapped just above the shoulders. One lateral portion of the base is also missing. Together, these are likely the reason for discard.

Plains Side-Notched (n=1)

The Plains Side-Notched typology is represented by a single arrow point from 5GA35 (Figure 4.7). The projectile point compares to points from the Olson game drive (LaBelle and Pelton 2013) and to sites on the nearby western Great Plains (Gilmore 1999; Kehoe 1966; Kornfeld et al. 2010; Peck and Ives 2001). Specimen 35.95 is a near complete arrow point made from a clear chalcedony. The base is straight with an expanded stem. Blade shape is triangular to ovate with a snapped tip, which is likely the reason for discard.

Figure 4.7: Projectile points diagnostic of the Plains Side-Notched typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

Unassigned Late Prehistoric (n=2)

Two arrow points are of unassigned Late Prehistoric types (Figure 4.8). Overall size and morphology was used to determine affiliation with the Late Prehistoric (Shott 1997). Specimen 37.2 is an arrow point base made from a red chert. Only a small portion of the base and one notch is present. Base, stem, and blade morphology are indeterminate. The degree of breakage and/or reworking is the likely reason for discard. Specimen 48.1 is an arrow point base made from Middle Park chert. The base is straight to slightly convex with an expanding stem. Blade morphology is indeterminate. The tip and lateral portion of the shoulder, neck, and base are snapped and likely the reason for discard.

Figure 4.8: Projectile point of an unassigned Late Prehistoric type. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

Indeterminate (n=8)

The remaining projectile points are of an indeterminate type (Figure 4.9). These specimens are characterized by tips and midsections, portions of the projectile point not temporally diagnostic. They were determined to be projectile points, as opposed to generic bifaces, by their symmetrical blade shapes. It must be noted here that 36.2 was initially assigned a specimen number associated with 5GA36. It was later discovered that this specimen clearly falls within the site boundary of 5GA35 and so has been grouped with 5GA35 here and for further analyses but was not reassigned a new catalog number. The specimens are represented

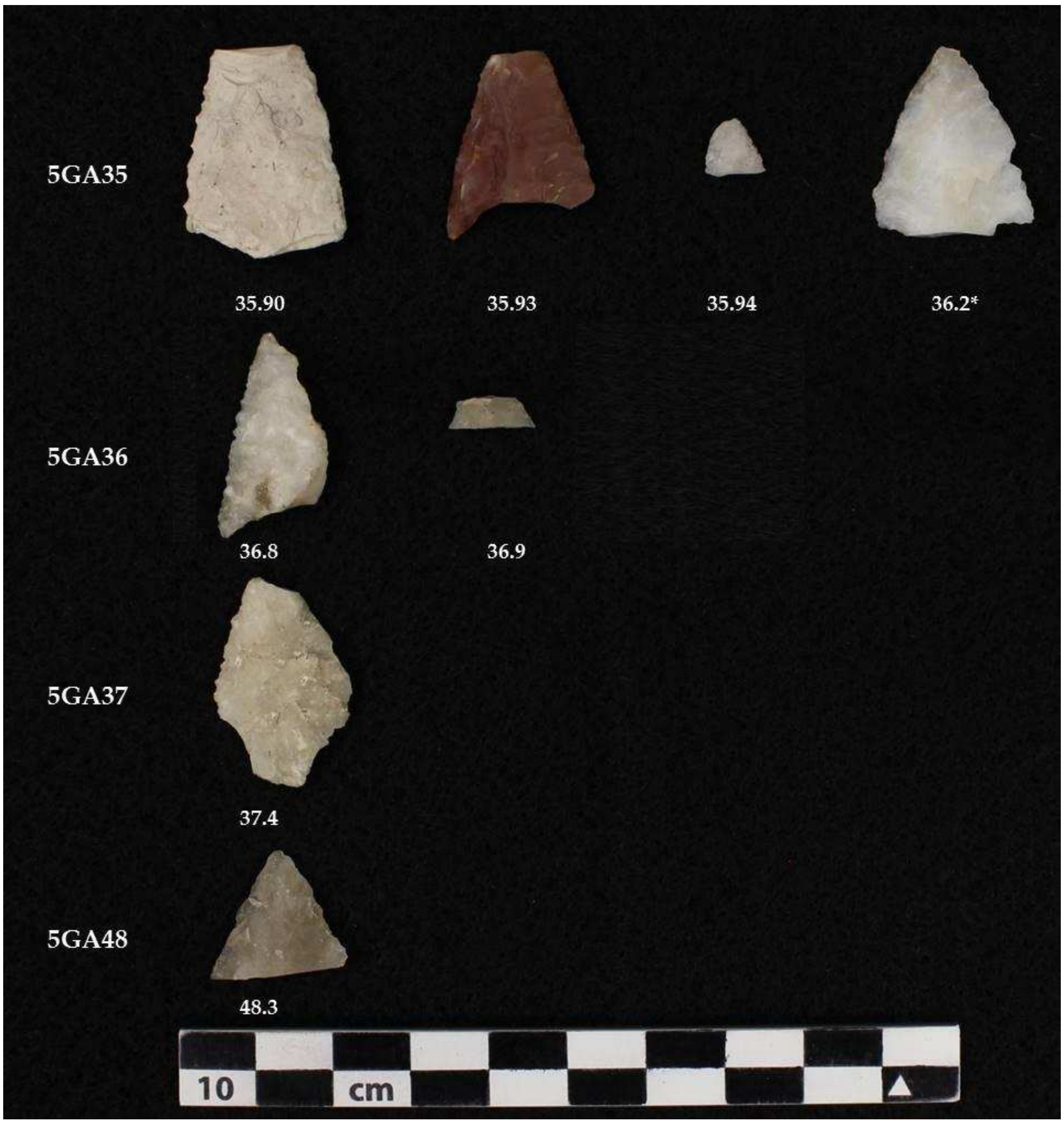


Figure 4.9: Projectile points of indeterminate typology. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

by four raw material types: Troublesome Formation chert (35.90, 35.94, 36.8, 37.4, and 48.3), Middle Park chert (36.2), a rose chert (35.93), and clear chalcedony (36.9). Two of specimens appear to have at least slight serrations along the blade margins (36.8 and 37.4). Three of the specimens have snapped tips (35.90, 35.93, and 37.4). The remaining specimens have varying degrees of breakage. Regardless of the type of breakage, this was likely the reason for discard of the artifact.

Bifaces (n=7)

There are six bifaces in the assemblage; three from 5GA35 and one each from 5GA36, 5GA37, and 5GA4268 (Figure 4.10). Bifaces are distinguished from projectile points here by their asymmetrical blade margins. Specimen 35.87 is an incomplete biface made from Middle Park chert. Flaking pattern is multidirectional from the edge margins. Specimen 35.97 is an incomplete biface made from a banded tan and white chert. Blade edges are straight and the biface has an overall triangular shape to it. It is possible it is the broken tip of a projectile point but also may have been a hafted or unhafted knife. The biface is laterally snapped. Specimen 35.98 is an irregularly shaped biface made from grey Windy Ridge quartzite. Flaking pattern in multidirectional from the edge margins. Specimen 36.5 is a small biface fragment made from tan Windy Ridge quartzite. Specimen 37.1 is a large incomplete biface made from Troublesome Formation chert. The blade is serrated along one lateral edge, suggesting this may have been a hafted or unhafted knife. The biface is snapped on both ends. Specimen 48.4 is a small biface fragment made from grey Windy Ridge quartzite. The flaking pattern is fairly regular and this

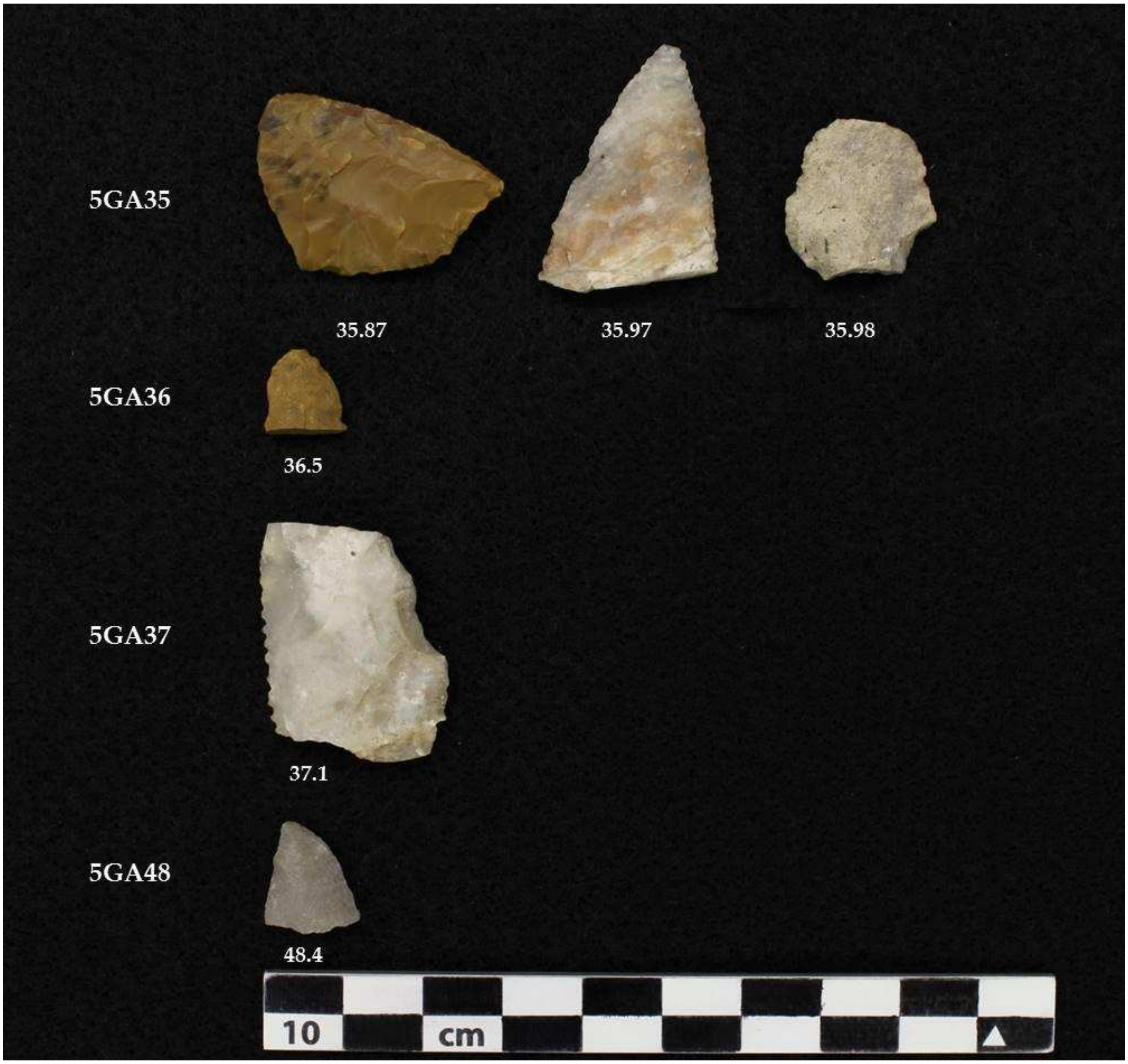


Figure 4.10: Bifaces collected from the game drive sites and 5GA4268. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

specimen may be a projectile point tip that through heavy reworking became asymmetrical. In addition to these bifaces, a double pointed knife is also reported in Olson and Benedict (1970) that is no longer in the collection (Figure 4.11). "The knife is extremely well made, with fine parallel pressure flaking along its blade edges. Its age and cultural affiliation are unknown" (Olson and Benedict 1970:17).

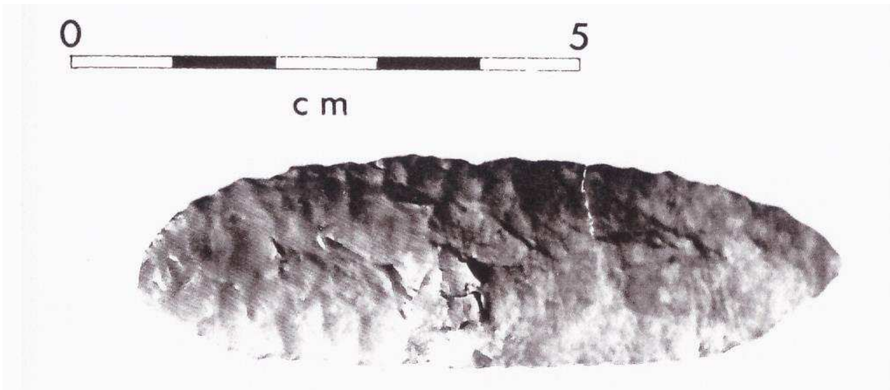


Figure 4.11: Biface excavated from pit 565 by Olson and Benedict and reported in Olson and Benedict (1970). The artifact has since been lost and is no longer in the collection. Original report and image scan on file at the Center for Mountain and Plains Archaeology.

Scrapers (n=6)

There are six scrapers in the assemblage: one from 5GA37 and five from 5GA4268 (Figure 4.12). The scrapers are expedient in nature with only light retouch visible along edge margins. Specimen 37.5 is an end scraper made from quartz. The distal end of the tool has steep retouch that is difficult to distinguish due to the raw material qualities. Specimen 48.6 is a side scraper made from Troublesome Formation chert with light retouch visible along one edge margin. The specimen has cortex along the opposing edge margin. Specimen 48.7 is a classic end scraper made from Troublesome Formation chert. The distal end of the tool has steep retouch. Specimen 48.10 is a side scraper made from Troublesome Formation chert with light retouch visible along one edge margin. The specimen has cortex along the opposing edge margin. Specimen 48.11 is a side scraper made from clear chalcedony with light visible retouch

Figure 4.12: Scrapers collected from the game drives and 5GA4268. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

along one edge margin. The specimen has cortex along the opposing edge margin. Specimen 48.12 is an incomplete side scraper made from Troublesome Formation chert. Light retouch is visible along one edge margin. The distal end is partially broken and cortex is visible on the proximal end.

Other Formal Tools (n=2)

Two additional tools are included in the assemblage (Figure 4.13). Specimen 35.86 appears to be a core or tested cobble of raw material with an interior flaw. The artifact is made from a brown Middle Park chert with a large geode-like inclusion. Specimen 48.5 is tool made

Figure 4.13: Additional tools collected from the game drives and 5GA4268. Image by Kelton Meyer; on file at the Center for Mountain and Plains Archaeology.

from Troublesome Formation chert. The tool has obvious flaking along the edge margins and is nearly spherical in cross-section. There is a small amount of cortex along one of the edges. This tool may be a broken tip of a large drill. Lyons sandstone groundstone fragments are also reported by Benedict for 5GA4268, although any additional data regarding their size, or location is not provided. These specimens are not in the collection and were likely not collected during original fieldwork.

Utilized/Edge Modified Flakes (n=60)

Utilized and/or edge modified flakes are numerous in the assemblage and all but two come from 5GA4268; there is one each from 5GA35 and 5GA36. Most flakes in this category show wear along the edge margins as the result of use with only a few specimens exhibiting signs of light retouch. Use wear is defined as polishes, striations, and/or slight nibbling of the edge. Flakes in this class average 17.8 millimeters in maximum length, 13.5 millimeters in maximum width, 3.4 millimeters in thickness, and weight 0.9 grams. Twelve of the flakes are primary or secondary flakes with cortex present and 31 have an intact platform visible. None of the flake exhibit evidence of burning.

Debitage (n=272)

The remaining artifacts are classified as chipped stone debitage, made up of waste flakes and angular debris. Artifacts were classified as flakes if at least one flake characteristic could be identified on the artifact, such as a platform, bulb of percussion, eraillure flake scar, or compression rings (Andrefsky 1994). If none of these characteristics were visible, the artifact was categorized as angular debris, as they are likely still cultural in origin due to the lack of these raw materials in the mountains. Multiple raw material categories are represented in the assemblage, including cherts, chalcedonies, quartzite, and petrified wood. Additional discussion and analysis regarding raw material is presented in Chapter 5. Only 17 specimens have cortex present. Coding for cortex was simply present or absent but a cursory inspection show there is a mix of primary and secondary flakes with cortex. Seventy-four specimens have a visible intact platform. Coding for platform was simply present or absent but most platforms are consistent with late-stage production. Burning was noted on five of the specimens, all from 5GA4268, although it is inconclusive as to whether this is from natural or cultural processes.

In general, the characteristics of the chipped stone debitage are consistent with primarily late-stage production or maintenance of chipped stone tools. This assertion is made based on the number of flakes with no cortex present in relation to the entire assemblage, the overall small size of complete flakes, and the type of platform observed, primarily lipped-platforms consistent with soft hammer or late-stage production (Andrefsky 1994). There is limited evidence in the debitage from 5GA4268 showing that primary reduction of raw material was taking place for the production of expedient tools in the form of scrapers and edge modified flakes. Chipped stone debitage is found in all contexts of the game drive system, including from within blinds, along or near drive walls, inside and outside of the kill zone, and in specialized activity areas. Additional data for chipped stone debitage is presented in following chapters.

Features

Site features include hunting blinds, walls, and cairns (Figure 4.14). This section is intended to provide a broad overview features associated with the three game drives. Each perform a different function within the overall drive system and this is discussed more in depth in following chapters. Table 4.5 provides a summary of the features recorded at the three sites. For more complete data, see Appendix C. The data is current as of September 2015.

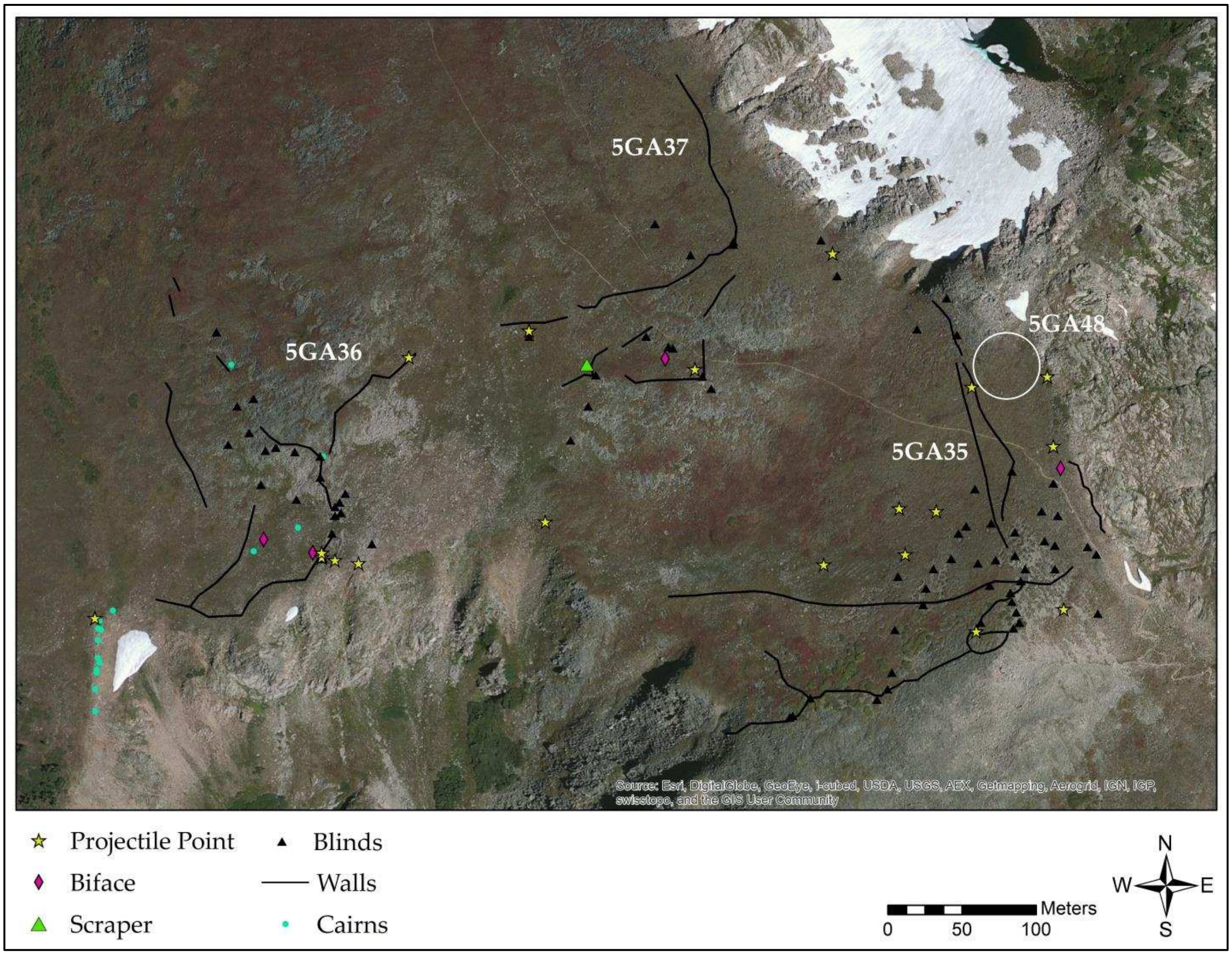


Figure 4.14: Overview of features and artifacts recorded for the game drives and 5GA4268.

Table 4.5: Summary of features recorded at the three game drive sites as of September 2015.

	5GA35	5GA36	5GA37	Totals
Blinds	44	20	16	80
Cairns	1 Line/10 meters	15 total/106 meters	1 Line/20 meters	136 meters
Walls (cumulative)	973 meters	539 meters	423 meters	1935 meters

Blinds (n=80)

The hunting blinds at the Rollins Pass game drive are perhaps the most conspicuous features of the sites. A total of 80 hunting blinds have been identified: 44 at 5GA35, 20 at 5GA36, and 16 at 5GA37. Blind morphology is highly variable within and between game drives. Blind shapes range from circular to square, although a majority of the blinds are described as either circular or semi-circular. A single C-shaped blind was also recorded at 5GA35. Interior blind size ranges from just 60 centimeters to 304 centimeters; a majority of the blinds fall in the 100-200 centimeter range. The recorded depth of the blinds is highly variable and likely more related to the degree of wall preservation rather than the original depth of the blind. Blind depths range from 20 centimeters to 136 centimeters and averages about 70 centimeters and a majority are in the 40-80 centimeter range. Blind walls are of dry-laid construction, generally two to three courses high. Again, this is highly variable depending on the immediately available construction material or the presence of natural features. The data on blind morphology for these games drives is consistent with blind morphologies reported from other game drive sites along the Continental Divide (e.g. Benedict 1975a, 1978a, 1985, 1996, 2000; Benedict and Cassells 2000; Cassells 1995, 2000; LaBelle and Pelton 2013).

Walls

The drive walls may not be the best preserved walls seen at alpine hunting sites but they are still visible features on the landscape to the trained eye. A total of 1,935 meters of walls have been recorded between the three sites: 973 meters at 5GA35, 539 meters at 5GA36, and 423 meters at 5GA37. The walls are of dry-laid construction and no more than 60 centimeters in height, representing two to three courses of stone. Some walls are in such a state of disrepair that they are little more than a line of collapsed stones while others still exhibit a stacked, built, quality. The walls conform to the standard V- or U-shape that is characteristic of game drives

(Benedict 1996). Most walls are generally continuously linear in form although the walls at 5GA36 are more discontinuous and more sinuous. This may be attributed to the local landscape; whereas 5GA35 and 5GA37 are located in an open alpine setting, 5GA36 is located on a steeper slope characterized by talus and patterned ground. Some of the walls are redundant in their apparent function, such as those of 5GA35 and, to a lesser extent, 5GA36. These overlapping, redundant walls may be indicative of separate construction episodes. The data on wall morphology for these games drives is consistent with wall morphologies reported from other game drive sites along the Continental Divide (e.g. Benedict 1975a, 1978a, 1985, 1996, 2000; Benedict and Cassells 2000; Cassells 1995, 2000; LaBelle and Pelton 2013).

Cairns (n=15, plus two additional lines)

Cairns are the least visible features at the game drives. A total of 15 cairns have been recorded, all from 5GA36, and two additional cairn lines are reported by Olson and Benedict (1970), one each from 5GA35 and 5GA37. These cairns were not relocated and recorded by the CMPA due to issues of time. In total, the cairn lines are at least 136 meters in overall length. The cairns recorded at 5GA36 are simple rockpile cairns. Eleven of these cairns form a line at the precipice of a steep, but navigable, slope descending to Corona Lake southwest of the site center. It appears these cairns functioned as a pseudo-wall to discourage animals from escaping over the edge and, instead, to turn them north and eventually east into the central part of the game drive. The additional four cairns are located in other parts of the game drive and are more or less isolated features; it is unclear how these cairns were used in conjunction with the walls, blinds, and/or other cairns in the system.

Summary

This chapter described the artifact and feature assemblage from 5GA35, 5GA36, 5GA37, and 5GA4268. The projectile point assemblage (n=27) demonstrates use of the sites extending from the Early Archaic through the Late Prehistoric. Additional formal tools (n=15), including bifaces, scrapers, and other tools demonstrate multiple classes of activity occurred during occupation of the sites, as will be discussed in later chapters. The chipped stone debitage is overwhelmingly indicative of late-stage production and/or maintenance of tools, suggesting that prehistoric hunters were arriving at the sites fully equipped, or nearly so, and ready to hunt. The features of the sites include stone walls (1935 cumulative meters), blinds (80), and cairns (15+ total with 136 cumulative meters) which generally conform to other reported game drives throughout the Colorado Front Range. Site 5GA35 is the largest and most complex of the sites in terms of features, accounting for over half the number of blinds (44) and walls (6 walls with 973 meters cumulative). Sites 5GA36 and 5GA37 are more modest in size and are generally similar. How these features functioned during a hunting episode is the focus of the following chapters.

CHAPTER 5 - THE PRE-HUNT

This chapter addresses questions related to the pre-hunt planning stage leading to a hunting event at one of the game drives. Analysis for this aspect of the hunt explores broad, regional contexts behind how and why prehistoric people were utilizing these sites. The chapter begins with a discussion of seasonal mobility patterns in northern Colorado. This sets up expectations for the second question discussed in chapter, where did prehistoric hunters stage themselves before a hunt? This question is addressed through raw material identification of the artifact assemblage. Finally, this chapter uses the artifact assemblage to explore the degree to which tool manufacturing was occurring on site. Together, these analyses connect the artifact assemblages with models of seasonal transhumance and provides a more robust and holistic interpretation of the archaeological record.

Seasonal Mobility Patterns in Northern Colorado

Year-round occupation of the high sub-alpine and alpine zones of the Colorado Front Range was unlikely during any period of the Holocene; the combination of low winter temperatures, strong winds, severe wind chills, and blowing snow makes exploring this region in the winter difficult, much less living in it. There are no known habitation or long-term occupation sites in the high sub-alpine and alpine zones. However, numerous game drives, hunting camps, butchering sites, and vision quest localities have been recorded in the region (Benedict 1992). Given the high number of sites it is obvious the high altitude regions of the

Front Range were an important area for prehistoric populations. The question is, if prehistoric people routinely visited this area to hunt game and gather foodstuffs, where did they spend the remainder of the year? Several seasonal mobility patterns for the region have been proposed (Benedict 1992; Benedict and Olson 1978; Black 1991; Metcalf and Black 1997); the two discussed here provide the most testable set of hypotheses and are used to set up expectations for which raw material types and which projectile point types might be anticipated to be present in the assemblages left behind by prehistoric populations. These expectations are outlined in Table 5.1.

Table 5.1: Summary of raw material source and projectile point expectations for seasonal mobility models.

Model	Raw Material Expectation	Projectile Point Expectation
Up-Down	*From Front Range: Predominately Eastern Foothills, Hogback, or western Great Plains sources; greater than expected use of mountain sources.* *From Western Slope: Predominately North Park or Middle Park sources with residual material from Western Slope sources.*	*From Front Range: Exclusively Eastern Foothills, Hogback, or western Great Plains styles.* *From Western Slope: Exclusively Western Slope, Colorado Plateau, or Great Basin-influenced styles*
Rotary	*Predominately North Park or Middle Park sources although residual sources from the Eastern Foothills, Hogback, or western Great Plains are possible.*	*Near exclusively Eastern Foothills, Hogback, or northwestern Great Plains styles. Little influence might be expected from the Colorado Plateau.*

The Up-Down System

The up-down system is the most simple of the seasonal mobility models and involves nothing more than simple there-and-back-again movements of groups from low elevation winter camps to high elevation summer hunting grounds along the Continental Divide (Figure 5.1). This simple seasonal mobility model is thought to have been practiced by populations who were new to the region and, thus, unaware of the location and/or full range of resources

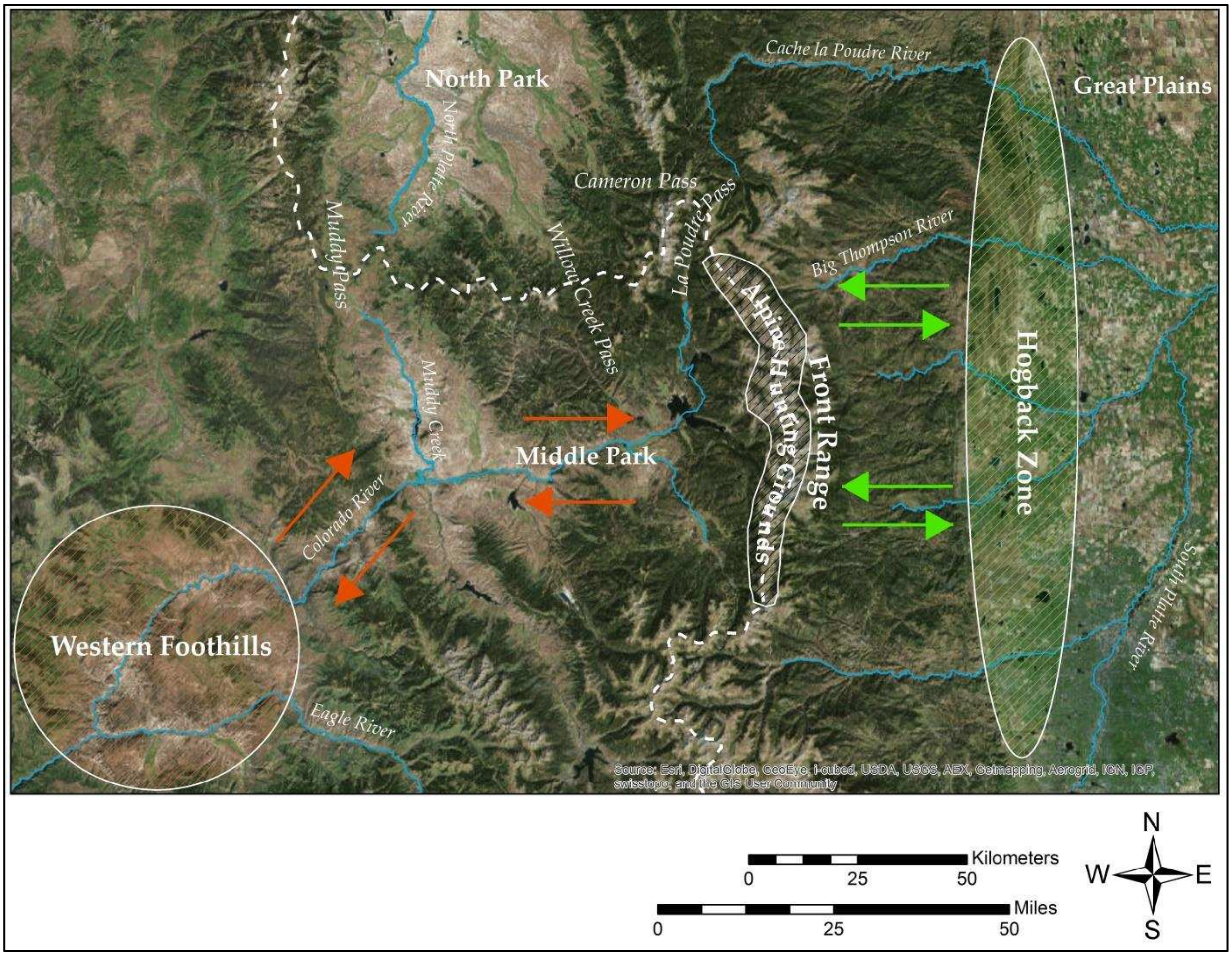


Figure 5.1: Schematic representation of the up-down system of seasonal mobility. Green arrows show this model operating from the Hogback zone in the Eastern Foothills. Orange arrows show this model operating from the Western Foothills.

available or by populations who were in competition with other groups, thus discouraging wide-ranging travels (Benedict 1992). In this model, groups moved into the high country as early in the season as possible, following the seasonal migration of animals into the mountains as snow melted from the sub-alpine zones. Groups spent a majority of the late spring through early fall in the mountains, exhausting their original supply of toolstone from quarried from near their winter camps and forced to use mountain sources. Resorting to the low quality toolstone of the mountains, such as vein quartz, is thought to be a function of the time groups spent in the mountains, far from low elevation sources of quality toolstone (Benedict 1992).

As modeled by Benedict (1992), the up-down system operated out of winter base camps in and near the Hogback zone of the Eastern Foothills. From these camps, groups moved westward into the mountains to high elevation hunting grounds as soon as seasonally possible (Benedict 1992). This model is best documented for the Mount Albion complex, dated between 5800-5300 rcyBP (6210-5940 B.P.) during the Early Archaic (Benedict and Olson 1978). Mount Albion complex groups are thought to have entered the mountains during the Altithermal, a period of regional drought and, being newcomers to the region, were unfamiliar with the location and/or full range of resources of the region (Benedict and Olson 1978). Raw material expectations for game drive assemblages for groups using this model are fairly limited. Groups utilizing the Eastern Foothills and Hogback zone as winter base camps would begin their seasonal mobility stocked with toolstone from quarries located in the Eastern Foothills, Hogback zone, or western Great Plains. Some of the more predominate sources found in these areas are quartzites and red argillite from the Hogback zone and petrified wood from the Denver Basin (Benedict 1992; Black 2000). As the season progressed and groups depleted these superior materials, they were forced to utilize lower quality material found in the mountains, namely vein-quartz (Benedict 1992). Similarly, projectile point typologies in game drive assemblages of groups using this system would also be expected to be fairly limited. Spatially-limited typologies only known from the Hogback zone or mountains east of the Continental divide would be expected. Yearly seasonal movement could have been as low as 60 kilometers, well within ethnographically known distances traveled during annual migrations (Binford

1990) and a distance of 30-40 kilometers from the game drives back to the winter base camps is easily managed by pedestrian hunter-gatherers laden with meat and hides acquired through a communal hunt.

Although not definitively demonstrated, this model of seasonal mobility could also function from winter base camps on the Western Slope (Benedict 1990). The specifics of this aspect of the model are essentially the same as the Front Range aspect of the model. Groups moved eastward into the high mountain parks west of the Continental Divide in late-spring and into hunting grounds in the sub-alpine and alpine mountains by summer. Groups utilizing the Western Slope/foothills for winter base camps would begin their seasonal mobility stocked with toolstone quarried from sources in the same region. Lithic sources are sporadic in west-central Colorado, particularly along the Colorado River, although sources of chert and quartzite do occur along the Yampa River in the northwest part of the state and along the White River near where it enters Utah (Black 2000). As groups moved eastward and into the Middle Park area they would likely replenish their toolstone supply with high quality material from the area, namely Troublesome Formation chert and Table Mountain jasper. As the season progressed and the time spent away from high quality material increased, groups would increasingly utilize lower quality material found in the mountains, namely vein quartz. Projectile point typologies of groups using this system would similarly be spatially constrained, limited the central mountains or intermountain parks west of the Continental Divide would be expected. Yearly seasonally movement would likely be in the 200-250 kilometer range, again within ethnographically known distances for terrestrial hunting groups (Binford 1990). Supporting evidence for winter occupation of the Western Slope/foothills region comes from the Yarmony pit house site (5EA799). The Early Archaic occupation of the site shows evidence of high occurrences of processing for marrow and bone grease extraction, a common practice during food shortages (Metcalf and Black 1991). This practice, along with the presence of substantial dwellings and a shallow burial, led Metcalf and Black (1991) to interpret the site as a winter occupation of the site. The major prohibitory aspect of this model is not the overall distance traveled but rather the distance from the game drives located along the Continental Divide back to wintering areas. The distance from the Yarmony site to Rollins Pass is approximately 125 kilometers via the Colorado River to the Frasier River then up the Ranch Creek drainage. This is a prohibitively long distance for pedestrian hunters to carry the amount of resources acquired during a communal hunt (Benedict 1992). However, evidence of Archaic structures have also been found at the Granby and Hill Horn sites in Middle Park, much closer to the game drives (Huse 1977; Wheeler and Martin 1982). Here, excavations uncovered evidence of wattle and daub construction over a superstructure of upright posts and woven branches. This provides tantalizing evidence that Archaic populations utilized Middle Park year-round. Even so, this could be termed intermountain park habitation and not necessarily indicative of Western Slope populations extensively utilizing the area. Limited numbers of projectile points characteristic of the Colorado Plateau have been found at game drives but their association with communal hunting activities is unknown (Benedict 1992).

The Rotary System

The rotary system is more complex than the previously described system and involves a model of seasonal mobility that includes two crossings of the Continental Divide that eventually bring groups to alpine hunting grounds from the west (Figure 5.2). This complex model of seasonal mobility is thought to have been practiced by populations well-acquainted with the region and all the resources available or by populations with little outside competition from other groups that would prohibit such wide-ranging seasonal movement (Benedict 1992). In this model, groups moved into the high country late in their annual rounds during the late summer or early fall. Groups spent a relatively short time in the sub-alpine and alpine zones and were there almost exclusively to hunt (Benedict 1992). Because these groups spent so short

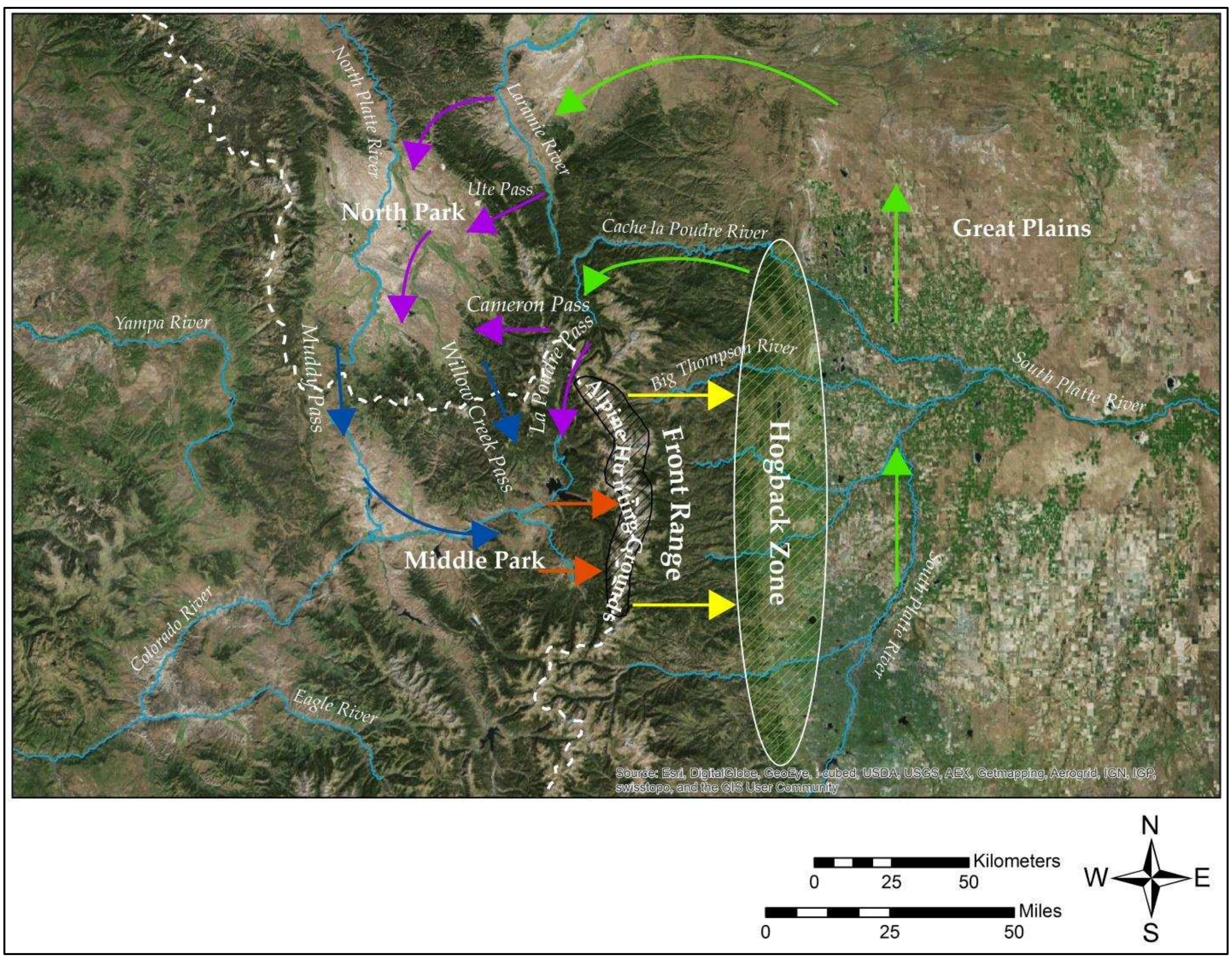


Figure 5.2: Schematic representation of the rotary system of seasonal mobility, adapted from Benedict 1992. Green arrows indicate early spring/spring movement. Purple arrows indicate late spring/summer movement. Blue arrows indicate summer/late summer movement. Orange arrows indicate late summer/fall movement. Yellow arrows indicate fall movement.

of time in the high country, there was no need to resort to using low-quality vein quartz to replenish their toolstone.

Like the up-down system, the rotary system operated out of winter base camps in and near the Hogback zone of the Front Range. From these camps, groups moved northward along the eastern flank of the Front Range in early spring equipped with toolstone and sandstone grinding slabs from Eastern Foothills or western Great Plains sources (Benedict 1992). From here, groups turned westward into the mountains. The Medicine Bow Mountains north of Rocky Mountain National Park offer several low passes (relative to passes farther south) that access either Middle Park or North Park. Near the Colorado/Wyoming border, the mountains crest is as low as 2,700 meters (8,850 feet) above sea level in some spots, offering a snow-free crossing as early as May in most years. Cameron Pass (3,133 meters; 10,300 feet) and La Poudre Pass (3,105 meters; 10,200 feet) offer shortcuts into North Park and Middle Park respectively, but are higher in elevation and do not become snow-free until June in most years. Groups spent their early summer in North Park, an area historically known to be rich in both faunal and floral resources (Benedict 1992; Byerly et al. 2015). As summer progressed, groups crossed the Continental Divide into Middle Park via Muddy Pass or Willow Creek Pass. The draw to Middle Park, in addition to an environment rich in faunal and flora resources, is the high quality toolstone. Troublesome Formation cherts, Table Mountain jasper, Windy Ridge quartzite, and petrified wood are the primary sources in the area (Bamforth 2006; Benedict 1992; Black 2000). By late summer, groups that had traveled in small bands aggregated into macrobands and began preparations to move eastward into the high country for communal game drive hunting (Benedict 1992). By late summer or early fall, group, now equipped with toolstone from Middle Park sources, groups were actively utilizing the many game drives along the Continental Divide. As fall progressed and temperatures began to drop, groups laden with meat and hides dispersed eastward through the narrow canyons back towards their winter base camps in and along the Hogback zone. Yearly seasonal movement was likely 300-400 kilometers (Benedict 1992), comparable to ethnographically known distances of sub-Arctic and Arctic terrestrial hunting groups (Binford 1990), and a distance of 30-40 kilometers from the game drives back to the winter base camps is easily managed by pedestrian hunter-gatherers.

This model is best illustrated by the Hogback Phase (Nelson 1971) of the Early Ceramic period. The phase is well represented at a number of game drive sites along the Front Range (Benedict 1975a, 1985, 1996; Cassells 1995; LaBelle and Pelton 2013; Olson and Benedict 1970; Olson 1971) and is characterized by small corner-notched, often serrated, projectile points, small; pressure flaked bifaces and preforms; and cord-marked pottery. Perhaps most significant is that these sites and their associated assemblages are found in all three environments encountered by the rotary system model, in the Hogback zone and adjacent plains, the intermountain parks and basins, and the sub-alpine and alpine zones of the mountains.

Expectations for artifact assemblages of groups using the rotary model of seasonal mobility are more diverse than for groups using the up-down system. Raw material expectations of game drive assemblages would be predominately Middle Park sources of chert, jasper, and petrified wood, a lesser amount of North Park material and little, if any, raw material originating from the Eastern Foothills, Hogback zone, or western Great Plains. Expectations for projectile point typologies are limited in this model. Projectile point typologies would be near exclusively Eastern Foothills, Hogback, or western Great Plains styles and they would bear similarities to point typologies in adjacent regions. Slight influence may also be expected from the Colorado Plateau if such groups were also utilizing the intermountain parks and adjacent mountains as part of their seasonal rounds. A limited number of projectile points characteristic of the Colorado Plateau have been found at game drives but their association with communal hunting activities is unknown (Benedict 1992).

Addressing Mobility through Raw Material Identification

By identifying the raw materials present in the toolkits of prehistoric hunters, it is possible to create a scenario for seasonal mobility in the region. Rates of raw material attrition in toolkits are influenced by a number of factors, including the quality and physical character of the raw material, the uses to which it is applied, and the distance and time elapsed between quarrying, production and use, and discard (Benedict 1992). Disregarding cases such as preferential raw material conservation or trade, the abundance of a raw material type in an assemblage is inversely related to the time elapsed between quarrying and use (Benedict 1992). Raw material availability and quality also plays a role in the organization of technology and impacts the types of tools produced and utilized at sites (Andrefsky 1994).

Methods

The methods used in this analysis were devised to directly answer questions about prehistoric mobility. The artifact assemblage was first sorted into five broad raw material categories based on macroscopic identification: chert, chalcedony, petrified wood, quartzite, and quartz. The sorted assemblage was then compared to a comparative collection housed at the CMPA at CSU. The comparative sample contains 165 processed samples from known locations, predominately in Colorado and Wyoming with a limited number from other surrounding states. The Colorado samples cover the Western Slope, the intermountain parks, the mountains, and the western Great Plains. The amount of raw material per category in the assemblage was quantified using both the absolute number of artifacts per raw material category and mass in grams of each raw material category. This was done to better understand the overall character of the assemblage, as some raw material categories contained numerous pieces of small artifacts (such as debitage) while others contained few pieces of large artifacts (such as tools). Finally, the assemblage for the three game drive sites (5GA35, 5GA36, and 5GA37) were grouped into a single sample population and the assemblage from 5GA4268 was a separate sample population.

Results

Analysis of raw material categories shows that the two samples are quite different (Table 5.2). The game drive sample is a variable assemblage with a total of 13 raw material categories identified with no single category contains more than 25% of the assemblage by mass. Of the 13 raw material categories identified, five were confidently matched to a source location using the comparative sample. These include Troublesome Formation chert (commonly called Kremmling chert), Table Mountain jasper, various other Middle Park cherts, Windy Ridge quartzite, and Cowdrey quartzite. A total of 90 artifacts, accounting for about 44% of the assemblage, were identified as one of these types. By total count, petrified wood as a single category is the most represented, with 57 pieces identified (about 30%). This is followed by

Windy Ridge quartzite with 49 artifacts identified (about 24%) and a brown chert with 26 pieces identified (about 13%). The remaining categories individually represent less than 10% of the total count. A different pattern is evident when looking at mass. Troublesome Formation chert is the most represented with 23.8 grams, or about 25% of the assemblage. This is followed by various Middle Park cherts, accounting for 19.4 grams, or about 20% of the assemblage, Windy Ridge quartzite with 15.4 grams (17.5%), and petrified wood with 11.1 grams (11.6%). The remaining categories individually represent less than 10% of the total mass.

Table 5.2: Summary of count and mass of raw materials in the two Rollins Pass sample populations (all artifacts).

	Game Drives				5GA4268			
	Count		Mass		Count		Mass	
Raw Material	#	%	Grams	%	#	%	Grams	%
Brown chert	26	12.7	3.3	3.5	3	2.2	0.8	0.8
Middle Park chert	13	6.3	19.4	20.3	7	5.1	6.2	5.8
Red/Rose chert	5	2.4	2.4	2.5	0	0	0.0	0.0
Table Mountain jasper	10	4.9	1.6	1.7	0	0	0.0	0.0
Tan chert	8	3.9	4.0	4.2	0	0	0.0	0.0
Troublesome chert	13	6.3	23.8	24.9	93	67.4	72.5	68.0
White chert	1	0.5	1.9	2.0	0	0	0.0	0.0
Subtotal	***76***	***37.1***	***56.4***	***59.0***	***103***	***74.6***	***79.5***	***74.6***
Cowdrey quartzite	5	2.4	0.5	0.5	0	0	0.0	0.0
Grey quartzite	0	0	0.0	0.0	5	3.6	5.6	5.3
White quartzite	8	3.9	0.8	0.8	0	0	0.0	0.0
Windy Ridge quartzite	49	23.9	15.4	16.1	5	3.6	2.0	1.9
Subtotal	***62***	***30.2***	***16.7***	***17.5***	***10***	***7.2***	***7.6***	***7.1***
Clear chalcedony	3	1.5	3.4	3.6	23	16.7	17.8	16.7
Tan chalcedony	6	2.9	0.6	0.6	1	0.7	1.0	0.9
Subtotal	***9***	***4.4***	***4.0***	***4.2***	***24***	***17.4***	***18.8***	***17.6***
Petrified Wood	57	27.8	11.1	11.6	1	0.7	0.7	0.7
Subtotal	***57***	***27.8***	***11.1***	***11.6***	***1***	***0.7***	***0.7***	***0.7***
Quartz	1	0.5	7.4	7.7	0	0	0.0	0.0
Subtotal	***1***	***0.5***	***7.4***	***7.7***	***0***	***0***	***0.0***	***0.0***
Total	**205**		**95.6**		**138**		**106.6**	

The artifact assemblage for 5GA4268 shows less variability than the game drive assemblage. A total of eight raw material categories were identified for 5GA4268 and three of these were matched with a source location. The identified materials include Troublesome Formation chert, various Middle Park cherts, and Windy Ridge quartzite. A total of 105 artifacts, accounting for about 76% of the assemblage, were identified as one of these types. Troublesome Formation chert dominates the assemblage. A total of 93 artifacts were identified to this type, accounting for about 67% of the assemblage by count. Clear chalcedony, with 23 artifacts identified (about 17%) is the only other category representing more than 10% of the assemblage. Similarly, Troublesome Formation chert and clear chalcedony are the most represented materials by mass, with 79.5 grams (about 75%) and 17.8 grams (about 17%) identified in the assemblage.

Discussion

The artifact assemblage for both the game drive sample and 5GA4268 show a preference to raw materials originating west of Rollins Pass in the intermountain basins of North Park and Middle Park. For the game drive sample, 44% of the assemblage by count and 62% of the assemblage by mass can be traced back to Middle Park and/or North Park sources. For 5GA4268, 67% of the assemblage by count and 76% of the assemblage by mass can be traced back to Middle Park or North Park sources. Together with the absence of any identifiable materials originating from the Front Range or from Western Slope sources, this indicates prehistoric populations were preferentially using Middle Park or North Park sources as their primary toolstone and, given their proximity to the game drives, groups were likely acquiring this material through direct acquisition rather than trade. There are subtle differences between the two samples, however.

The primary difference is the amount raw material in each category. Whereas the game drive assemblage is relatively diverse, no one category accounts for more than 30% of the sample by count or mass, the sample from 5GA4268 shows a strong preference for Troublesome Formation chert. Similarly, Windy Ridge quartzite accounts for the largest percentage of identified raw material by count or mass in the game drive sample, but represented by just five artifacts in the 5GA4268 sample. This difference may be attributed to differences in site function. The primary function at the game drives is hunting and, thus, a large portion of the tool assemblage would be expected to be projectile points. As a tool category, projectile points are classified as formal tools and generally curated for a longer period of the seasonal movements, especially when the group is expecting to encounter areas with no or low-quality raw material sources (Andrefsky 1994; Kelly 1988). As such, it might be expected that the game drive sample would show more diversity of toolstone, including sources from a greater distance. This does indeed seem to be the case in the game drive sample. Additionally, the game drives are likely palimpsests, being utilized for centuries. Such extended use would result in a more uniform raw material sample. 5GA4268 is a lithic scatter and activity area likely related to the processing of game acquired during the hunt. Bifaces, scrapers, and edge modified flakes dominate the tool assemblage at 5GA4268, as would be expected of a processing site. As a tool category, scrapers and edge modified flakes are informal tools expediently produced when the need for such tools arises (Andrefsky 1994; Binford 1979; Hayden 1979; Kamminga 1982). These tool types are also generally produced with local raw material, whether high or low quality (Andrefsky 1994; Hayden 1979; Kamminga 1982). As such, it might be expected that the sample from 5GA4268 would show less diversity in toolstone and its source would indicate where prehistoric populations were located immediately prior to the hunt. The sample from 5GA4268 fits this pattern. A majority of the edge modified flakes and all of the scrapers are made from either Troublesome Formation chert or a clear chalcedony. Only 6 of the 58 edge modified flakes are not made from these materials. The clear chalcedony is likely a local mountain park source, as evidenced by the preponderance of early stage production flakes containing cortex, but there was no comparative sample to firmly make this conclusion. The one biface from this assemblage is made from Windy Ridge quartzite. As a formal tool, it is not surprising that this source comes from a greater distance from the site. Additionally, 5GA4268 may represent a site which was used few times and, thus, does not contain the diversity of raw materials seen at the game drives.

As identified in the results section above, petrified wood is highly represented, by count, in the game drive sample. There are 57 artifacts made from petrified wood: 54 flakes or angular debris and 3 projectile points. All petrified wood artifacts were excavated from pit 573 (Figure 4.1 above) during the Olson and Benedict (1970) excavations. The flakes are all small, tertiary flakes with no cortex, averaging just 7.4 millimeters wide, 5.1 millimeters wide, and 1.1 millimeters thick. These measurements are consistent with size attributes of final stage biface production and tool rejuvenation (Andrefsky 2005). The petrified wood flakes bear a striking similarity to the color and texture of one of the projectile points, 35.89, identified as a Mount Albion corner-notched point. It is possible that the flakes excavated from pit 573 are the result pre-hunt maintenance of the projectile point. This is a tantalizing prospect as it shows a specific behavior in a specific context within the game drive system. Further analysis of the flakes and projectile point, such as microscopic analysis or refitting, might confirm this hypothesis but such analyses were beyond the scope of this thesis. The color and texture of the petrified wood in the game drive sample is similar to a comparative sample from Douglas County, Colorado, about 100 kilometers southeast of the sites along the Front Range. Unlike other raw materials identified in this analysis which have spatially limited source locations, petrified wood is available in numerous locations along the Front Range and in North, Middle, and South Parks (Black 2000). Given the range in variation among petrified woods and the lack of an extensive comparative sample from Middle and North Parks, it is difficult to confidently assign Douglas County as the source location for the material in the game drive sample. One piece of supporting evidence, however, is the fact that the projectile point is a Mount Albion point. As discussed earlier, Mount Albion groups are thought to have wintered along the Front Range and, thus, acquired all their toolstone exclusively from Eastern Slope or Front Range sources (Benedict 1992; Benedict and Olson 1978). If this is the case, then the Mount Albion projectile point and associated petrified wood flakes supports at least one aspect of the up-down system described above.

Testing the raw materials present at the game drive sites and 5GA4268 against the expectations outlined above provides a more complete picture of seasonal mobility patterns. It is clear from the data presented above that a preponderance of the material found at Rollins Pass is derived from Middle Park sources. When the two sample populations are combined, 40% of the artifacts (n=136) can be attributed to Middle Park locations (Troublesome Formation chert, Table Mountain jasper, and various Middle Park cherts) while 17% of the artifacts (n=59) can be attributed to North Park sources (Windy Ridge quartzite and Cowdrey quartzite). This represents 100% of the confidently identified raw material in the assemblage. At least some of the petrified wood in the assemblage may originate from Douglas County but there is not enough of a comparative sample to confidently assign Douglas County as the source location. No other Eastern Slope or Front Range foothills sources were identified in the assemblage. These data indicate that a majority, if not all, the groups utilizing the game drives at Rollins Pass were routinely accessing Middle Park lithic sources as part of their seasonal mobility strategy. This strongly supports the rotary system of seasonal mobility.

A comparative study to other game drive sites along the Continental Divide is useful for demonstrating the range of variability of raw material sources present at these sites and helps to put the game drives at Rollins Pass in a larger regional context. This comparison utilizes data from the Sawtooth game drive (5GA55/5BL523) and nearby Fox Park camp sites (Cassells 1995, 2000), located near Buchanan Pass about 23 kilometers north of Rollins Pass along the Continental Divide. The Sawtooth site actually consists of two game drives which together compose a complex arrangement of 59 hunting blinds, 18 walls, and three cairn lines (Cassells 1995, 2000). The Fox Park sites are a collection of 13 prehistoric campsites located in Fox Park, a large north/south oriented glacial hanging valley immediately west of Buchanan Pass (Cassells 1995, 2000). A slightly different pattern in raw material use is evident at the Sawtooth site (Table 5.3). Raw material analysis by Cassells (1995, 2000) shows that the game drives at the Sawthooth sites show a preference for Table Mountain jasper (55% of the total assemblage), followed by Troublesome Formation chert (38% of the total assemblage). Several other materials were identified as well, including unsourced cherts, quartzite, quartz, and petrified wood, but combined account for less than 10% of the assemblage. A much different pattern emerges at the Fox Park sites. Here, the raw material is predominately Troublesome Formation chert, at 74% of the total assemblage, followed by Table Mountain jasper, at 11% of the total assemblage. Several other materials were identified as well, including unsourced cherts, quartzite, quartz, and petrified wood, but combined account for less than 10% of the assemblage.

Table 5.3: Summary of the count of raw materials in the two Sawtooth game drive sample populations.

	Sawtooth Sites		Fox Park Sites	
Raw Material	Count	Percentage	Count	Percentage
Troublesome chert	99	37.5	106	74.1
Table Mountain jasper	145	54.2	16	11.2
Unsourced chert	4	1.5	4	2.8
Quartzite	7	2.7	10	7.0
Quartz	2	0.8	1	0.7
Other	7	2.7	6	4.2
Total:	**264**		**143**	

Overall, the Sawtooth sites sample shows less variability than the game drive sample from Rollins Pass. The raw material for the Sawtooth sites comes primarily from two sources, Troublesome Formation chert and Table Mountain jasper, accounting for over 90% of the assemblage. Both are Middle Park sources (Black 2000). A much greater degree of raw material variability is seen in the Rollins Pass game drive sample. However, like the Rollins Pass 5GA458 sample, the Fox Park sites exhibit a strong preference for Troublesome Formation chert, accounting for 74% of the assemblage. The general pattern of more raw material variability at game drives and less variability from nearby camp sites or activity areas is borne out in these two assemblages. One explanation for this pattern is that projectile points are the primary tool found at game drive sites whereas bifaces, scrapers, and other expedient tools are typically found at other sub-alpine and alpine sites. As discussed earlier, projectile points might be expected to remain in the toolkit for a longer period and, thus, raw material sources would be more variable. As a result, the flakes found at game drives, primarily from excavated contexts in blinds, would also be variable as it is likely that these flakes are the result of tool rejuvenation in preparation of a hunt (Cassells 1995, 2000). At the other sites, more expedient, informal tools are better represented. These tend to be produced when the need for such tools arises and are typically made with locally available raw material (Andrefsky 1994; Binford 1979). It follows, then, that the camp sites at Fox Park and 5GA4268 at Rollins Pass should show less variability overall with a strong preference for local, immediate sources and this is, indeed, the case. Additional studies from other well reported game drives with nearby processing or camp sites would need to be conducted to support or refute this possible explanation.

Conclusion

Understanding seasonal mobility in prehistoric northern Colorado is a key facet in understanding which populations used the game drives at Rollins Pass, where these people were stationed before a hunt, and how they were equipped. While several models have been presented for seasonal mobility in this region, two of the most testable were utilized to set up expectations for further analysis. The up-down system is the simplest of the seasonal mobility models and involves nothing more than simple there-and-back-again movements of groups from low elevation winter camps to high elevation summer hunting grounds along the Continental Divide. As modeled by Benedict (1992), this system operates out of winter base camps along the Eastern Slope and Front Range foothills and does not move west of the Continental Divide. Raw materials in this system are derived exclusively from Eastern Slope or Front Range foothills, western Great Plains, or the mountains. This system could have operated out of winter camps in the Western Foothills as well and raw material sources would be expected to be derived exclusively from sources west of the Continental Divide, either in Middle Park or North Parks or from the Western Slope. The rotary system is more complex than the up-down system and involves a model of seasonal mobility that includes two crossings of the Continental Divide that eventually bring groups to alpine hunting grounds from the west. As modeled by Benedict (1992), this system similarly operates out of winter camps along the Eastern Slope and Front Range foothills but takes groups north along the Front Range, crossing low passes in the Medicine Bow Mountains into North Park by early summer before crossing the Continental Divide into Middle Park by mid to late summer. Finally, aggregated groups move eastward towards alpine hunting grounds in early fall before descending the Eastern Slope in late fall/early winter. Raw material expectations in this system are primarily Middle Park sources, with limited amounts of North Park sources and few, if any, Front Range sources.

The data show a strong signature for Middle and North Park sources with no Eastern Slope, Front Range foothills, or western Great Plains sources present. This supports the rotary system of seasonal mobility in Northern Colorado. Troublesome Formation chert is the best represented of any of the identified raw materials. This is no surprise as this raw material was widely utilized in the region since the Paleoindian period and is easily accessible as primary outcrops or secondary deposits along the Colorado River (Black 2000). This pattern of raw material signatures may also support the up-down model from the Western Slope. However, the lack projectile points showing signatures of Colorado Plateau or Great Basin typologies strongly suggests that if Western Slope peoples used game drives, their occupation was brief and very sporadic, leaving no archaeological traces. A brief comparison with the Sawtooth game drive (Cassells 1995, 2000) shows a similarly strong signature for Middle Park or North Park sources with a notable absence of Eastern Slope, Front Range foothills, or western Great Plains sources. 5BL147, just south of Rollins Pass and part of the same overall complex of game drives surrounding the pass shows the same signature; 58.8% of the site assemblage is attributed to Troublesome Formation chert (LaBelle and Pelton 2013). Analysis of the chipped stone debitage in the assemblage indicates that the blinds functioned as a pre-hunt activity area related to the maintenance of projectile points in preparation for a hunt while more expedient tools were produced at 5GA4268, indicating a short-term activity area possibly related to post-hunt processing of game.

Although not an aspect of the drive system studied in this thesis, a short discussion of the construction, maintenance, and repair of the features of the drive systems is warranted. This aspect undoubtedly was a major pre-hunt activity as it was unlikely the drives were used year after year. Instead, game drives were likely abandoned for many intervening years as animals utilized different parts of the landscape and, thus, drew hunters to use other game drives located along the Continental Divide. As such, sites fell into disrepair due to the ravages of the alpine environment, necessitating that hunters spend time to repair them to make them functional. Experiments conducted by Cassells (1995, 2000) at the Sawtooth game drive show that blinds and walls could be constructed or repaired relatively quickly, often in 10 minutes or less, although he notes the caveat that his crews were motivated by competition for which group could construct blinds or walls the quickest. Additionally, Jenness (1922) notes that hunters in the Arctic regions were able to dig expedient blinds for caribou hunting using sharpened antlers in a few minutes. Reconstruction and modification of the drive system can be seen in the series of redundant walls and apparent overlapping of blinds at the sites.

The data indicate that groups of hunters utilizing the game drives at Rollins Pass were moving into the high country from the west with a toolkit primarily composed of raw materials acquired directly from Middle Park sources. Hunting groups likely spent some time immediately before a hunt camping in the high subalpine basins directly west of the alpine zone, as evidenced by the Fox Park sites. Here, hunters made final preparations for the hunt. When animals were spotted and a game drive selected for use, hunters moved into the alpine zone, where they repaired parts of the drive system which had fallen into disrepair. As the time for the hunt neared, hunters positioned themselves in blinds to conceal themselves from incoming game. Here, final preparations were made, sharpening and rejuvenating tools, while waiting for the commencement of the hunt.

CHAPTER 6 - THE HUNT

This chapter addresses questions related to hunting events at the game drives. Analyses for this chapter operate on a small spatial scale and are limited to the sites themselves. The chapter begins with descriptive statistics analysis of feature morphometrics in order to set up spatial analyses of features and artifacts to define site boundaries and explore site structure and possible associated activities. The basis of using site structure to elucidate activity areas is that humans exhibit patterned behavior, generally defined by specific groupings of related features or artifacts, when carrying out repeated tasks and these patterns can be extracted from the archaeological record (Binford 1978, 1983; Enloe 1983; Enloe et al. 1994; O'Connell 1987; Rigaud and Simek 1991). The second question in this chapter explores which animals were hunted at alpine game drives. Protein residue analysis was conducted to address this question as no faunal remains have been recovered from these sites. The rational for conducting this analysis is the limited evidence of faunal remains from any of the alpine game drives in the Front Range (but see Benedict 1975a, Cassells 1995, 2000, LaBelle and Pelton 2013, and Olson 1971 for cases where faunal remains have been recovered). Together, these two analyses reveal varying activities within different parts of the drive system that, together, form the crux of a hunt.

Spatial Analysis

Interpreting human behavior is a cornerstone of anthropological research and within archaeology requires the use of sometimes scant amounts of evidence to derive behaviors at sites such as the organization of people or activity areas. Therefore, more creative methods must be explored to understand human behavior at these types of sites. The use of descriptive statistics and spatial distributions of features and artifacts is not new in archaeological analyses but their use for the analysis of alpine game drives is limited. These methods hold great potential for enhancing our understanding of the various human behaviors likely associated with these hunting sites. Descriptive statistics are used in this analysis to quantify feature attributes and the spatial distribution of artifacts and features within the sites and are used to elucidate possible behaviors associated with features and where activities may have occurred. In particular, blind sizes can be especially illuminating for the overall operation of a game drive. Variations in blind size can be expected and it is where these variations occur within the drive structure that is of particular interest. As animals enter the intercept zone where their movement is hindered, it might be expected that larger blinds, able to house a higher number of hunters, would be constructed (LaBelle 2012). Similarly, it might be expected that small blinds be positioned in areas away from the intercept zone along the drive wall wings. As will be shown, this is an important aspect in the overall organization of people within the drive structure.

Methods

The methods used in these analyses were devised to directly answer questions regarding the spatial relationship of site features and artifacts. Two primary types of data were used for this research: the geographic location and attributes of features and artifacts. Only data and artifacts collected by the CMPA was used in this analysis. All geographic and attribute data was first entered into *Microsoft Excel* to create a database that could then be used for further analysis. Using the *Descriptive Statistics* tool in the *Analysis ToolPak* function of *Excel*, descriptive statistics for blind size were produced using maximum interior and exterior dimensions. The statistical computing and graphics program *RStudio* was used to produce box plots of the descriptive statistics to better understand the data. The *Excel* database was uploaded into *ArcGIS 10.4* to perform more complicated statistical analysis. The *Euclidean Distance* toolbox was used to generate a straight line distance between artifacts and features. These distances were then input back into *Excel* and *RStudio*, where descriptive statistics and box plots were created.

ArcGIS 10.4 was used to analyze the spatial relationship between site features. The geographic and attribute data of features was uploaded to *ArcGIS 10.4* from an *Excel* datasheet. Three functions were performed on this data. First, a 20 meter buffer with dissolved boundaries was applied to the blinds to simulate the maximum effective shot distance of a hunter stationed in a blind (Blehr 1990; Pope 1918, 1923; Tomka 2013). Second, maximum interior blind size was classified into six categories using the data derived from previously discussed descriptive statistics. These were then displayed using graduated symbols to illustrate how blind size may be related to its location within the overall game drive system. Finally, the *Kernel Density Analysis* toolbox was used to better understand the density of blinds as they relate to other site features.

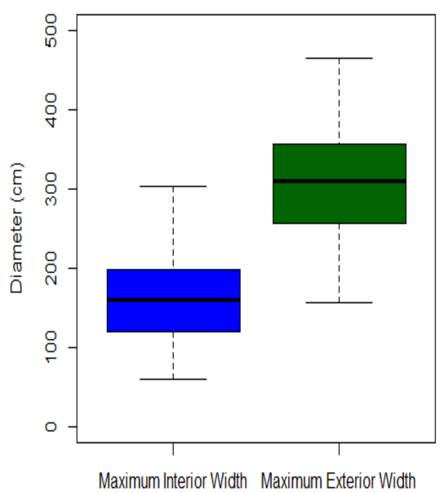
Results

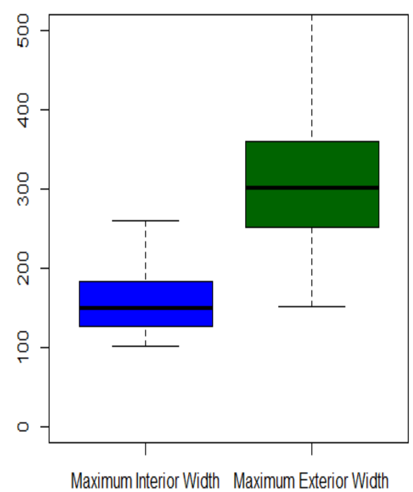
Analysis of descriptive statistics regarding blind size shows that the sites are nearly identical (Table 6.1). To better understand the range of variability in blind size, maximum

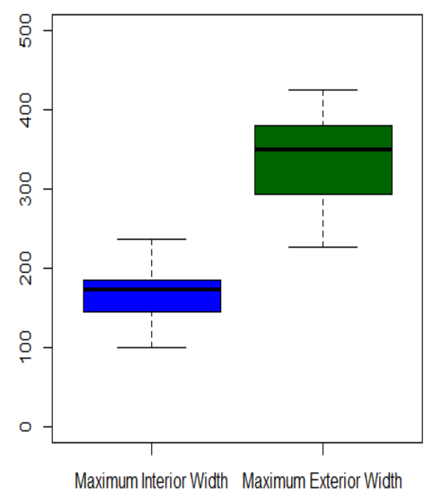
Table 6.1: Summary of descriptive statistics for attributes related to blind morphology for the three game drive sites.

Blind Size	5GA35 (n=44)					5GA36 (n=20)					5GA37 (n=16)				
Dimension	**Min (cm)**	**Max (cm)**	**Mean (cm)**	**Std. Dev.**	**Med. (cm)**	**Min (cm)**	**Max (cm)**	**Mean (cm)**	**Std. Dev.**	**Med. (cm)**	**Min (cm)**	**Max (cm)**	**Mean (cm)**	**Std. Dev.**	**Med. (cm)**
Maximum Interior	60.0	304.0	165.9	56.1	159.5	102.0	260.0	160.8	44.9	149.0	100.0	237.0	168.2	32.9	173.5
Maximum Exterior	157.0	465.0	310.9	70.0	310.0	152.0	520.0	306.3	82.7	301.0	227.0	425.0	338.1	56.4	350.0
Depth	20.0	108.0	61.1	19.5	59.0	53.0	136.0	92.1	23.6	92.0	35.0	96.0	69.5	17.5	71.5

Box Plots of Size Distribution







interior and exterior dimensions and depth were used. Maximum interior dimensions range from 60 centimeters to 304 centimeters, both at 5GA35. Mean maximum interior dimensions range from 160.8 centimeters at 5GA36 to 168.2 centimeters at 5GA37. Median maximum interior dimensions range from 149 centimeters at 5GA36 to 174 centimeters at 5GA37. Maximum exterior dimensions range from 152 centimeters to 520 centimeters, both at 5GA36. Mean maximum exterior dimensions range from 306.3 centimeters at 5GA36 to 338.1 centimeters at 5GA37. Median maximum exterior dimensions range from 301 centimeters at 5GA36 to 350 centimeters at 5GA37. The recorded depth of the blinds is more variable between the sites. Depths range from 20 centimeters at 5GA35 to 136 centimeters at 5GA36. Mean depths range from 61.1 centimeters at 5GA35 to 92.1 centimeters at 5GA36. Median depth ranges are similarly variable, from 59 centimeters at 5GA35 to 92 centimeters at 5GA36.

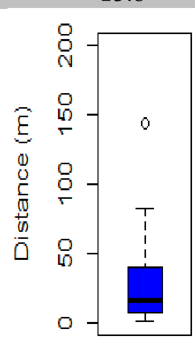
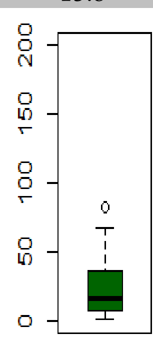
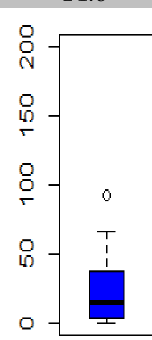
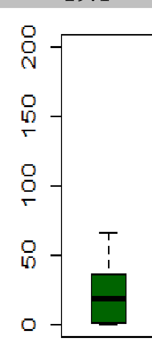
Descriptive statistics regarding the distance from artifacts to site features shows slight differences between the tool type and the feature type (Table 6.2). When all tools are considered, slightly more variability is observed. The distances between all tools and blinds ranges from 1.4 meters to 143.7 meters. The mean distance is 29.0 meters. The median distance, however, is considerably less at 15.8 meters. The distance between all tools and walls ranges from 0.02 meters to 92.4 meters. The mean distance is 23.7 meters. The median distance is considerably less at 14.6 meters. When only projectile points are considered, a similar pattern is observed. The distances between projectile points and blinds range from 1.4 meters to 82.2 meters. The mean distance is 25.0 meters while the median distance is considerably less at 15.8 meters. The distances between projectile points and walls range from 0.02 meters to 66.6 meters. The mean distance is 23.0 meters and the median distance is 19.4 meters.

Additional spatial analyses are based on visual interpretation of maps produced in *ArcGIS 10.4* and, as such, are difficult to quantify and discussed in the results section. These analyses and maps are incorporated into the following discussion section.

Discussion

Analysis of blind morphology and their spatial distribution within the drive systems shows several trends which provide evidence for human behaviors associated with these features. The mean and median blind diameters across the three sites are similar regardless of whether the variable is interior or exterior diameter. Because of the wide range in sizes and the relatively low sample size, the mean is more likely to be affected by outliers. Additionally, the maximum exterior means and medians show a higher degree of variability than the interior dimensions. This higher degree of variability is not surprising. When blind walls fall into

Table 6.2: Summary of descriptive statistics for the *Euclidean Distance* between artifacts and features of the three game drive sites.

	All Tools to Blinds	**Projectile Points to Blinds**	**All Tools to Walls**	**Projectile Points to Walls**
Minimum (m)	1.4	1.4	0.02	0.02
Maximum (m)	143.7	82.2	92.4	66.6
Mean (m)	29.0	25.0	23.7	23.0
Std. Dev.	32.8	23.6	24.6	21.7
Median (m)	15.8	15.8	14.6	19.4
Box Plots of Distribution of Distances				

disrepair, the rocks fall from their original position and those that fall outside of the blind are likely to fall farther from their original position or move through various taphonomic processes. To account for these variables, the median value of the maximum interior blind dimension is used to map the spatial distribution of blind sizes at the sites. When these values are mapped, two important trends emerges which may be indicative of behaviors and the organization of people during a hunting episode (Figure 6.1). First, blinds are more numerous near areas of wall convergence in the presumed kill zone. From an organizational standpoint, this spatial arrangement of blinds positions more hunters positions in the most critical area of the drive

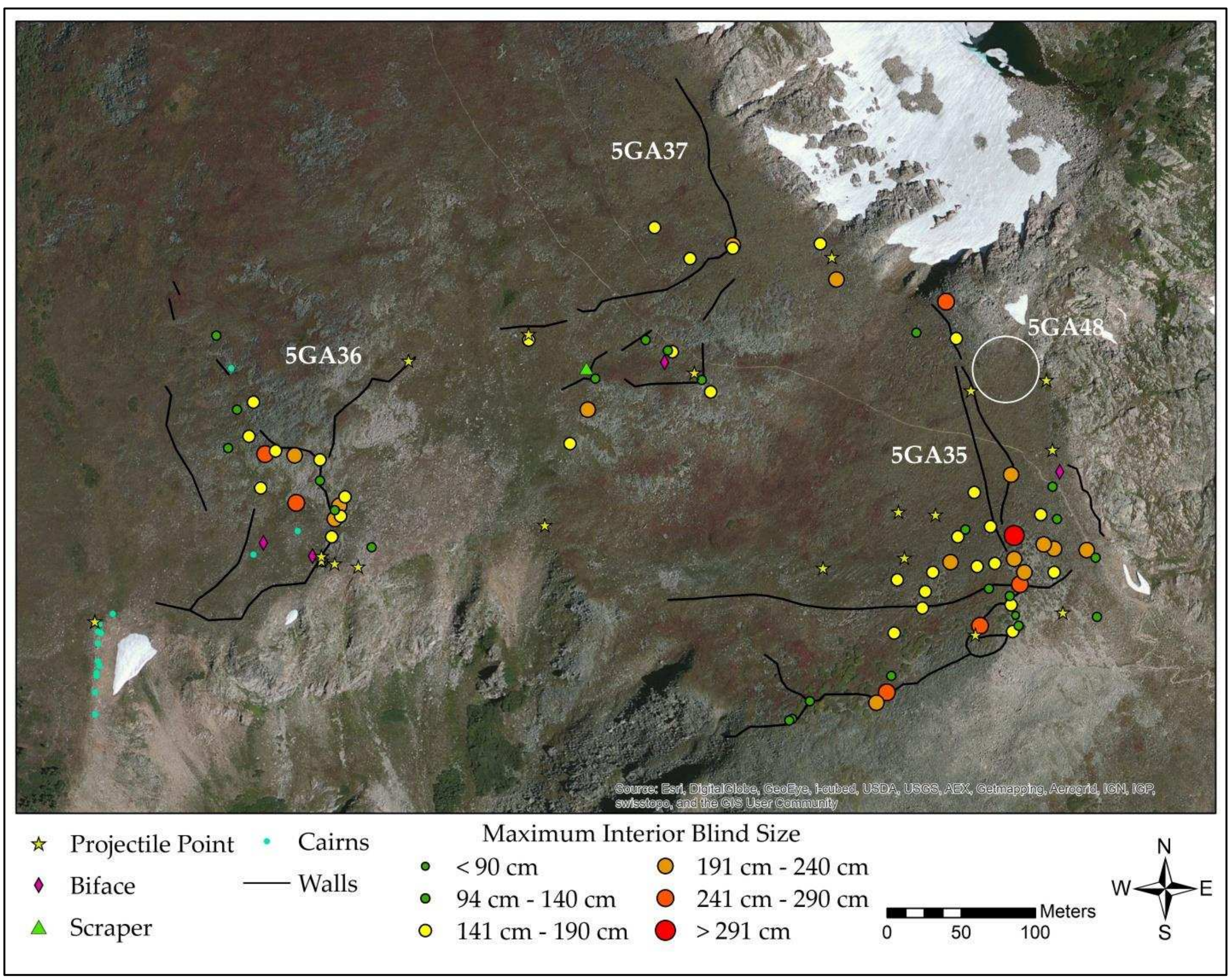


Figure 6.1: Spatial arrangement of blinds mapped by maximum interior blind dimensions.

system and greatly increases the chances of successfully dispatching game. Second, the mapped values of blind sizes indicate that larger blinds tend to be located in the presumed kill zone while smaller blinds tend to be located outside of this area. Larger blinds can potentially accommodate multiple hunters and by constructing larger blinds in the kill zone, more hunters could be positioned in this important location within the drive system (LaBelle 2012). Additionally, it was shown that blinds served multiple roles in addition to concealment (Binford 1978) and larger blinds may have helped accommodate these additional roles and associated behaviors.

Analysis of the spatial distribution of blinds also reveals several trends which provide evidence for human behaviors associated with these features. Blind density shows the same general trend across all three sites; each site tends to have a dense concentration of blinds in and around areas of wall convergence (Figure 6.2). However, the sites differ in the overall size and intensity of this area. 5GA35 is the largest (both spatially and the number of features) of the three and shows the greatest variability in blind location and size. The site also has the largest apparent kill zone. 5GA36 exhibits a somewhat similar pattern with a concentration of blinds in areas of wall convergence. However, the density of blinds at 5GA36 also extends north along the wall whereas the blinds at 5GA35 tend to stay clustered in and near the kill zone. This difference may be the result of local topography and environment. The kill zone at 5GA35 is largely positioned on a gentle alpine slope composed primarily of alpine bunch grasses and thus is less constricting to animal movement. The wall and associated blinds extending north from the kill zone at 5GA36, however, are located on a steep talus slope. This local environment was likely more amenable to hunting as the talus would severely restrict the movement of

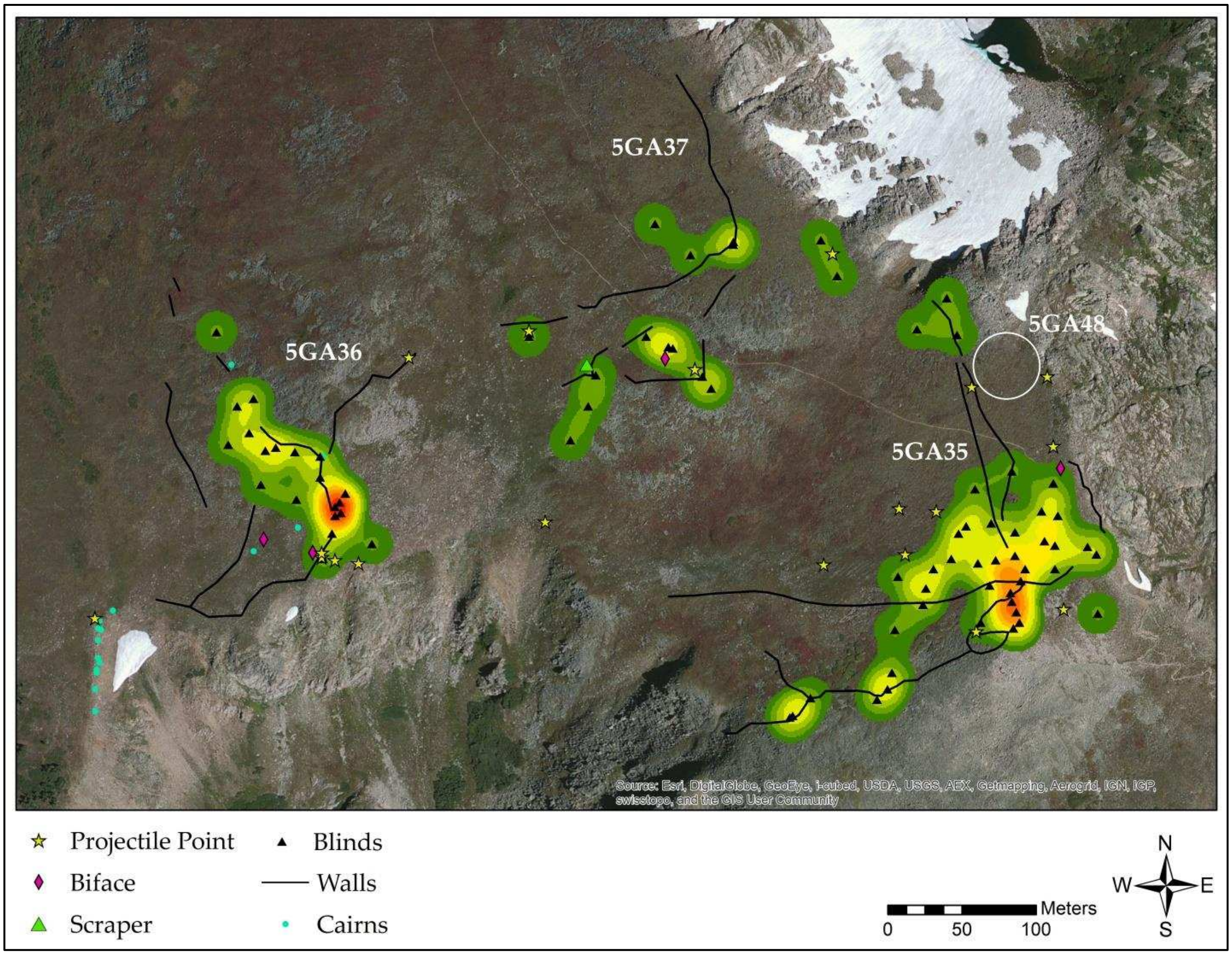


Figure 6.2: Spatial arrangement of blinds with a kernel density overlay showing areas of high intensity (in oranges and red) and low intensity (greens).

game. Additional blinds constructed along this wall would effectively elongate the kill zone away from the area of wall convergence north along the wall. The pattern at 5GA37 is less evident, but there are two areas of low-intensity density, both located near areas of wall convergence. The exact reasons for this lower-than-expected intensity are unknown. The low projectile point count for 5GA37 suggests the site was not used as intensively as the other two game drives. If the low count is representative of less-intensive use, then it follows that the site would have fewer features. The location of the site on the landscape may have played a role in this less-intensive use. Site 5GA37 is situated in a setting with no natural restrictions and animal movement across this area was likely more sporadic and/or dispersed. This is opposed to 5GA36, which sits just upslope of the upper stretches of the sub-alpine forest where animals shelter or 5GA35 where the site is bound on three sides by steep talus slopes or cirques. This setting likely made 5GA37 an unreliable location where hunters could expect to encounter game and, therefore, the site saw less intensive use.

When the two variables described above (blind size and density) are combined, a more holistic picture of the use of the game drives emerges. First, large blinds are clustered in areas of high overall blind density and these areas are located around areas of wall convergence (Figure 6.3). As discussed previously, large blinds likely held multiple roles during a hunting event including pre-hunting activities such as the production and maintenance of tools (Binford 1978). But they also held a pivotal role in the execution of the hunt itself as well. A concentration of larger blinds in the intended kill zone likewise concentrates hunters in this crucial location within the game system. This organization keeps a majority of the hunters within visual (and sometimes vocal) communication range, a fact that no-doubt made the various hunting activities easier to conduct, and gave the hunters the best chance for success.

The spatial distribution of artifacts, particularly their spatial relationship to walls and blinds show an important trend with implications for human behaviors, activity areas, as well as future archaeological work at alpine game drives. The data indicate that artifacts show a strong tendency to be located within 20 meters of blinds, walls, or both (Figure 6.4; Table 6.3). Twenty meters represents the maximum effective bow/dart range from each of the blinds (Blehr 1990; Dalton 2011; Pope 1918, 1923; Tomka 2013). Several tools, particularly projectile points, are

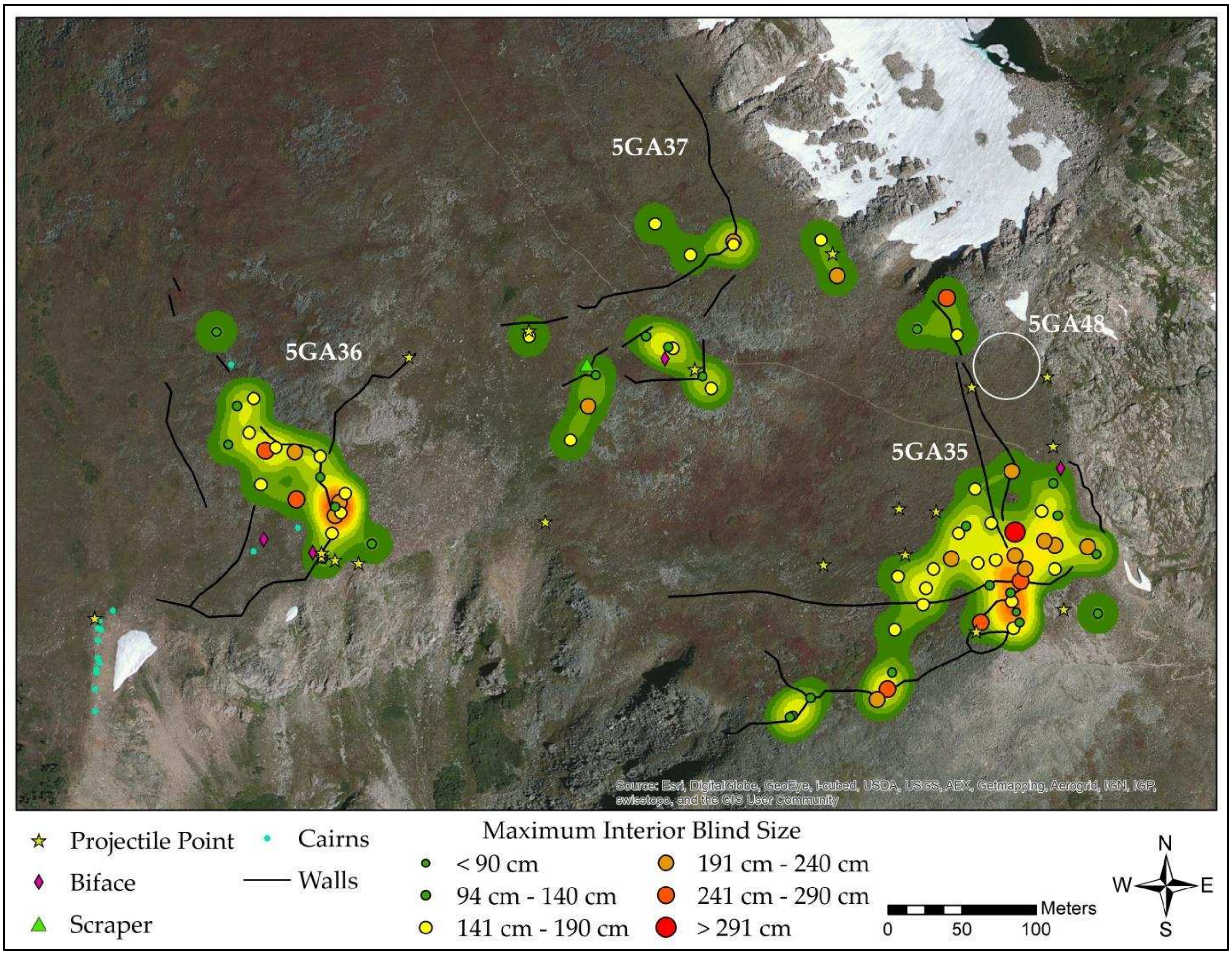


Figure 6.3: Spatial arrangement of blinds mapped by maximum interior blind dimensions with a kernel density overlay showing areas of high intensity (in oranges and red) and low intensity (greens).

located near this 20 meter margin and may represent missed shots resulting in lost tools. Additionally, numerous projectile points are located within two meters of blinds or walls and may represent successful shots resulting in broken and subsequently discarded projectile points. If the spatial distribution of artifacts can serve as a proxy for activity areas, spatial analysis suggests that most artifacts found within 20 meters of blinds may be related to the hunt itself. Conversely, several flakes, a few bifaces, and a scraper have been found on the surface outside of this 20 meter zone. Artifacts found outside of these areas may be related to pre- or

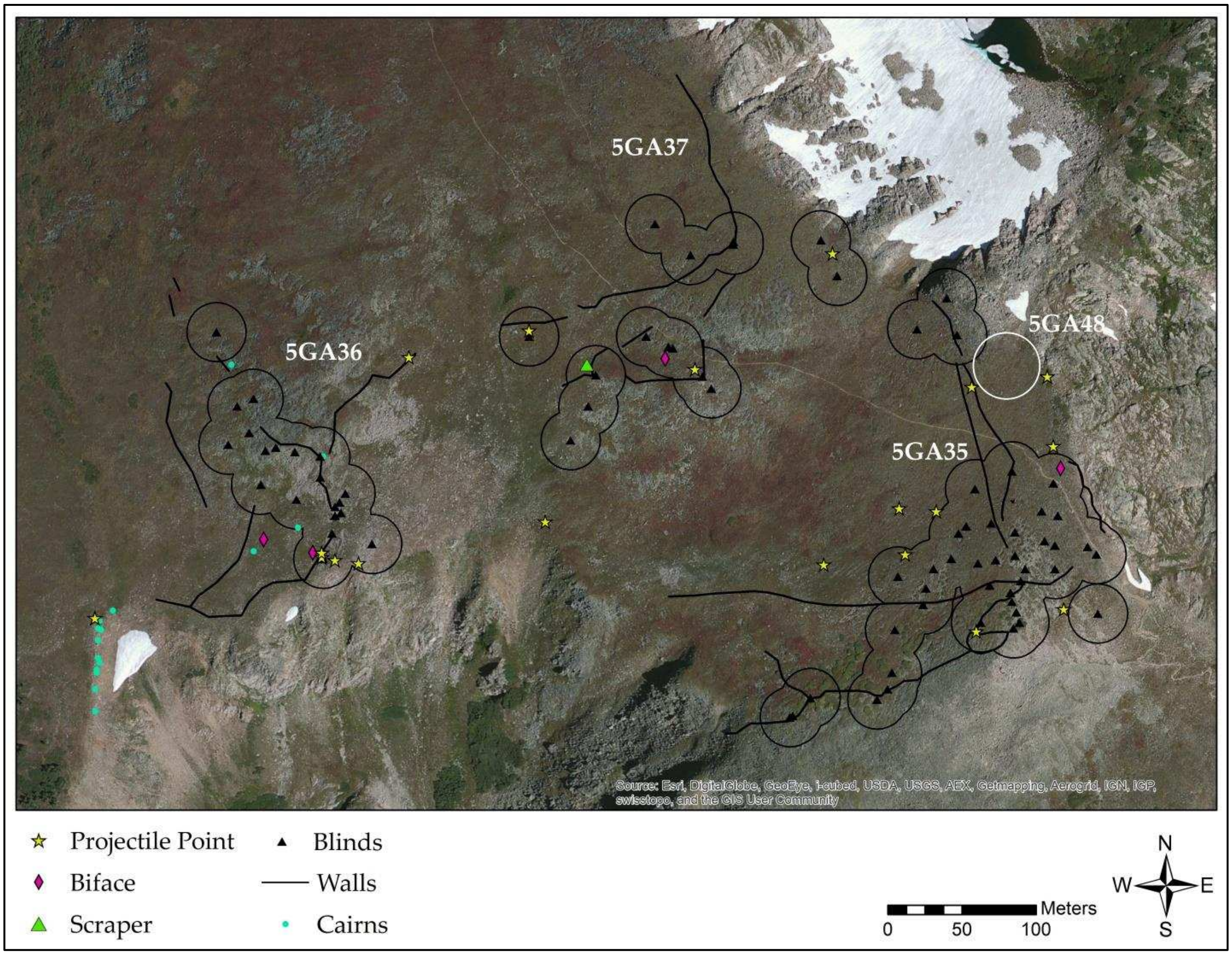


Figure 6.4: Spatial arrangement showing the relationship of site features and artifacts with a 20 meter buffer applied to the blinds.

post-hunt activities such as tool production and maintenance or game processing. It is also possible that these represent lost tools.

Table 6.3: Spatial distribution of all tools to blinds for each of the three hunting sites.

	5GA35		5GA36		5GA37		Total	
	Count	Percent Total	Count	Percent Total	Count	Percent Total	Count	Percent Total
Within 20 meters	4	40%	6	60%	4	80%	14	56%
Outside 20 meters	6	60%	4	40%	1	20%	11	44%
Total:	10	100%	10	100%	5	100%	25	100%

Protein Residue Analysis

The following is a synthesis and interpretation of protein residue analysis conducted on a sample of the artifact assemblage. For the full report and an introduction and discussion of the use of protein residue analysis in archaeological analysis prepared by the Laboratory of Archaeological Sciences at California State University, Bakersfield see Appendix E.

The paucity of preserved faunal remains at alpine game drives in the Colorado Front Range continues to hinder conclusive archaeological interpretations regarding which animals were targeted by prehistoric hunters utilizing these game drives. While there are isolated reports of faunal remains at a few of these drive systems (e.g. LaBelle and Pelton 2013), there still exists a dearth of tangible evidence regarding the target animal species at these game drives. Most arguments rely on inferences made from modern ecological studies regarding environmental contexts and animal behavior. A scientific-based approach to the problem with deciphering the target species of Colorado game drives is using protein residue analysis. As opposed to ethnographic research and oral histories, which rely on associations and accounts of activities that are not directly observed, protein residue analysis provides archaeologists the opportunity to directly link artifacts with their usage on animal species. Studies by several researchers indicate lithic artifacts can retain residual traces of organic compounds obtained through their original use (Briuer 1976, Gerlach et al. 1996, Hyland et al. 1990, Kooyman et al. 1992, Loy 1983, Loy and Hardy 1992, Loy and Dixon 1998, Newman et al. 1993, Yohe et al. 1991; Yohe and Bamforth 2013). Despite claims to the contrary (Cattaneo et al. 1993, Eisele et al. 1995), protein residue analysis is a method that can provide tangible evidence for the association of artifacts with animal species procured at high elevation game drives.

Gaining a better understanding of which animal species were targeted at the game drives and processed at 5GA4268 will enhance the interpretive power of the thesis. Although it is suspected that bighorn sheep (*Ovis canadensis*), elk (*Cervus canadensis*), and/or mule deer (*Odocoileus hemionus*) were the likely animals harvested at high elevation game drives, little solid evidence of their zooarchaeological remains has yet been uncovered. This is mainly due to the harsh environment of the alpine tundra environment and its propensity to quickly destroy bone (e.g. acid soils, long-term exposure before burial, and gnawing by small animals) (Benedict 1996; Olson 1971). As such, only the youngest game drives have produced identifiable faunal material, including bighorn sheep (LaBelle and Pelton 2013; Olson 1971), mule deer (Cassells 1995, 2000), and antlered species such as deer or elk (Benedict 1975a). Bighorn sheep bone from the Olson site returned radiocarbon ages of 80 ±25 BP and 140 ±25 BP, both firmly in the Protohistoric or Historic period (LaBelle and Pelton 2013), providing further evidence that it takes special preservation situations to preserve old faunal material in alpine areas. Without substantial zooarchaeological evidence to aid interpretation, alternative, multidisciplinary, sources of evidence must be used. One alternative approach is protein residue analysis.

Protein residue analysis has been successfully applied in many studies to determine a species of origin for organic compounds identified on chipped stone tools. One particularly pertinent case study comes from the De Long Mountains of Alaska where the archaeological context of the Red Dog sites closely parallel contexts typically found above treeline in Colorado. That is, the sites produce chipped stone artifacts, but lack stratigraphy, organic materials, and/or preserved faunal material. Protein residue analysis was conducted on all 25 lithic artifacts collected from the site to determine which animal species were being processed at these sites. The analysis was successful on 14 of the 25 (56%) artifacts, and identified a number of different species (Gerlach et al. 1996). This high success rate was likely due to the fact that these artifacts were collected with protein residue analysis in mind, which included special collection and storage methods above and beyond standard archaeological practices, and this may have artificially inflated the rate of preservation of identifiable protein residue. Other studies (e.g. Kooyman et al. 1992) show a preservation rate of 25%-30% for artifacts collected and curated using standard archaeological techniques.

The appropriateness of protein residue analysis is further supported by case studies in Colorado in which this method has been successfully applied to archaeological investigations. Investigations at the Jerry Craig site in Middle Park included protein residue analysis on four projectile points recovered during excavations as well as on the surrounding sediments. This analysis used the immunoelectrophoresis technique. Analysis was successful on the sediment surrounding the projectile points and two of the projectile points, testing positive for deer and bison antiserum (Kornfeld and Frison 2000). The results from this analysis along with the tool types are interpreted as a butchery event (Kornfeld and Frison 2000). Across the Continental Divide on the Front Range, archaeological investigation of the Mahaffy cache from Boulder, Colorado similarly used protein residue analysis on tools to better understand the age of the cache, by way of identified species (Yohe II and Bamforth 2013). This analysis subjected all 83 artifacts recovered in the cache to cross-over immunoelectrophoresis. Four of the 83 (5%) reacted positively to antigens from four different taxa: sheep, bear, horse, and camel (Yohe II and Bamforth 2013). This study was important for understanding the age of the Mahaffy cache, as two of the four taxa are known to have gone extinct during the terminal Pleistocene (Yohe II and Bamforth 2013). This age is important for the current study as it demonstrates that artifacts recovered in Colorado can retain protein residues for a considerable time. Together, these studies demonstrate the usefulness of protein residue analysis in addressing a range of questions regarding prehistoric lifeways in Colorado.

One issue with protein residue analysis is the possibility that it will produce a positive result for species not known to occur in locations where the artifact was deposited, often argued as the result of re-use and/or transport of an artifact. This was encountered by E. Steve Cassells (1995, 2000), who used protein residue analysis on a total of 21 chipped stone artifacts to identify possible animal species hunted at the Sawtooth game drive in the Indian Peaks Wilderness Area, about 23 kilometers north of Rollins Pass. The 21 chipped stone artifacts came from a variety of contexts, including the surface of drive lanes, within hunting blinds, and from excavation. Only one of the 21 artifacts used in the analysis (5%) produced positive results. A projectile point collected from a surface context of a drive lane showed a weak reaction to pronghorn antelope (*Antilocapra americana*) (Cassells 1995, 2000), a species not historically known to inhabit alpine environments. This is likely the result of leftover residue from a previous use of the tool at lower elevations and subsequent transport to the game drive (Cassells 1995, 2000). Despite this cautionary tale, the use of protein residue analysis on chipped stone artifacts from the game drives and 5GA4268 is still a useful endeavor as the potential for positive data far outweighs the cost of such analysis.

Results

Cross-over immunoelectrophoresis (CIEP) protein residue analysis was conducted on a sample of 15 chipped stone tools recovered in the late 1960s and early 1970s by Olson and Benedict (Olson and Benedict 1970) and by the CMPA in the 2010s, including eight projectile points, four bifaces, and three scrapers (Table 6.4). One projectile point and one biface are from excavated contexts; the remaining artifacts are from surface contexts from varying locations within the drive system. Although these samples are derived from surface contexts, protein residue has been shown to withstand harsh environmental treatment and can adhere to artifacts for a considerable amount of time (Kooyman et al. 1992, Lowenstein 1992, Loy and Hardy 1992) and is therefore a viable method of analysis to address these specific questions of the thesis.

Table 6.4: Summary of artifacts used in protein residue analysis.

	5GA35	**5GA36**	**5GA37**	**5GA4268**
Excavated	1 Projectile Point 1 Biface	NA	NA	NA
Surface	6 Projectile Points 1 Biface	None Selected	1 Biface	1 Projectile Point 1 Biface 3 Scrapers

The spatial location of these samples is important as different aspects of the game drive likely functioned in different ways and held different roles in the hunt (LaBelle and Pelton 2013) (Table 6.5). Earlier research on the spatial distribution of site features and artifacts of game drives suggests that activity associated with a hunt would likely be located near areas of wall convergence in the presumed kill zone (LaBelle and Pelton 2013; Whittenburg 2014; Chapter 6, this thesis). Therefore, projectile points drawn from these zones have the highest probability of having been used in a hunt and, thus, contain protein residue. Finally, five samples were drawn surface contexts at 5GA4268. These tools consist of end- and side-scrapers and have a high probability of use in post-hunt processing of game taken during the hunt.

Table 6.5: Location of artifacts within the game drive. Positive results are bolded and highlighted.

		Blind	Drive Wall	Kill Zone	Atlatl/Bow Shot	Other	Unknown	Activity Area
5GA35	*Excavated*	1 P.P. 1 BF	0	0	0	0	0	0
	Surface	0	**1 P.P**	0	1 P.P.	2 P.P. **(1 positive)** 1 Biface	2 P.P. **(1 positive)**	0
5GA36	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	0	0	0	0	0
5GA37	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	1 BF	0	0	0	0
5GA4268	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	0	0	0	0	**1 P.P** 1 BF 3 SP

The 15 artifacts were tested against a suite of ten animal antisera (Table 6.6). The animal antiserums used for this analysis were selected based on 1) fauna known to have inhabited the region historically; 2) fauna known to have been prey species for prehistoric hunters in the region; and 3) antiserums available for testing at the Laboratory for Archaeological Sciences at

Table 6.6: Summary of antiserum used in protein residue analysis and the possible prey species in Colorado available to prehistoric hunters associated with each antisera. References for possible prey species: Tate and Gilmore 1999; Reed and Metcalf 1991.

Antiserum	Reacts with	Possible Prey Species in Colorado
Bear	Black, Grizzly, Polar, etc.	Black bear; Grizzly bear
Bovine	Bison, Cow, Musk-Ox	Bison
Canine	Coyote, dog, Wolf, etc.	Coyote, Fox, Wolf
Deer	Caribou, Deer, Elk, Moose	White-tailed deer, Mule deer, Elk, Moose
Feline	Bobcat, Lynx, Mountain Lion, etc.	Bobcat, Lynx, Mountain Lion,
Guinea Pig	Beaver, Guinea pig, Porcupine, Squirrel	Beaver, Marmot, Porcupine, Squirrel
Horse	Donkey, Horse, Kiang, etc.	Horse
Pronghorn	*Antilocapra americana*	Pronghorn (*Antilocapra americana)*
Rabbit	Hare, Pika, Rabbit	Pika, Rabbit, Snowshoe hare
Sheep	Bighorn, Domestic, etc.	Bighorn sheep

California State University, Bakersfield. The antiserums generally test to the family level of taxonomy (except in the case of pronghorn), but by cross referencing those families with known historic ranges of animals it is possible to narrow down the possible genus and species represented (Table 6.6).

Four of the 15 samples (27%) reacted positive for animal protein residue (Table 6.7). Two samples (35.90 and 35.93) reacted positive against bovine antisera, one sample (36.2*) reacted positive against deer antisera, and one sample (48.3) reacted positive to pronghorn antisera. As is standard practice, all artifacts showing positive reactions were subjected to a repeated analysis to verify the results. None of these samples reacted positive to a second analysis. The absence of protein residues on artifacts may result from a number of variables, including poor preservation of protein, insufficient protein amounts, or that they were not in contact with any of the animals included in the antisera tested.

Discussion

While few solid conclusions can be drawn on the basis of the limited sample and lack of positive re-tests, it is still worthwhile to discuss the presence of residual protein residues on a high percentage of the samples and the representation of numerous species. All of the positive reactions occurred on projectile points of indeterminate point styles, represented by two midsections and two tips. None of the scrapers or bifaces tested positive. The four positive reactions represent three different antiserums, bovine (2), deer (1), and pronghorn (1). As shown

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* As discussed in a previous chapter on the artifact assemblage, artifact 36.2 was incorrectly catalogued as being from 5GA36 and is, instead, located within the site boundary of 5GA35.

in Table 6.6 above, a bovine reaction may be indicative of bison hunting while a pronghorn reaction indicates hunting of *Antilocapra americana.* While bison are known historically to use the alpine zones of Colorado as migration corridors (Fryxell 1928; Meany and Van Vuren 1993;

Table 6.7: Summary of the results of protein residue analysis.

Catalog Number	Site	Artifact Type	Provenience	Spatial Location	Results – Antiserum	Possible Prey Species
35.87	5GA35	Biface	Excavation	Blind	Negative	
35.88	5GA35	Projectile Point	Surface	Unknown	Negative	
35.89	5GA35	Projectile Point	Excavation	Blind	Negative	
35.90	**5GA35**	**Projectile Point**	**Surface**	**Unknown**	**Positive – Bison**	**Bison**
35.93	**5GA35**	**Projectile Point**	**Surface**	**Other**	**Positive – Bison**	**Bison**
35.95	5GA35	Projectile Point	Surface	Atlatl/Bow shot	Negative	
35.97	5GA35	Biface	Surface	Other	Negative	
35.99	5GA35	Projectile Point	Surface	Other	Negative	
36.2	**5GA35**	**Projectile Point**	**Surface**	**Drive Wall**	**Positive – Deer**	**Deer, Elk, Moose**
37.1	5GA37	Biface	Surface	Kill Zone	Negative	
48.3	**5GA4268**	**Projectile Point**	**Surface**	**Activity Area**	**Positive – Pronghorn**	**Pronghorn**
48.4	5GA4268	Biface	Surface	Activity Area	Negative	
48.7	5GA4268	Scraper	Surface	Activity Area	Negative	
48.11	5GA4268	Scraper	Surface	Activity Area	Negative	
48.12	5GA4268	Scraper	Surface	Activity Area	Negative	

Toll 2003) it is unlikely they were the quarry prehistoric hunters sought. Even at the height of their physical representation, it is unlikely the drive walls would contain animals as large as bison. Secondly, no bison bone-beds are known to exist in the Indian Peaks or adjacent Rocky Mountain National Park (Benedict 1996). Similarly, *Antilocapra americana* are not known to have used the Colorado alpine zones. However, the exploitation of both animals is well documented in both Middle Park on the west side of the Continental Divide (e.g. Kornfeld et al. 1999; Kornfeld and Frison 2000) and on the Great Plains to the east (e.g. Johnston 2016; Todd et al. 2001). These positive reactions should not be taken as indicative that these animals were hunted at the alpine game drives. Instead, it seems likely that these projectile points were used on previous hunts but were still in working condition and reused at the Rollins Pass game drives, where they were broken or lost as the result of an unsuccessful throw or shot attempt which carried the projectile point outside the intercept zones. Their location outside of the intercept zones supports this interpretation.

A fourth projectile point reacted positively to deer antiserum and may indicate the hunting of deer, elk, or moose at the game drives. Moose is an unlikely candidate, as their more solitary behavior is not conducive to communal hunting. Elk or deer seem the most likely candidate; both exist in the area today. Benedict (1996) suggests that game drives built near tundra ridges or along rocky terrain were likely used to hunt bighorn sheep while game drives built away from these areas on grassy slopes near forest cover were likely used to hunt elk or deer. The geographic setting of the three game drives supports either interpretation. The alpine zone continues west and north of the site, gradually grading into the forested sub-alpine zone approximately three quarters of a mile to the west. Based on these two lines of evidence, it seems likely that at least one episode of elk or deer hunting took place at 5GA35.

The lack of any positive re-tests on these four projectile points limits the interpretative power of the protein residue analysis. Lack of positive re-tests may be the result of two different processes with drastically different interpretations. First, the harsh alpine environment may not be conducive to good preservation of blood proteins on tools. This would leave little protein to be detected by a single residue analysis, much less a second round of analysis on the same tool. Second, the results are simply a false positive. It seems unlikely there would be false positives for four different antisera in almost 25% of the samples, however. Instead, it seems likely that the alpine environment is not conducive enough for adequate protein preservation to allow a second positive reaction on the same sample. Despite this limiting factor, protein residue analysis is still believed to enhance the interpretations in this thesis.

Conclusion

Understanding the spatial distribution and relationship of site features and artifacts is key to understanding the behavioral organization or activities of hunters at Rollins Pass. The spatial distribution of features and artifacts, and the resulting behavioral organization and activities associated with them, strongly suggests that the areas near wall convergence in the apparent kill zone were the focal points for hunting activities. The dense concentration of large blinds in these areas indicates that a majority of the people involved with the hunt were positioned in these locations. This behavioral organization kept hunters in visual and vocal communication with one another and placed them in close proximity to animals as they reached this critical part of the drive system. Projectile points and other tools were broken or lost through use and their location in relation to blinds and walls is indicative of certain activity areas. Tools found within 20 meters of blinds are likely directly related to the hunting activity. Tools found outside of this 20 meter zone are likely related to pre- or post-hunt activities as these artifacts tend to be bifaces, scrapers, and flakes rather than projectile points.

Data from the protein residue analysis was inconclusive as to which animals were specifically targeted at the Rollins Pass game drives. None of the four positive results retested positive. The positive results are for a variety of animals, including two bison, one pronghorn, and one elk/deer. The presence of proteins from these animals on the projectile points is unsurprising but its presence need not be taken as an indication that those animals were hunted at the sites. Elk and/or deer are the only likely candidate out of the three as these animals are known to utilize the alpine tundra on a regular basis. The positive results for bison and pronghorn, if true, provide interesting evidence for the reuse of projectile points by groups. Bison and pronghorn are known to have utilized both the western Great Plains and Middle and North Parks (at least prehistorically, in the case of bison), so it is unsurprising that prehistoric populations also utilizing these areas hunted these animals.

The data indicate that hunting parties at Rollins Pass constructed sites in such a way as to maximize the number of hunters located in the kill zone near areas of wall convergence. From these blinds, concealed hunters made final preparations to their projectile points and laid in wait as the animals were slowly pushed into the drive system by other members of the hunting party. The cairns and drive walls guided the animals into an increasingly restricted area and effectively limiting movement and escape routes. Hunters maintained visual communication with one another as the animals moved through the drive system and when they were within dart/bow range, hunters stood from their positions of concealment and let loose their darts or arrows. In the ensuing chaos, hunters focused on the injured or immobilized animals while allowing the others to escape the drive system. As the excitement of the hunt wound down, hunters dispatched the remaining animals, began preparations for processing, and searched and retrieved missing dart or arrow points.

CHAPTER 7 - THE POST-HUNT

This chapter addresses questions related to post-hunt activities following the completion of a successful hunt. Again, analyses in this chapter pertain to a small spatial scale limited to the sites under investigation. The first part of this chapter builds on the spatial analysis presented in the previous chapter and explores whether there any activity areas specialized to post-hunt activities of butchery and processing. And related, if activity areas are present, where do these occur spatially within the sites? The basis for studying specialized activity areas in this context are largely the same as outlines in the previous chapter and, thus, will not be restated here. The second part of this chapter explores specific activities related to post-hunt activities. High powered use wear analysis was conducted to address this question as it can identify signatures left on tools by specific activities (Keeley 1980; Semenov 1964). This analysis was conducted to elucidate more specific activities at the sites in addition to the broad behaviors that can be gleaned from more macroscopic analysis of the chipped stone assemblage.

Activity Areas

Primary post-hunt activities associated with the game drives include processing of carcasses and repairing damaged projectile points or other tools. Several pieces of evidence indicate if and where these post-hunt activities occur, including: presence of butchered bone, numerous processing tools (i.e. scrapers, bifaces, grinding slabs), flake tools or edge modified flakes, and chipping debris indicative of informal tool production. There is no definitively prehistoric bone reported from any of the three game drives sites or 5GA4268 that would indicate substantial post-hunt processing occurred at the sites. As discussed previously, the lack of faunal material at game drive sites indicates either a taphonomic issue with preservation or a repeated human behavior of removing animals from the site before extensive processing of the carcasses. The artifact assemblage from the game drives and 5GA4268 do, however, contain numerous tools and debitage that can be used to elucidate these possible activities. The spatial location of the artifacts within the drive system also gives evidence as to where activities occurred. The methods used for this spatial analysis are the same as the methods used in the previous chapter and, thus, only discussion of this particular analysis is presented below. Spatial analyses are based on visual interpretation of maps produced in *ArcGIS 10.4* and, as such, are difficult to quantify and discuss in the results section. Data on artifact attributes are presented elsewhere in this thesis (see previous chapters and Appendix A and B) and are not repeated here. These analyses and maps are incorporated into the following discussion section.

Discussion

Post-hunt activity in the kill zone, but outside of the blinds, appears to be limited to the removal of carcasses from the area to other activity areas for processing. The presence of three bifaces and a scraper in or near the kill zones at 5GA36 and 5GA37, however, suggests at least initial disarticulation may have taken place in those areas. The opposite pattern is evident at 5GA35; the kill area is devoid of any tools or projectile points. This difference may be related to the size class of the target species (Table 7.1) (Bunn 1982; Kelly and Thomas 2012; Lyman 1984) or the overall size of the game drive and resulting number of animals. If elk were the target

Table 7.1: Size class definitions and examples. Based on Bunn (1982), Lyman (1984), and Kelly and Thomas (2012).

Size Class	Definition (live weight)	Examples
1	Less than 50lbs	Rodents, Rabbit
2	51-150lbs	Wolf; Pronghorn Antelope
3	251-750lbs	Mule Deer; Bighorn Sheep
4	751-2000lbs	Elk; Bison

species, disarticulation of the carcass may be needed before it could be removed to a different location for additional processing. Bighorn sheep or small deer, however, could likely be removed as a complete package. Ethnographic evidence from the Northern Paiute, who carried unbutchered mule deer carcasses back to camp using tumplines (Fowler 1989), indicates this is easily done. More importantly, though, the difference between the game drive sites may be related to the size of the game drive and the number of animals killed during a hunt (Figure 7.1). 5GA36 and 5GA37 are smaller game drives individually, containing less than half the number of blinds as 5GA35. A smaller hunt and the resulting fewer number of animals killed may not require hunters to remove the animals to a more specialized area and, instead, processing could be done individually where the animal was killed. Alternatively, 5GA35 could accommodate a much higher number of hunters. The large numbers of animals killed by these hunters necessitated a group effort for efficient processing which required that animal carcasses be removed to a centralized location (5GA4268) where the group worked together to process the carcasses.

Post-hunt activity in blinds is limited to retooling broken tools and possible snacking on small bits of marrow or meat. Evidence for the latter comes primarily from ethnographic data (Binford 1978) but also from the presence of a possible hearth found during excavation of blind

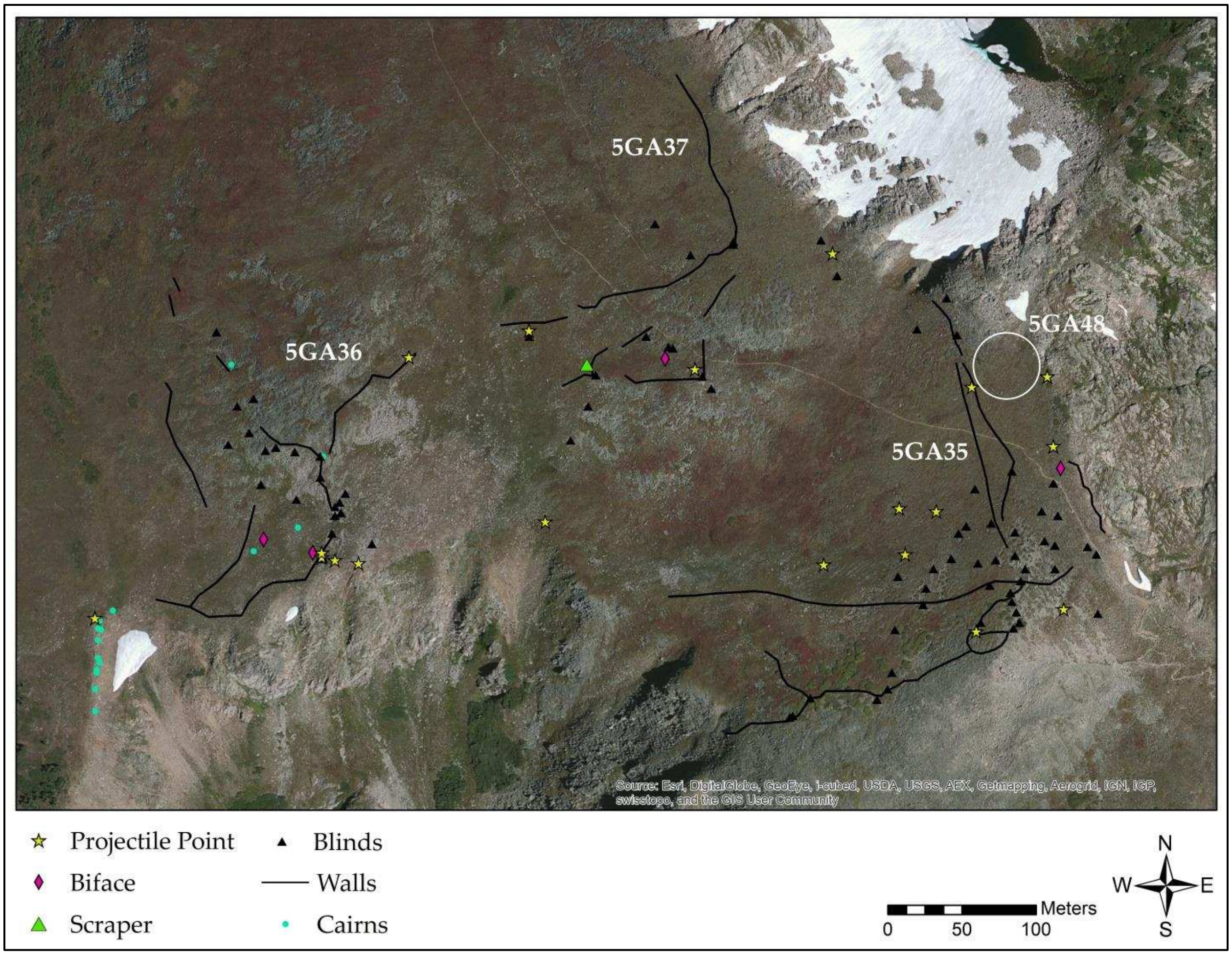

Figure 7.1: Overview of the three game drives and 5GA4268 showing the size of each site in relation to one another.

513 by Olson and Benedict (1970). It must be noted, though, that the hearth could also be indicative of pre-hunt activities occurring within the blinds as well. Although bone has not been recovered from blinds at the three game drive sites under investigation in this thesis, limited quantities of bone have been found in the context of blinds at other game drive sites along the Continental Divide (Cassells 1995, 2000; LaBelle and Pelton 2013). The numerous chipping debris found in the context of blinds during excavation and survey provides evidence that blinds served as a location for the late-stage production of tools or the repairing of broken tools.

The chipping debris is largely small, late-stage production flakes and angular debris exhibiting no cortex. Late-stage chipping debris was also found in large quantities during excavations of blinds at the Sawtooth game drive (Cassells 1995, 2000) adding additional evidence for the variety of roles which blinds served during a hunting episode. Given that blinds were likely focal points for activity throughout all phases of the hunt, it is impossible to parse out during which phase of the hunt these activities occurred.

5GA4268 likely represents a specialized activity area for processing game killed during a hunt at 5GA35 and possibly for repairing damaged projectile points. The presence of six scrapers, a (non-projectile point) biface, and over 50 edge modified flakes strongly suggest that this site served a specialized processing role in the game drive sequence. Scrapers are reported from around the world and in numerous archaeological periods and are generally interpreted as hide working tools (Hayden 1979; Kamminga 1982). Additionally, the proportion of edge modified flakes to debitage is nearly 1:1, suggesting an intensive use of available raw material for the processing of carcasses, in this case the removal of meat packages from bone. The debitage at 5GA4268 indicates a minimal amount of tool production or maintenance occurred on-site. A majority of the debitage, however, is indicative of the production of informal tools for the sole purpose of processing game. The assemblage is characterized by a high percentage of Troublesome Formation chert or clear chalcedony (see chapter 5 above); these are same raw materials that characterize a majority of the tool assemblage from the site. Furthermore, the assemblage is characterized by a higher proportion of large primary flakes than the assemblage from the context of blinds. Lyons sandstone milling slab fragments are also reported from the site, adding additional evidence for processing activities, such as plant processing. The spatial proximity of these tools and debitage from 5GA4268 to 5GA35 along with the lack of similar tools in the kill zone of 5GA35 are strong indicators that 5GA4268 served as, at least, the initial processing location for game killed during a hunt at 5GA35.

Use Wear Analysis

The following is a synthesis and interpretation of use-wear analysis conducted on a sample of the artifact assemblage. For the full report and an introduction and general discussion of use wear analysis in archaeological investigations prepared by Flora Church, Cultural Resource Analysts Inc., see Appendix F.

Use wear analysis (also called microwear by some researchers) is useful for identifying the signatures of specific activities on tools and may help elucidate on-site behaviors. Use wear analysis seeks to attribute specific wear and polish patterns found on chipped stone tools with specific activities performed with those tools (Bamforth 1988; Keeley 1974, 1980; Rots 2005; Semenov 1964). Identifying these activities can elucidate the exact nature of behaviors exhibited at a site. Coupled with spatial data for the tools, this becomes a powerful tool for analyzing the locations of specific behaviors and the relationship of behaviors within and between sites. Although behaviors associated with these game drives and nearby lithic scatters are broadly known (or assumed based on perceived tool function), more specific behaviors are less well understood. A more holistic interpretation of the relationships of behaviors within and between sites is provided by tying specific activities revealed by use wear analysis with spatial data.

Results

High-powered microscopic use wear analysis was conducted on a sample of 15 chipped stone tools recovered in the late 1960s and the early 1970s by Olson and Benedict (Olson and Benedict 1970) and by the CMPA in the 2010s, including eight projectile points, four bifaces, and three scrapers (Table 7.2). These are the same sample of chipped stone tools as was used in protein residue analysis discussed in the previous chapter. The suite of tools were selected for their perceived difference in functions, i.e. projectile points for hunting, bifaces for butchery, and scrapers for hide processing.

Table 7.2: Summary of artifacts used in use wear analysis.

	5GA35	5GA36	5GA37	5GA4268
Excavated	1 Projectile Point 1 Biface	NA	NA	NA
Surface	6 Projectile Points 1 Biface	None Selected	1 Biface	1 Projectile Point 1 Biface 3 Scrapers

The spatial location of these samples helps discern and add further evidence to the activity areas described above (Table 7.3). Earlier research on the spatial distribution of site features and artifacts of game drives suggests that activities related to different phases of the hunt would be located in different, but sometimes overlapping, locations. (LaBelle and Pelton 2013; Whittenburg 2014; Chapter 6 and 7, this thesis). As such, the sample was drawn from various locations throughout the drive systems and from 5GA4268.

The 15 artifacts were analyzed at magnifications of 80X, 250X, and 300X to analyze the tool edges for evidence of polishes and striations that result from specific activities. Both the action and the material worked can be distinguished at this level of magnification and, together, provides a detailed description of the use of the tool. The primary actions include chopping, scraping, cutting, slicing, and hafting. The primary materials worked included hide, meat, bone, and wood.

Table 7.3: Location of artifacts within the game drive.

		Blind	**Drive Wall**	**Kill Zone**	**Atlatl/Bow Shot**	**Other**	**Unknown**	**Activity Area**
5GA35	*Excavated*	1 P.P. 1 BF	0	0	0	0	0	0
	Surface	0	1 P.P	0	1 P.P.	2 P.P. 1 Biface	2 P.P.	0
5GA36	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	0	0	0	0	0
5GA37	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	1 BF	0	0	0	0
5GA4268	*Excavated*	0	0	0	0	0	0	0
	Surface	0	0	0	0	0	0	1 P.P 1 BF 3 SP

Eight of the 15 samples (53%) showed signs of use wear in the form of 45 traces related to polishes and/or striations (Table 7.4). Actions are limited to scraping, cutting, slicing, and hafting. Scraping is by far the most dominant action, represented by 60% of all wear traces. Scraping traces are evident on four of the samples and are represented by each of the tool types: one biface (35.87), one projectile point (36.2), and two scrapers (48.11 and 48.12). Cutting is represented by about 16% of the wear traces and is found exclusively on projectile points (35.89 and 35.90). Hafting actions is represented by 13% of the wear traces and is also found exclusively on projectile points (35.88 and 35.89). Finally, slicing activity is represented by 9% of the wear traces and is found exclusively on one projectile point (35.89). Unknown activities account for the remaining 2% of use wear traces.

Table 7.4: Summary of use wear analysis. Bolded artifacts highlight those containing use wear traces.

Catalog Number	Site	Artifact Type	Provenience	Spatial Location	Actions	Materials Worked	Activities
35.87	5GA35	Biface	Excavation	Blind	Scraping	Hide	Scraping greased hide
35.88	5GA35	Projectile Point	Surface	Unknown	Hafting	Hide	Hafting
35.89	5GA35	Projectile Point	Excavation	Blind	Cutting; Slicing; Hafting	Hide; Meat; Bone	Cutting hide/meat; Slicing meat/bone; Hafting
35.90	5GA35	Projectile Point	Surface	Unknown	Cutting	Hide; Meat	Cutting hide/meat
35.93	5GA35	Projectile Point	Surface	Other	No wear traces	No wear traces	No wear traces
35.95	5GA35	Projectile Point	Surface	Atlatl/Bow shot	No wear traces	No wear traces	No wear traces
35.97	5GA35	Biface	Surface	Other	No wear traces	No wear traces	No wear traces
35.99	5GA35	Projectile Point	Surface	Other	No wear traces	No wear traces	No wear traces
36.2	5GA35	Projectile Point	Surface	Drive Wall	Scraping	Hide	Scraping fresh hide
37.1	5GA37	Biface	Surface	Kill Zone	No wear traces	No wear traces	No wear traces
48.3	5GA4268	Projectile Point	Surface	Activity Area	No wear traces	No wear traces	No wear traces
48.4	5GA4268	Biface	Surface	Activity Area	No wear traces	No wear traces	No wear traces
48.7	5GA4268	Scraper	Surface	Activity Area	Unknown	Meat; Hide	Unknown
48.11	5GA4268	Scraper	Surface	Activity Area	Scraping	Hide	Scraping fresh hide
48.12	5GA4268	Scraper	Surface	Activity Area	Scraping	Hide	Scraping greased hide

Materials worked are limited to a single category – animal carcasses. No wear traces related to non-animal material (such as wood or shell) were found. Hide was the most dominant material worked, represented by 78% of all wear traces. Traces of hide working are evident on all samples documenting signs of use wear. Meat working is represented by 27% of the use wear traces and is found on three samples: two projectile points (35.89 and 35.90) and one scraper (48.7). Bone working is represented by 9% of the wear traces and is found exclusively on one projectile point (35.89). Note that the total percentage is greater than 100% because some wear traces include more than one material worked.

Discussion

When actions are combined with materials worked, activities related to the use of the tools in question begin to emerge. Scraping hide is the dominant activity identified by the use wear analysis, accounting for 60% of the activities. Evidence of hide scraping is found primarily on scrapers (48.11 and 48.12) and a biface (35.87) (as would be expected) but is also found on one projectile point (36.2). The spatial context of this activity is highly varied, occurring on tools found in a blind (35.87), along a drive wall (36.2), and at the activity area, 5GA4268. Cutting and/or slicing of meat or bone is the next most common activity, accounting for 27% of activities. This type of use wear exists exclusively on projectile points (35.89 and 35.90) found at 5GA35. The spatial context of this activity is much more restricted than scraping, occurring only in a blind (35.89). The spatial location of 38.90 is unknown. Finally, hafting accounts for the remaining 13% of activities and occurs, as would be expected, exclusively on projectile points (35.88 and 38.89). It is interesting that the remaining projectile points do not show evidence of hafting wear. It is still likely these projectile points were hafted during use but the wear traces are no longer distinguishable even by high powered microscopic analysis.

One of the key objects to microscopic use wear analysis was to discern activities evidenced by wear traces on tools and be able to tie those activities to different spatial contexts within the sites. A suite of post-hunt activities are associated with blinds, including scraping hide and cutting and/or slicing meat and bones. This suggests that blinds served an important role in post-hunt activities in addition to the pre-hunt and hunting activities discussed in previous chapters. Activities associated with 5GA4268 relate primarily to post-hunt activities. The earlier discussed interpretation that this site is an activity area related to post-hunt processing of game is supported by microscopic traces of scraping wear on the tools. Initial post-hunt processing of game took place at the game drives, possibly where the animals ultimately expired. The existence of cutting and/or slicing traces on tools from these areas together with the lack to the same traces on tools from 5GA4268 supports this.

Regardless of the tool type or its spatial context, the activities identified in this study are consistent with a short term occupation of the sites with activities directed towards the procurement and processing of animal carcasses for consumption or transport. Given the overall light wear traces on the tools, it is argued that minimal post-hunt processing occurred on site. On-site processing was limited to the minimum amount needed to facilitate an easy transport of the animal carcasses to lower elevation sites in the alpine basins adjoining Rollins Pass. Processing was likely limited to the disarticulation of major body parts (if larger animals such as elk were taken) into more manageable packages that could then be carried by members of the group to lower elevation camps for further processing. On-going and future research by the CMPA indicates that the sub-alpine elevations surrounding Rollins Pass are rife with archaeological sites that may relate to the use of the alpine hunting sites in the area.

Conclusion

Understanding patterns in the data regarding activities and behaviors and their location within the overall drive system is necessary to understanding the degree to which the role of post-hunt on-site activities played during a hunting episode. Three potential areas of activity are identified for post-hunt activities: the kill zone (outside of blinds), within hunting blinds, and 5GA4268 (). There is little evidence to suggest that a substantial amount of activity occurred in the kill zone (beyond the killing of game) and is limited to three bifaces and a scraper in and near the kill zone at 5GA36 and 5GA37; this may be the result of either a difference in the size of the targeted species or fewer animals taken during a hunt. One biface from this area was submitted for use wear analysis; no wear traces were detected, however. The underrepresentation of butchery tools and debitage in the kill zone is characteristic of a majority of game drive sites throughout the Front Range (Benedict 1992), so it is unsurprising to see a similarly low number of these tools at the game drive sites investigated in this thesis.

Post-hunt activities within blinds include repairing projectile points, possible snacking on marrow or meat, and the processing of carcasses. The quantity of secondary chipping debris, limited tools, and a possible hearth reported from blind 513 indicate that blinds served a critical role during a hunting event. Two artifacts from blinds were submitted for use wear analysis. Both exhibited traces of use wear. A biface (35.87) showed tracing of scraping hide while a projectile point (35.89) showed evidence of cutting or slicing hide or meat. This evidence

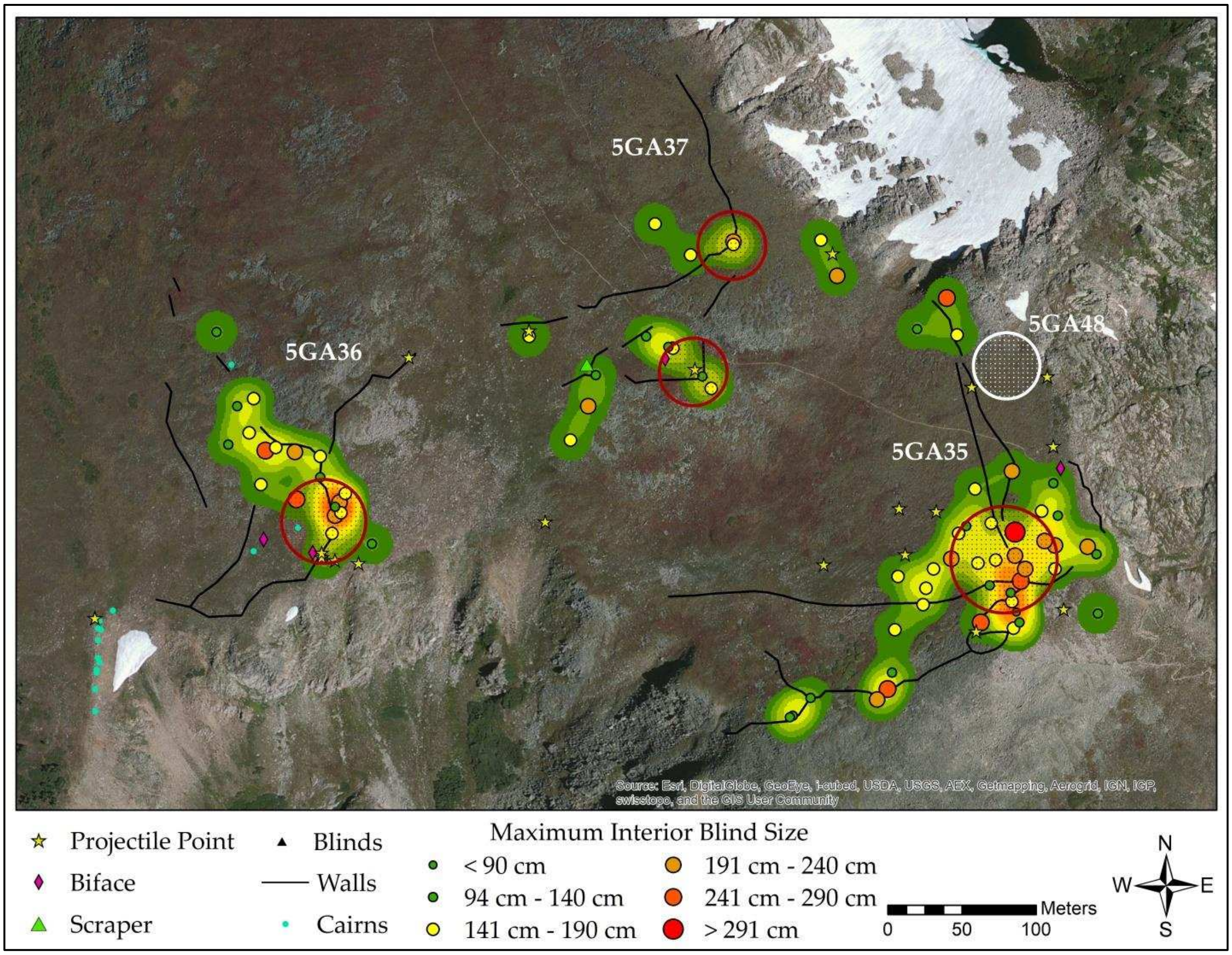

Figure 7.2: Overview of the sites showing the location of the described activity areas. Blinds are presented by their maximum interior measurements. Intercept/kill zones are depicted in red outlined circles. 5GA4268 is shown outlined in white.

indicates that blinds not only served critical roles throughout all phases of a hunt, but also served highly variable roles during any particular phase of a hunt as well. However, it is difficult, if not impossible to distinguishing pre-hunt activities from post-hunt activities within blinds, so caution must be taken when assigning any of the aforementioned activities to a specific phase of use.

5GA4268 functioned as a specialized processing area associated with 5GA35. The tool and debitage data are consistent with disarticulation of carcasses, removal of meat packages from bone, and hide processing. Five tools from 5GA4268 were submitted for use wear analysis and three showed evidence of use wear traces. All three tools with use wear traces were scrapers and two of them (48.11 and 48.12) exhibited evidence of scraping hide. The third scraper had evidence of meat and hide being worked, but the specific action was not distinguishable, although it is likely scraping as well. Regardless of where processing took place within the overall drive system, it appears that it involved minimal butchering of carcasses which were then transported to lower elevations for more intensive processing.

Following a successful hunt, hunters removed the animal carcasses from the kill area to specialized processing areas located outside of the drive system. Activities were largely focused outside of the drive system itself, although a limited number of individuals may have utilized the blinds as locations where they could repair broken tools, snack on small bits of meat or marrow, or begin processing animals. Scraping tools and bifaces were used to process the carcasses and prepare the hides and meat for transport to lower elevation sites or back to winter camps along the Front Range. After minimal processing, hunting parties moved eastward over the Continental Divide and into the sub-alpine basins where water was plentiful and temperatures and wind were less extreme. More intensive processing of game likely occurred in these locations as final preparations were being made to vacate the mountains with the onset of winter. By late fall, groups were back in their winter camps along the Front Range.

CHAPTER 8 - CONCLUSIONS

When linear and circular stone features above treeline were first noticed by Euro-Americans in the late 1800s, speculation as to their exact nature and relationship to human activities was rampant and varied. Some believe the features to be the remains of fortifications, ceremonial structures, structures, or hunting sites (Olson 1970). Today, due to the pioneering efforts of James Benedict and Byron Olson, these features are interpreted as communal hunting sites. Traditional archaeological investigations of game drives focused on quantifying various morphological characteristics of game drives, including drive wall length or the number of cairns and blinds, excavating hunting blinds, lithic analysis, and radiocarbon and lichonometrically dating sites. These studies demonstrated an impressive array of regional and local adaptations to the generalized Colorado Front Range game drive and allowed researchers to discuss the integral role high-elevation game drives played in the lives of prehistoric populations living in Colorado. This thesis set out to expand on those studies and incorporate explicitly spatial data of features and artifacts to parse out specific behaviors related to various parts of the overall game drive system.

The research in this thesis is guided by the three phases of a hunt. The pre-hunt planning phase explored broad, regional contexts behind how and why prehistoric populations utilized the game drives. This analysis was regional in scale and incorporated two testable models for prehistoric mobility: the up-down system and the rotary system. The hunting phase explored the spatial relationship of features and artifacts at a local, site-level, scale to elucidate how these game drives functioned. To aid in this interpretation, 15 samples were sent to California State University-Bakersfield Laboratory of Archaeological Science for protein residue analysis. The post-hunt processing phase explored the relationship between features and artifacts to identify areas that served as specialized processing areas. Spatial analysis and artifact data was used to better understand the relationship between 5GA4268 and the game drives. To aid in this interpretation, 15 samples were sent to Cultural Resource Analysists, Inc. for microscopic use wear analysis.

The alpine game drives at Rollins Pass conform to the generalized structure and organization of other game drives reported throughout the Front Range. Wall structures are low, continuous or discontinuous linear and/or sinuous features constructed from loosely piled rock which follow routes across the alpine tundra selectively chosen by hunters for maximum visibility and ease of construction. Drive walls generally form a V- or U-shaped pattern designed to funnel game into an increasingly constricted area. A total of 1,935 meters of wall are recorded between the three game drive sites. In areas where continuous drive walls were unneeded, such as far from the kill zone or along cliff edges, cairns were built to control game movement into the drive system. Cairn construction is primarily simple rockpile cairns. A total of 15 cairns are recorded for 5GA36 with two additional cairn lines reported by Olson and Benedict (1970) for 5GA35 and 5GA37. Hunting blinds and shooting pits are circular, semi-circular, or oval shaped in their construction and were used to conceal hunters from incoming game. Blinds were typically excavated out of areas of loose rock forming a pit 50-110 centimeters in depth and ringed with varying levels of stone courses and 100-200 centimeters in diameter. A total of 80 hunting blinds are recorded between the three sites.

The tool assemblage is dominated by projectile points. Twenty-seven projectile points have been collected from the four sites from both excavated and surface contexts. Temporally diagnostic projectile point types indicate Early Archaic through Late Prehistoric use of the sites. This is supported by a radiocarbon date of 3,090 ±250 radiocarbon years before present (Olson 1971). Most of the projectile points are broken to some degree; in nearly all cases the tip is missing. The snapped tip is likely the reason for discard of the projectile points, although it is entirely possible these are simply lost tools as well. Eight bifaces have been collected from the sites from both excavated and surface contexts. Bifaces range from finely made blades to small fragments. Six scrapers have been collected from the sites. Only two scrapers show evidence of steep retouch along the distal end; the remaining scrapers show only light retouch along the edge margins. Other tools include a core or tested cobble and a possible drill tip. Utilized and edge modified flakes show wear along the edge margins as a result of use with only a few specimens exhibiting signs of light retouch. Chipped stone debitage is made up of waste flakes and angular debris. In general, the chipped stone debitage is characteristic of late-stage production or maintenance of chipped stone tools.

Understanding seasonal mobility in prehistoric northern Colorado is an important facet to understanding the pre-hunt planning stage of a communal hunt along the Continental Divide. Two seasonal mobility models originally proposed by Benedict (1990, 1992) provide testable models of mobility using raw material sourcing. The up-down model is simply a 'there and back again' movement of groups from low elevation winter camps to alpine hunting grounds relatively early in their seasonal mobility. The rotary model is a more complex system involving two crossings of the Continental Divide and brings groups to alpine hunting grounds from the west late in their seasonal mobility. Raw material sourcing of the artifact assemblage from Rollins Pass shows a strong signature for Middle Park or North Park sources with no definitively Eastern Slope or Front Range sources. Troublesome Formation chert is the best represented of any of the identified raw materials, an unsurprising result given the quality of the material, its close distance from Rollins Pass, and the ease to which is can be procured. The raw material assemblage in general supports more of a rotary system of seasonal mobility for northern Colorado.

Understanding the spatial distribution and relationship of site features and artifacts is key to understanding the behavioral organization or activities of hunters at Rollins Pass. The spatial distribution of features and artifacts, and the resulting behavioral organization and activities associated with them, strongly suggests that the areas near wall convergence in the apparent kill zone were the focal points for all hunting activities. The dense concentration of large blinds in these areas indicates that a majority of the people involved with the hunt are in these locations. Projectile points and other tools were broken or lost through use and their location in relation to blinds and walls is indicative of certain activity areas. Tools found within 20 meters of blinds are likely directly related to the hunting activity. Tools found outside of this 20 meter zone are likely related to pre- or post-hunt activities as these artifacts tend to be bifaces, scrapers, and flakes rather than projectile points. Data from protein residue analysis proved inconclusive as to which animals were specifically targeted at the Rollins Pass game drives. The positive results for two bison, one pronghorn, and one elk/deer did not show a second positive reaction. These results need not be taken as an indication that those animals were hunted at the sites. Bison and pronghorn are highly unlikely candidates as target species (at least in the alpine zones). Elk and/or deer are the only likely candidate out of the three as these animals are known to utilize the alpine tundra on a regular basis.

Patterns in the data regarding activities and behaviors and their location within the overall drive system show three potential areas of activity are identified for post-hunt activities: the kill zone (outside of blinds), within hunting blinds, and 5GA4268. There is evidence in the form of three bifaces and a scraper of minimal processing in and near the kill zone at 5GA36 and 5GA37; this may be the result of either a difference in the size of the targeted species or fewer animals taken during a hunt. Blinds served critical and highly variable roles throughout all phases of a hunt. Post-hunt activities in blinds include repairing projectile points, possible snacking on marrow or meat, and the processing of carcasses. However, it is difficult, if not impossible, to distinguishing pre-hunt activities from post-hunt activities within blinds, such as tool maintenance or snacking, so caution must be taken when assigning any of the aforementioned activities to a specific phase. 5GA4268 functioned as a specialized processing area associated with 5GA35. The tool and debitage data are consistent with disarticulation of carcasses, removal of meat packages from bone, and hide processing. Use wear analysis conclusively demonstrated that scraping hide was the dominant activity at the sites.

Future Research Directions

The summary presented above demonstrates the utility in applying spatial data to sites to gain a more holistic understanding of site use. However, there is much more research on these sites and game drives in general that could be undertaken that was out of the scope of this thesis research. Some ideas for directions for future research are offered below.

Field Methods

First, the survey methods employed by LaBelle and the CMPA demonstrate that systematic intensive surface survey is highly profitable. Given that game drives usually produce relatively small surface assemblages, recording geographic data for tools and debitage takes a little extra time but can pay major dividends for future research regarding site structure and the organization of behaviors within and between sites. Intensive survey needs to be conducted not only in areas where features are present, such as near areas of wall convergence, but also outside of these areas. It was shown that limited activities related to post-hunt processing of game occurred within the drive system and only by surveying outside of this area can archaeologists hope to find evidence of additional processing areas.

Second, future research on activity areas within game drive systems would benefit greatly from the excavation of blinds from within and outside the kill zone as well as block excavation of areas near wall convergence. Excavation of blinds from varied spatial contexts may demonstrate if there is a pattern of preferential use of larger more concentrated blinds as focal points for activity. Block excavation within the kill zone may demonstrate whether the pattern of underrepresentation of artifacts in this area is a true depiction of preferential behavior by hunting groups or, instead, the tools are slightly buried due to taphonomic processes acting on the sites.

Research

Future research on blind morphology, diameter and depth in particular, from other high altitude hunting sites throughout Colorado will help to build a more robust database for the true range in variation of these features. Only a limited amount of reported hunting sites contain attribute data for blinds making discussions of blind variability unsubstantiated by solid data. Furthermore, blind morphology can then be tied to the spatial organization of sites and help derive patterns of behavior. In particular, it would be interesting to see if larger blinds are nearly always located in areas of wall convergence in the kill zones.

Additionally, future studies focused on raw material sourcing would likely prove highly productive to understanding the role game drives played in the seasonal mobility of groups in northern Colorado. It was shown here that groups primarily came to the game drives from the west, bringing with them substantial amounts of Middle Park and North Park raw materials. If these groups were truly wintering along the Front Range, then their Front Range raw materials were discarded somewhere along their mobility route. Raw material studies at key mountain passes, such as Ute Pass, Cameron Pass (especially the Joe Wright site, 5LR220/450), or La Poudre Pass hold great potential for elucidating these seasonal mobility models. Additionally, more studies regarding raw material sources in for chipped stone artifacts found at North Park and Middle Park sites would prove enlightening.

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APPENDIX A - TOOL DATA

		Characteristics					Dimensions						
Site	**Catalog Number**	**Tool Class**	**Type**	**Portion**	**Base Type**	**Raw Material**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Stem Length (mm)**	**Basal Width (mm)**	**Neck Width (mm)**	**Weight (g)**
5GA35	35.81	Projectile Point	Oxbow/Yonkee	Base	Concave	Petrified Wood	7.56	14.25	3.7	ND	14.32	9.66	0.4
5GA35	35.82	Biface	NA	Incomplete	NA	Tan Chert	17.69	11.21	3.73	ND	ND	ND	0.5
5GA35	35.83	Projectile Point	Hogback Corner-notched	Base	Convex	Petrified Wood	13.08	12.97	3.89	5.57	10.45	8.1	0.6
5GA35	35.85	Projectile Point	Pelican Lake	Base	Concave	Troublesome Formation Chert	19.03	19.05	4.31	4.07	10.73	8.87	1.5
5GA35	35.86	Core	NA	NA	NA	Middle Park Chert	34.28	23.24	10.71	ND	ND	ND	10.3
5GA35	35.87	Biface	NA	Incomplete	NA	Middle Park Chert	29.19	26.26	4.97	ND	ND	ND	2.9
5GA35	35.88	Projectile Point	Pelican Lake	Mostly Complete	Straight	Troublesome Formation Chert	32.38	20.92	4.21	5.16	16.2	9.99	2.5
5GA35	35.89	Projectile Point	Mount Albion Corner-notched	Mostly Complete	Convex	Petrified Wood	32.92	19.15	6.21	6.25	13.66	11.74	4.3
5GA35	35.90	Projectile Point	Indeterminate	Medial	ND	Troublesome Formation Chert	28.07	20.73	5.95	ND	ND	ND	3.6
5GA35	35.91	Projectile Point	Mount Albion Corner-notched	Base	Convex	Middle Park Chert	25.06	18.42	3.06	5.25	12.25	12.03	1.5
5GA35	35.92	Projectile Point	Oxbow/Yonkee	Base	Concave	Table Mountain Chert	11.25	17.41	3.96	ND	17.5	ND	0.7
5GA35	35.93	Projectile Point	Indeterminate	Medial	ND	Rose Chert	21.56	18.83	4.18	ND	ND	ND	1.6
5GA35	35.94	Projectile Point	Indeterminate	Tip	ND	Troublesome Formation Chert	7.29	7.74	2.12	ND	ND	ND	0.1

5GA35	35.95	Projectile Point	Plains Side-notched	Mostly Complete	Straight	Clear Chalcedony	17.63	11.93	2.75	4.38	10.56	7.21	0.6
5GA35	35.96	Projectile Point	Hogback Corner-notched	Mostly Complete	Straight	Troublesome Formation Chert	23.61	16.15	3.92	5.42	9.87	7.87	1.2
5GA35	35.97	Biface	NA	Incomplete	NA	Tan Chert	29.39	22.41	4.59	ND	ND	ND	2.9
5GA35	35.98	Biface	NA	Incomplete	NA	Windy Ridge Quartzite	20.31	18.87	4.35	ND	ND	ND	1.8
5GA35	35.99	Projectile Point	Mount Albion Serrated Corner-notched	Mostly Complete	Convex	Windy Ridge Quartzite	45.82	23.76	6.42	8.08	13.69	13.33	8.5
5GA35	35.100	Projectile Point	Hogback Corner-notched	Base	Straight	Brown Chert	19.88	18.85	3.85	4.47	12.11	10.95	1.5
5GA35	36.2	Projectile Point	Indeterminate	Tip	NA	Middle Park Chert	24.02	21.04	3.59	ND	ND	12.21	1.6
5GA36	36.3	Projectile Point	Pelican Lake	Complete	Straight	White Chert	29.93	18.3	4.48	5.28	12.89	8.37	1.9
5GA36	36.4	Projectile Point	Pelican Lake	Mostly Complete	Straight	Middle Park Chert	29.28	19.59	4.1	5.45	15.26	11.54	2.3
5GA36	36.5	Biface	NA	Incomplete	NA	Windy Ridge Quartzite	10.67	10.03	3.34	ND	ND	ND	0.4
5GA36	36.6	Projectile Point	Mount Albion Corner-notched	Base/Medial	ND	Clear Chalcedony	25.13	16.23	4.79	ND	ND	12.16	2.7
5GA36	36.7	Projectile Point	Hogback Corner-notched	Mostly Complete	Straight	Troublesome Formation Chert	21.47	19.56	4.23	5.33	ND	7.24	1.4
5GA36	36.8	Projectile Point	Indeterminate	Tip	ND	Troublesome Formation Chert	25.65	15.23	4.02	ND	ND	ND	1.2
5GA36	36.9	Projectile Point	Indeterminate	Medial	ND	Clear Chalcedony	4.72	10.82	2.27	ND	ND	ND	0.1
5GA37	37.1	Biface	NA	Incomplete	ND	Troublesome Formation Chert	30.24	23.34	6.78	ND	ND	ND	5.7
5GA37	37.2	Projectile Point	Unassigned Late Prehistoric Corner-Notched	Base	Concave	Red Chert	14.22	12.42	3.21	ND	ND	ND	0.5
5GA37	37.3	Projectile Point	Unassigned Archaic Corner-Notched	Base/Medial	ND	Troublesome Formation Chert	32.48	26.73	4.42	ND	ND	15.61	3.9

5GA37	37.4	Projectile Point	Indeterminate	Medial	ND	Troublesome Formation Chert	26.56	18.11	4.34	ND	ND	ND	1.7
5GA37	37.5	Scraper	NA	Complete	ND	Quartz	32.13	23.97	9.12	ND	ND	ND	7.4
5GA4268	48.1	Projectile Point	Unassigned Late Prehistoric Corner-Notched	Base	Straight	Middle Park Chert	15.14	13.88	5.32	ND	ND	ND	1.0
5GA4268	48.2	Projectile Point	Hogback Corner-notched	Base	Straight	Middle Park Chert	18.91	18.26	4.2	8.04	ND	7.48	1.0
5GA4268	48.3	Projectile Point	Indeterminate	Tip	ND	Troublesome Formation Chert	15.83	18.3	3.63	ND	ND	ND	0.8
5GA4268	48.4	Biface	NA	Incomplete	NA	Windy Ridge Quartzite	13.44	11.76	4.41	ND	ND	ND	0.7
5GA4268	48.5	Tool	NA	Incomplete	NA	Troublesome Formation Chert	24.19	7.18	4.92	ND	ND	ND	1.1
5GA4268	48.6	Scraper	NA	Complete	NA	Troublesome Formation Chert	24.67	10.62	4.86	ND	ND	ND	1.2
5GA4268	48.7	Scraper	NA	Complete	NA	Clear Chalcedony	26.52	13.23	4.32	ND	ND	ND	1.7
5GA4268	48.10	Scraper	NA	Incomplete	NA	Troublesome Formation Chert	30.01	23.6	6.01	ND	ND	ND	3.6
5GA4268	48.11	Scraper	NA	Complete	NA	Clear Chalcedony	42.69	16.5	10.69	ND	ND	ND	4.7
5GA4268	48.12	Scraper	NA	Incomplete	NA	Troublesome Formation Chert	27.81	19.74	5.1	ND	ND	ND	2.7

***5GA4268 = 5GA4268**
****NA = Not applicable; ND = No data**

APPENDIX B - DEBITAGE DATA

		Characteristics					Dimensions			
Site	Catalog #	Item Type	Raw Material	Platform	Cortex	Burning	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)
5GA35	35.1	Angular Debris	Windy Ridge Quartzite	No	No	No	3.05	1.89	0.44	< 0.1
5GA35	35.2	Angular Debris	Windy Ridge Quartzite	No	No	No	5.55	3.34	0.78	< 0.1
5GA35	35.3	Angular Debris	Windy Ridge Quartzite	No	No	No	5.16	4.59	0.92	< 0.1
5GA35	35.4	Flake	Windy Ridge Quartzite	Yes	No	No	6.55	4.09	0.75	< 0.1
5GA35	35.5	Flake	Windy Ridge Quartzite	No	No	No	7.86	4.95	1.00	< 0.1
5GA35	35.6	Angular Debris	Windy Ridge Quartzite	No	No	No	5.82	4.80	1.02	< 0.1
5GA35	35.7	Flake	Windy Ridge Quartzite	Yes	No	No	11.19	6.50	1.52	0.10
5GA35	35.8	Flake	Windy Ridge Quartzite	No	No	No	15.68	12.03	1.24	0.20
5GA35	35.9	Angular Debris	Windy Ridge Quartzite	No	No	No	3.75	3.30	0.62	< 0.1
5GA35	35.10	Angular Debris	Windy Ridge Quartzite	No	No	No	3.14	1.68	0.55	< 0.1
5GA35	35.11	Flake	Windy Ridge Quartzite	No	No	No	6.31	4.86	1.20	< 0.1
5GA35	35.12	Angular Debris	Windy Ridge Quartzite	No	No	No	4.92	3.44	0.64	< 0.1
5GA35	35.13	Angular Debris	Windy Ridge Quartzite	No	No	No	3.04	1.71	0.43	< 0.1
5GA35	35.14	Flake	White Quartzite	Yes	No	No	9.26	7.77	1.38	0.10
5GA35	35.15	Flake	White Quartzite	No	No	No	6.79	6.25	1.17	0.10
5GA35	35.16	Angular Debris	White Quartzite	No	No	No	7.63	3.10	0.68	< 0.1
5GA35	35.17	Flake	White Quartzite	No	No	No	5.74	3.90	1.28	< 0.1
5GA35	35.18	Flake	White Quartzite	No	No	No	4.81	4.07	0.86	< 0.1
5GA35	35.19	Flake	White Quartzite	Yes	No	No	3.61	2.26	0.43	< 0.1
5GA35	35.20	Flake	White Quartzite	Yes	No	No	3.56	2.13	0.77	< 0.1
5GA35	35.21	Angular Debris	White Quartzite	No	No	No	1.95	1.10	0.28	< 0.1
5GA35	35.22	Flake	Windy Ridge Quartzite	No	No	No	10.72	8.45	1.74	0.10
5GA35	35.23	Flake	Windy Ridge Quartzite	No	No	No	10.02	7.69	2.25	0.10
5GA35	35.24	Flake	Windy Ridge Quartzite	Yes	No	No	8.07	7.78	1.58	0.10
5GA35	35.25	Flake	Windy Ridge Quartzite	No	No	No	5.73	3.17	1.19	< 0.1
5GA35	35.26	Flake	Windy Ridge Quartzite	Yes	No	No	8.57	8.08	2.24	0.10
5GA35	35.27	Flake	Windy Ridge Quartzite	No	No	No	7.88	6.28	1.68	0.10
5GA35	35.28	Flake	Windy Ridge Quartzite	Yes	No	No	8.27	7.51	1.54	0.10
5GA35	35.29	Flake	Windy Ridge Quartzite	No	No	No	4.35	4.42	0.86	< 0.1
5GA35	35.30	Flake	Windy Ridge Quartzite	No	No	No	4.52	3.65	0.86	< 0.1
5GA35	35.31	Flake	Windy Ridge Quartzite	Yes	No	No	4.42	3.81	1.19	< 0.1

5GA35	35.32	Angular Debris	Windy Ridge Quartzite	No	No	No	3.69	2.82	0.43	< 0.1
5GA35	35.33	Angular Debris	Windy Ridge Quartzite	No	No	No	2.44	1.51	0.26	< 0.1
5GA35	35.34	Flake	Windy Ridge Quartzite	No	No	No	3.37	2.97	1.10	< 0.1
5GA35	35.35	Flake	Windy Ridge Quartzite	No	No	No	3.47	2.59	0.53	< 0.1
5GA35	35.36	Angular Debris	Windy Ridge Quartzite	No	No	No	3.46	2.11	0.61	< 0.1
5GA35	35.37	Angular Debris	Windy Ridge Quartzite	No	No	No	2.68	2.30	0.40	< 0.1
5GA35	35.38	Angular Debris	Windy Ridge Quartzite	No	No	No	3.11	2.32	0.51	< 0.1
5GA35	35.39	Flake	Windy Ridge Quartzite	No	No	No	2.99	2.10	0.40	< 0.1
5GA35	35.40	Angular Debris	Windy Ridge Quartzite	No	No	No	3.07	1.76	0.89	< 0.1
5GA35	35.41	Angular Debris	Windy Ridge Quartzite	No	No	No	3.27	1.60	0.32	< 0.1
5GA35	35.42	Angular Debris	Windy Ridge Quartzite	No	No	No	2.07	1.67	0.29	< 0.1
5GA35	35.43	Flake	Windy Ridge Quartzite	Yes	No	No	10.77	7.05	1.58	0.10
5GA35	35.44	Angular Debris	Windy Ridge Quartzite	No	No	No	5.43	4.04	0.71	< 0.1
5GA35	35.45	Flake	Windy Ridge Quartzite	Yes	No	No	4.23	3.71	0.92	< 0.1
5GA35	35.46	Flake	Windy Ridge Quartzite	No	No	No	7.44	7.06	1.26	< 0.1
5GA35	35.47	Flake	Windy Ridge Quartzite	No	No	No	5.17	4.41	0.68	< 0.1
5GA35	35.48	Flake	Windy Ridge Quartzite	No	No	No	3.48	2.27	0.68	< 0.1
5GA35	35.49	Flake	Windy Ridge Quartzite	Yes	No	No	5.22	4.61	0.86	< 0.1
5GA35	35.50	Angular Debris	Windy Ridge Quartzite	No	No	No	2.41	2.21	0.38	< 0.1
5GA35	35.51	Flake	Windy Ridge Quartzite	No	No	No	10.51	6.65	1.95	0.10
5GA35	35.52	Flake	Windy Ridge Quartzite	Yes	No	No	9.37	6.23	1.57	0.10
5GA35	35.53	Flake	Cowdrey Quartzite	No	No	No	6.14	3.86	0.87	< 0.1
5GA35	35.54	Flake	Cowdrey Quartzite	No	No	No	4.61	2.95	0.73	< 0.1
5GA35	35.55	Angular Debris	Cowdrey Quartzite	No	No	No	3.19	2.08	0.31	< 0.1
5GA35	35.56	Flake	Cowdrey Quartzite	No	No	No	4.43	2.84	0.55	< 0.1
5GA35	35.57	Angular Debris	Cowdrey Quartzite	No	No	No	2.66	2.02	0.45	< 0.1
5GA35	35.58	Flake	Petrified Wood	No	No	No	12.81	6.34	1.36	0.10
5GA35	35.59	Flake	Petrified Wood	No	No	No	13.35	4.81	1.56	0.10
5GA35	35.60	Flake	Petrified Wood	No	No	No	9.69	9.11	2.23	0.20
5GA35	35.61	Flake	Petrified Wood	Yes	No	No	10.17	8.93	2.39	0.20
5GA35	35.62	Flake	Petrified Wood	No	No	No	7.87	5.16	1.27	< 0.1
5GA35	35.63	Flake	Petrified Wood	Yes	No	No	11.77	5.31	1.41	< 0.1
5GA35	35.64	Flake	Petrified Wood	Yes	No	No	10.32	7.14	1.51	< 0.1
5GA35	35.65	Flake	Petrified Wood	No	No	No	4.68	3.95	0.33	< 0.1
5GA35	35.66	Flake	Petrified Wood	Yes	No	No	9.14	4.18	0.99	< 0.1
5GA35	35.67	Flake	Petrified Wood	Yes	No	No	9.28	8.92	2.43	0.10
5GA35	35.68	Flake	Petrified Wood	No	No	No	7.74	5.12	1.06	< 0.1
5GA35	35.69	Flake	Petrified Wood	No	No	No	6.72	4.63	0.69	< 0.1
5GA35	35.70	Flake	Petrified Wood	No	No	No	4.27	3.42	0.64	< 0.1

5GA35	35.71	Flake	Petrified Wood	Yes	No	No	5.14	4.04	0.99	< 0.1
5GA35	35.72	Flake	Petrified Wood	No	No	No	5.48	3.74	1.01	< 0.1
5GA35	35.73	Flake	Petrified Wood	No	No	No	6.62	4.86	0.72	< 0.1
5GA35	35.74	Angular Debris	Petrified Wood	No	No	No	3.38	2.18	0.79	< 0.1
5GA35	35.75	Flake	Petrified Wood	Yes	No	No	13.91	5.37	0.97	< 0.1
5GA35	35.76	Flake	Petrified Wood	No	No	No	12.46	8.33	1.10	0.10
5GA35	35.77	Flake	Petrified Wood	Yes	No	No	10.23	7.90	1.53	0.10
5GA35	35.78	Flake	Petrified Wood	No	No	No	9.22	6.38	1.45	< 0.1
5GA35	35.79	Flake	Petrified Wood	Yes	No	No	8.71	6.11	2.24	< 0.1
5GA35	35.80	Flake	Petrified Wood	Yes	No	No	7.33	6.77	1.29	< 0.1
5GA35	35.84	Edge Modified Flake	Troublesome Formation Chert	No	No	No	14.75	6.33	2.88	0.30
5GA35	35.101.1	Flake	Brown Chert	Yes	No	No	7.81	6.80	1.93	< 0.1
5GA35	35.101.2	Flake	Brown Chert	Yes	No	No	7.82	7.17	1.09	< 0.1
5GA35	35.101.3	Flake	Brown Chert	No	No	No	7.82	6.61	0.64	< 0.1
5GA35	35.101.4	Flake	Brown Chert	No	No	No	9.04	6.64	1.71	< 0.1
5GA35	35.101.5	Flake	Brown Chert	Yes	No	No	10.01	7.60	2.22	0.20
5GA35	35.101.6	Flake	Brown Chert	No	No	No	10.11	6.52	1.69	0.10
5GA35	35.101.7	Flake	Brown Chert	No	No	No	8.56	6.22	0.79	< 0.1
5GA35	35.101.8	Flake	Brown Chert	No	No	No	6.16	4.57	0.97	< 0.1
5GA35	35.101.9	Flake	Brown Chert	No	No	No	6.08	5.83	1.14	< 0.1
5GA35	35.101.10	Flake	Brown Chert	No	No	No	8.43	4.69	0.89	< 0.1
5GA35	35.101.11	Flake	Brown Chert	Yes	No	No	5.82	4.56	0.56	< 0.1
5GA35	35.101.12	Flake	Brown Chert	No	No	No	7.40	3.90	1.14	< 0.1
5GA35	35.101.13	Flake	Brown Chert	Yes	No	No	5.41	4.92	0.73	< 0.1
5GA35	35.101.14	Angular Debris	Brown Chert	No	No	No	4.47	4.10	0.89	< 0.1
5GA35	35.101.15	Angular Debris	Brown Chert	No	No	No	4.10	3.98	1.49	< 0.1
5GA35	35.101.16	Flake	Brown Chert	Yes	No	No	5.46	4.89	1.00	< 0.1
5GA35	35.101.17	Flake	Brown Chert	Yes	No	No	4.37	3.52	0.92	< 0.1
5GA35	35.101.18	Angular Debris	Brown Chert	No	No	No	3.83	2.75	1.19	< 0.1
5GA35	35.101.19	Angular Debris	Brown Chert	No	No	No	3.21	2.80	0.60	< 0.1
5GA35	35.101.20	Angular Debris	Brown Chert	No	No	No	2.79	1.69	0.54	< 0.1
5GA35	35.101.21	Angular Debris	Brown Chert	No	No	No	2.33	1.97	0.34	< 0.1
5GA35	35.102.1	Flake	Petrified Wood	Yes	No	No	16.27	7.57	2.82	0.20
5GA35	35.102.2	Flake	Petrified Wood	Yes	No	No	13.02	9.73	1.65	0.20
5GA35	35.102.3	Flake	Petrified Wood	No	No	No	13.39	9.16	1.28	0.10
5GA35	35.102.4	Flake	Petrified Wood	Yes	No	No	11.92	8.81	1.96	0.10
5GA35	35.102.5	Flake	Petrified Wood	No	No	No	9.11	8.70	1.91	0.10
5GA35	35.102.6	Flake	Petrified Wood	No	No	No	9.03	7.72	1.47	< 0.1
5GA35	35.102.7	Flake	Petrified Wood	Yes	No	No	9.66	5.91	1.22	< 0.1

5GA35	35.102.8	Flake	Petrified Wood	No	No	No	7.98	7.70	1.36	< 0.1
5GA35	35.102.9	Flake	Petrified Wood	No	No	No	7.36	5.00	0.75	< 0.1
5GA35	35.102.10	Flake	Petrified Wood	No	No	No	8.35	3.98	0.88	< 0.1
5GA35	35.102.11	Flake	Petrified Wood	Yes	No	No	5.97	4.01	1.53	< 0.1
5GA35	35.102.12	Flake	Petrified Wood	No	No	No	5.46	5.33	0.63	< 0.1
5GA35	35.102.13	Flake	Petrified Wood	No	No	No	6.86	4.07	0.74	< 0.1
5GA35	35.102.14	Flake	Petrified Wood	No	No	No	6.04	4.09	1.32	< 0.1
5GA35	35.102.15	Flake	Petrified Wood	Yes	No	No	5.97	3.14	0.71	< 0.1
5GA35	35.102.16	Flake	Petrified Wood	No	No	No	5.10	3.46	1.06	< 0.1
5GA35	35.102.17	Flake	Petrified Wood	Yes	No	No	3.95	3.29	0.72	< 0.1
5GA35	35.102.18	Angular Debris	Petrified Wood	No	No	No	4.86	3.86	0.53	< 0.1
5GA35	35.102.19	Angular Debris	Petrified Wood	No	No	No	3.65	2.84	0.25	< 0.1
5GA35	35.102.20	Angular Debris	Petrified Wood	No	No	No	3.28	3.21	0.31	< 0.1
5GA35	35.102.21	Angular Debris	Petrified Wood	No	No	No	4.79	2.01	0.45	< 0.1
5GA35	35.102.22	Angular Debris	Petrified Wood	No	No	No	4.07	2.54	0.57	< 0.1
5GA35	35.102.23	Angular Debris	Petrified Wood	No	No	No	4.95	3.47	0.46	< 0.1
5GA35	35.102.24	Angular Debris	Petrified Wood	No	No	No	4.56	2.73	0.64	< 0.1
5GA35	35.102.25	Flake	Petrified Wood	Yes	No	No	4.97	3.68	0.90	< 0.1
5GA35	35.102.26	Angular Debris	Petrified Wood	No	No	No	3.85	3.62	0.36	< 0.1
5GA35	35.102.27	Angular Debris	Petrified Wood	No	No	No	2.29	2.13	0.77	< 0.1
5GA35	35.102.28	Angular Debris	Petrified Wood	No	No	No	3.09	2.09	0.41	< 0.1
5GA35	35.102.29	Angular Debris	Petrified Wood	No	No	No	3.19	2.71	0.27	< 0.1
5GA35	35.102.30	Angular Debris	Petrified Wood	No	No	No	3.22	2.04	0.34	< 0.1
5GA35	35.102.31	Angular Debris	Petrified Wood	No	No	No	2.93	1.61	0.30	< 0.1
5GA35	35.103.1	Angular Debris	Unidentified	No	No	No	4.32	3.43	0.99	< 0.1
5GA35	35.103.2	Flake	Unidentified	No	No	No	3.84	2.89	0.65	< 0.1
5GA35	35.103.3	Angular Debris	Unidentified	No	No	No	3.10	2.58	0.44	< 0.1
5GA35	35.103.4	Angular Debris	Unidentified	No	No	No	2.28	1.54	0.10	< 0.1
5GA35	35.103.5	Angular Debris	Unidentified	No	No	No	1.86	1.48	0.24	< 0.1
5GA35	35.103.6	Angular Debris	Unidentified	No	No	No	1.81	1.25	0.21	< 0.1
5GA35	35.103.7	Angular Debris	Unidentified	No	No	No	1.61	1.31	0.41	< 0.1
5GA35	35.104.1	Flake	Tan Chert	No	No	No	9.04	5.14	0.74	< 0.1
5GA35	35.104.2	Flake	Tan Chert	No	No	No	4.64	4.30	0.98	< 0.1
5GA35	35.104.3	Flake	Tan Chert	Yes	No	No	4.88	4.39	0.77	< 0.1
5GA35	35.104.4	Angular Debris	Tan Chert	No	No	No	3.21	2.19	0.52	< 0.1
5GA35	35.104.5	Angular Debris	Tan Chert	No	No	No	3.67	2.18	0.59	< 0.1
5GA35	35.104.6	Angular Debris	Tan Chert	No	No	No	3.38	2.28	0.57	< 0.1
5GA35	35.105.1	Angular Debris	Windy Ridge Quartzite	No	No	No	5.70	1.93	0.81	< 0.1
5GA35	35.105.2	Angular Debris	Windy Ridge Quartzite	No	No	No	2.68	2.64	0.57	< 0.1

5GA35	35.106.1	Flake	Tan Chalcedony	Yes	No	No	6.46	3.52	0.68	< 0.1
5GA35	35.106.2	Angular Debris	Tan Chalcedony	No	No	No	4.62	4.59	0.98	< 0.1
5GA35	35.106.3	Flake	Tan Chalcedony	Yes	No	No	5.05	3.49	0.84	< 0.1
5GA35	35.106.4	Flake	Tan Chalcedony	No	No	No	5.06	3.73	0.51	< 0.1
5GA35	35.106.5	Angular Debris	Tan Chalcedony	No	No	No	2.86	1.73	0.37	< 0.1
5GA35	35.106.6	Angular Debris	Tan Chalcedony	No	No	No	1.86	1.72	0.22	< 0.1
5GA35	35.107.1	Flake	Table Mountain Chert	Yes	No	No	7.90	6.82	1.00	< 0.1
5GA35	35.107.2	Angular Debris	Table Mountain Chert	No	No	No	5.26	2.81	1.16	< 0.1
5GA35	35.108.1	Flake	Dendritic Brown Chert	Yes	No	No	13.10	8.83	1.29	0.10
5GA35	35.108.2	Flake	Dendritic Brown Chert	Yes	No	No	6.09	5.25	0.81	< 0.1
5GA35	35.108.3	Flake	Dendritic Brown Chert	No	No	No	4.17	3.56	0.52	< 0.1
5GA35	35.108.4	Angular Debris	Dendritic Brown Chert	No	No	No	5.78	3.13	0.34	< 0.1
5GA35	35.109.1	Flake	Table Mountain Chert	Yes	No	No	8.67	5.85	0.66	< 0.1
5GA35	35.109.2	Flake	Table Mountain Chert	Yes	No	No	7.77	7.18	1.44	< 0.1
5GA35	35.109.3	Flake	Table Mountain Chert	Yes	No	No	4.78	4.68	0.49	< 0.1
5GA35	35.109.4	Angular Debris	Table Mountain Chert	No	No	No	4.86	3.14	1.03	< 0.1
5GA35	35.109.5	Angular Debris	Table Mountain Chert	No	No	No	3.89	2.39	0.41	< 0.1
5GA35	35.109.6	Angular Debris	Table Mountain Chert	No	No	No	3.12	1.82	0.76	< 0.1
5GA35	35.109.7	Angular Debris	Table Mountain Chert	No	No	No	3.36	1.58	0.47	< 0.1
5GA35	35.110.1	Flake	Middle Park Chert	Yes	No	No	8.47	7.22	1.40	< 0.1
5GA35	35.110.2	Flake	Middle Park Chert	Yes	No	No	8.14	7.30	1.18	< 0.1
5GA35	35.110.3	Flake	Middle Park Chert	Yes	No	No	6.56	5.26	1.52	< 0.1
5GA35	35.110.4	Flake	Middle Park Chert	No	No	No	5.94	4.02	0.55	< 0.1
5GA35	35.110.5	Angular Debris	Middle Park Chert	No	No	No	6.34	2.35	0.37	< 0.1
5GA35	35.111.1	Flake	Middle Park Chert	No	No	No	10.20	7.80	1.14	< 0.1
5GA35	35.111.2	Flake	Middle Park Chert	No	No	No	8.59	5.70	0.73	< 0.1
5GA35	35.111.3	Flake	Middle Park Chert	Yes	No	No	5.73	5.62	1.82	< 0.1
5GA35	35.112.1	Flake	Red Chert	Yes	No	No	10.48	10.16	1.76	0.10
5GA35	35.112.2	Flake	Red Chert	Yes	No	No	6.88	6.15	1.36	< 0.1
5GA35	35.112.3	Angular Debris	Red Chert	No	No	No	8.15	3.92	1.01	< 0.1
5GA35	35.113	Flake	Troublesome Formation Chert	No	No	No	21.19	11.44	2.79	0.60
5GA36	36.1	Edge Modified Flake	Troublesome Formation Chert	No	No	No	14.63	4.47	2.02	0.10
5GA4268	48.9	Edge Modified Flake	Clear Chalcedony	Yes	Yes	No	21.01	16.05	5.91	1.40
5GA4268	48.8	Edge Modified Flake	Clear Chalcedony	No	Yes	No	19.10	12.26	5.22	0.90
5GA4268	48.13	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	39.23	29.84	7.37	4.40
5GA4268	48.14	Flake	Troublesome Formation Chert	No	No	Yes	13.38	10.19	3.15	0.40
5GA4268	48.15	Flake	Tan Chalcedony	No	Yes	Yes	17.39	10.47	6.12	1.00
5GA4268	48.16	Flake	Unidentifiable	No	No	Yes	21.44	14.44	4.36	1.50
5GA4268	48.17	Flake	Troublesome Formation Chert	Yes	No	Yes	12.86	16.13	3.15	0.50

5GA4268	48.18	Flake	Troublesome Formation Chert	No	No	Yes	9.21	6.78	1.53	0.10
5GA4268	48.19	Edge Modified Flake	Middle Park Chert	No	No	No	19.09	20.46	3.09	1.30
5GA4268	48.20	Edge Modified Flake	Troublesome Formation Chert	Yes	Yes	No	17.22	19.91	5.69	1.90
5GA4268	48.21	Edge Modified Flake	Middle Park Chert	No	No	No	19.23	15.18	3.08	1.00
5GA4268	48.22	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	21.17	19.06	5.53	1.90
5GA4268	48.23	Edge Modified Flake	Troublesome Formation Chert	No	No	No	22.58	12.17	8.49	1.40
5GA4268	48.24	Edge Modified Flake	Troublesome Formation Chert	No	Yes	No	16.28	15.39	4.82	1.30
5GA4268	48.25	Edge Modified Flake	Troublesome Formation Chert	No	Yes	No	16.47	14.11	2.59	0.50
5GA4268	48.26	Edge Modified Flake	Troublesome Formation Chert	Yes	Yes	No	19.35	21.60	6.19	2.80
5GA4268	48.27	Edge Modified Flake	Troublesome Formation Chert	No	No	No	31.73	15.17	3.48	1.50
5GA4268	48.28	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	18.13	18.05	4.09	1.20
5GA4268	48.29	Edge Modified Flake	Troublesome Formation Chert	No	No	No	23.01	19.24	4.86	1.90
5GA4268	48.30	Edge Modified Flake	Troublesome Formation Chert	No	Yes	No	24.17	13.14	4.44	1.40
5GA4268	48.31	Flake	Troublesome Formation Chert	No	No	No	19.74	11.55	4.67	0.90
5GA4268	48.32	Edge Modified Flake	Troublesome Formation Chert	No	Yes	No	19.84	16.10	4.27	1.40
5GA4268	48.33	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	13.74	15.35	3.74	0.70
5GA4268	48.34	Edge Modified Flake	Troublesome Formation Chert	No	No	No	18.14	9.47	3.86	0.60
5GA4268	48.35	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	16.90	14.07	3.81	0.80
5GA4268	48.36	Edge Modified Flake	Troublesome Formation Chert	No	No	No	16.17	12.51	3.23	0.80
5GA4268	48.37	Edge Modified Flake	Troublesome Formation Chert	No	No	No	17.80	13.49	2.71	0.60
5GA4268	48.38	Edge Modified Flake	Troublesome Formation Chert	No	No	No	20.06	15.96	2.76	0.80
5GA4268	48.39	Edge Modified Flake	Troublesome Formation Chert	No	No	No	16.07	15.05	2.55	0.80
5GA4268	48.40	Flake	Troublesome Formation Chert	Yes	No	No	10.56	6.58	1.95	0.10
5GA4268	48.41	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	17.23	12.76	2.10	0.40
5GA4268	48.42	Flake	Troublesome Formation Chert	Yes	No	No	17.79	11.79	2.73	0.40
5GA4268	48.43	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	15.05	14.88	3.44	0.70
5GA4268	48.44	Edge Modified Flake	Troublesome Formation Chert	Yes	Yes	No	14.31	17.73	2.96	0.70
5GA4268	48.45	Edge Modified Flake	Troublesome Formation Chert	No	No	No	16.90	11.49	2.68	0.40
5GA4268	48.46	Flake	Troublesome Formation Chert	No	No	No	11.03	8.80	2.54	0.20
5GA4268	48.47	Edge Modified Flake	Troublesome Formation Chert	No	No	No	15.53	15.69	3.18	0.80
5GA4268	48.48	Edge Modified Flake	Clear Chalcendony	Yes	No	No	17.51	11.70	2.16	0.40
5GA4268	48.49	Edge Modified Flake	Windy Ridge Quartzite	Yes	No	No	10.66	9.73	2.13	0.20
5GA4268	48.50	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	12.35	7.01	1.56	0.20
5GA4268	48.51	Edge Modified Flake	Troublesome Formation Chert	No	No	No	7.82	11.51	1.44	0.10
5GA4268	48.52	Flake	Troublesome Formation Chert	Yes	No	No	11.79	9.74	1.75	0.20
5GA4268	48.53	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	13.37	11.16	2.13	0.30
5GA4268	48.54	Flake	Troublesome Formation Chert	No	No	No	13.35	13.71	2.64	0.60
5GA4268	48.55	Flake	Troublesome Formation Chert	Yes	No	No	15.37	9.43	2.45	0.40
5GA4268	48.56	Edge Modified Flake	Troublesome Formation Chert	No	No	No	13.17	12.53	2.52	0.50

5GA4268	48.57	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	22.35	19.53	2.88	1.30
5GA4268	48.58	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	23.89	17.12	4.83	1.80
5GA4268	48.59	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	21.37	14.19	3.41	0.80
5GA4268	48.60	Flake	Troublesome Formation Chert	No	No	No	17.92	12.94	2.37	0.50
5GA4268	48.61	Edge Modified Flake	Troublesome Formation Chert	No	No	No	21.44	18.30	3.42	1.10
5GA4268	48.62	Edge Modified Flake	Troublesome Formation Chert	No	No	No	25.66	14.02	3.66	1.20
5GA4268	48.63	Flake	Troublesome Formation Chert	No	No	No	18.43	15.11	2.47	0.70
5GA4268	48.64	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	18.95	8.82	2.21	0.30
5GA4268	48.65	Edge Modified Flake	Clear Chalcendony	Yes	No	No	14.19	10.95	2.99	0.30
5GA4268	48.66	Edge Modified Flake	Troublesome Formation Chert	No	No	No	16.03	15.67	4.92	1.10
5GA4268	48.67	Edge Modified Flake	Troublesome Formation Chert	No	No	No	21.29	9.09	3.65	0.70
5GA4268	48.68	Edge Modified Flake	Troublesome Formation Chert	No	No	No	20.68	14.32	4.13	1.40
5GA4268	48.69	Edge Modified Flake	Clear Chalcendony	Yes	No	No	12.32	9.23	3.46	0.40
5GA4268	48.70	Edge Modified Flake	Clear Chalcendony	Yes	Yes	No	17.33	16.86	4.39	1.30
5GA4268	48.71	Flake	Troublesome Formation Chert	No	Yes	No	11.78	9.48	3.29	0.30
5GA4268	48.72	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	10.55	8.90	2.76	0.30
5GA4268	48.73	Flake	Clear Chalcendony	No	Yes	No	15.92	11.39	4.66	0.70
5GA4268	48.74	Edge Modified Flake	Troublesome Formation Chert	Yes	Yes	No	15.33	9.63	2.38	0.40
5GA4268	48.75	Edge Modified Flake	Troublesome Formation Chert	Yes	Yes	No	14.43	12.24	3.63	0.60
5GA4268	48.76	Edge Modified Flake	Clear Chalcendony	No	No	No	15.80	12.63	2.13	0.50
5GA4268	48.77	Edge Modified Flake	Clear Chalcendony	No	No	No	14.69	7.53	2.19	0.20
5GA4268	48.78	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	16.17	10.26	2.06	0.40
5GA4268	48.79	Edge Modified Flake	Troublesome Formation Chert	Yes	No	No	17.34	8.86	2.64	0.40
5GA4268	48.80	Edge Modified Flake	Clear Chalcendony	Yes	No	No	14.06	10.65	2.52	0.40
5GA4268	48.81	Edge Modified Flake	Troublesome Formation Chert	No	No	No	16.99	9.13	2.93	0.40
5GA4268	48.82	Edge Modified Flake	Brown Chert	Yes	No	No	14.44	10.21	2.43	0.30
5GA4268	48.83	Edge Modified Flake	Brown Chert	Yes	No	No	15.05	10.81	1.98	0.30
5GA4268	48.84	Edge Modified Flake	Brown Chert	Yes	No	No	19.39	8.54	1.92	0.20
5GA4268	48.85	Flake	Petrified Wood	No	No	No	16.84	14.75	2.61	0.70
5GA4268	48.86	Flake	Windy Ridge Quartzite	No	No	No	14.45	7.43	1.94	0.20
5GA4268	48.87	Flake	Windy Ridge Quartzite	No	No	No	13.29	10.94	5.55	0.80
5GA4268	48.88	Flake	Windy Ridge Quartzite	No	No	No	5.11	4.90	1.20	< 0.1
5GA4268	48.89	Flake	Grey Quartzite	Yes	Yes	No	24.37	23.03	4.89	2.40
5GA4268	48.90	Flake	Grey Quartzite	No	Yes	No	21.77	18.08	4.50	1.50
5GA4268	48.91	Flake	Grey Quartzite	No	No	No	21.09	19.59	4.29	1.60
5GA4268	48.92	Flake	Clear Chalcendony	No	No	No	16.74	9.71	2.15	0.30
5GA4268	48.93	Flake	Clear Chalcendony	No	Yes	No	10.54	10.48	2.17	0.20
5GA4268	48.94	Flake	Clear Chalcendony	Yes	No	No	15.47	14.18	4.35	0.80
5GA4268	48.95	Flake	Middle Park Chert	Yes	No	No	14.57	12.14	2.64	0.40

5GA4268	48.96	Flake	Middle Park Chert	No	No	No	8.60	6.43	1.63	< 0.1
5GA4268	48.97	Flake	Middle Park Chert	No	No	No	15.36	8.80	5.23	0.40
5GA4268	48.98	Flake	Troublesome Formation Chert	No	No	No	9.79	8.97	1.65	0.10
5GA4268	48.99	Flake	Troublesome Formation Chert	Yes	No	No	6.86	6.69	1.58	< 0.1
5GA4268	48.100	Flake	Troublesome Formation Chert	No	No	No	5.61	3.44	0.70	< 0.1
5GA4268	48.101	Flake	Troublesome Formation Chert	No	No	No	7.62	7.28	1.41	< 0.1
5GA4268	48.102	Flake	Troublesome Formation Chert	No	No	No	8.00	3.77	3.03	< 0.1
5GA4268	48.103	Flake	Troublesome Formation Chert	No	No	No	9.14	7.04	1.55	< 0.1
5GA4268	48.104	Flake	Grey Quartzite	No	No	No	4.28	3.25	1.01	< 0.1
5GA4268	48.105	Flake	Troublesome Formation Chert	No	No	No	7.52	4.34	1.56	< 0.1
5GA4268	48.106	Flake	Troublesome Formation Chert	Yes	No	No	10.11	7.25	1.70	0.10
5GA4268	48.107	Flake	Grey Quartzite	No	No	No	7.39	5.92	1.23	< 0.1
5GA4268	48.108	Flake	Troublesome Formation Chert	No	No	No	9.84	6.41	2.40	0.10
5GA4268	48.109	Flake	Troublesome Formation Chert	No	No	No	20.22	14.44	2.67	0.80
5GA4268	48.110	Flake	Troublesome Formation Chert	No	No	No	12.66	7.45	2.03	0.20
5GA4268	48.111	Flake	Troublesome Formation Chert	Yes	No	No	13.43	9.42	2.69	0.30
5GA4268	48.112	Flake	Troublesome Formation Chert	No	No	No	15.59	7.67	5.17	0.60
5GA4268	48.113	Flake	Troublesome Formation Chert	No	No	No	17.35	12.32	3.82	1.00
5GA4268	48.114	Flake	Troublesome Formation Chert	Yes	No	No	19.51	18.24	3.19	1.20
5GA4268	48.115	Flake	Troublesome Formation Chert	Yes	No	No	19.36	15.44	5.43	1.30
5GA4268	48.116	Flake	Troublesome Formation Chert	No	Yes	No	14.35	13.99	2.52	0.50
5GA4268	48.117	Flake	Troublesome Formation Chert	No	Yes	No	13.14	7.63	5.20	0.40
5GA4268	48.118	Flake	Troublesome Formation Chert	No	No	No	9.80	7.24	1.47	< 0.1
5GA4268	48.119	Flake	Troublesome Formation Chert	Yes	No	No	17.21	12.02	2.65	0.40
5GA4268	48.120	Flake	Clear Chalcendony	No	No	No	8.32	3.52	1.39	< 0.1
5GA4268	48.121	Flake	Clear Chalcendony	Yes	No	No	12.12	7.98	3.27	0.20
5GA4268	48.122	Flake	Clear Chalcendony	No	Yes	No	11.43	5.27	1.88	0.10
5GA4268	48.123	Flake	Clear Chalcendony	No	No	No	6.77	6.22	2.40	< 0.1
5GA4268	48.124	Flake	Troublesome Formation Chert	No	No	No	6.03	4.94	0.96	< 0.1
5GA4268	48.125	Flake	Clear Chalcendony	No	No	No	9.98	6.51	1.69	0.10
5GA4268	48.126	Flake	Troublesome Formation Chert	No	No	No	10.94	9.68	1.81	0.20
5GA4268	48.127	Flake	Troublesome Formation Chert	No	No	No	12.60	9.18	2.16	0.20
5GA4268	48.128	Flake	Troublesome Formation Chert	Yes	No	No	14.62	6.53	1.75	0.10
5GA4268	48.129	Flake	Troublesome Formation Chert	Yes	Yes	No	12.06	9.75	2.70	0.30
5GA4268	48.130	Flake	Troublesome Formation Chert	No	Yes	No	16.13	14.04	2.57	0.60
5GA4268	48.131	Flake	Clear Chalcendony	No	Yes	No	18.44	14.90	5.93	1.30
5GA4268	48.132	Angular Debris	Troublesome Formation Chert	No	Yes	No	15.90	13.70	5.98	0.60
5GA4268	48.133	Flake	Clear Chalcendony	Yes	Yes	No	17.68	13.04	3.55	0.60
5GA4268	48.134	Flake	Troublesome Formation Chert	No	Yes	No	16.37	7.37	6.52	0.80

5GA4268	48.135	Flake	Troublesome Formation Chert	Yes	No	No	18.16	16.52	3.71	1.40
5GA4268	48.136	Flake	Troublesome Formation Chert	No	No	No	19.10	12.98	2.57	0.70
5GA4268	48.137	Flake	Troublesome Formation Chert	Yes	Yes	No	15.59	10.72	4.58	0.60
5GA4268	48.138	Flake	Troublesome Formation Chert	Yes	No	No	18.61	14.55	3.47	0.90
5GA4268	48.139	Flake	Clear Chalcendony	No	Yes	No	13.92	6.24	2.74	0.20
***5GA48 = 5GA4268**										

APPENDIX C - FEATURE DATA

Blinds

Site	ID	Maximum Interior Width (cm)	Maximum Width Orientation (degrees)	Minimum Interior Width (cm)	Maximum Exterior Width (cm)	Depth (cm)	Blind Shape	Blind Opening Orientation (degrees)	Excavated
5GA35	F14-A1	95	70	41	305	58	SEMI-CIRCULAR	165	NO
5GA35	F14-A2	265	209	235	465	30	CIRCULAR	4	NO
5GA35	F14-A3	141	22	80	356	70	OVAL	NA	NO
5GA35	F14-A4	135	286	128	310	50	CIRCULAR	NA	NO
5GA35	F14-A5	112	308	77	360	40	OVAL	NA	NO
5GA35	F14-A6	140	1	50	ND	20	CIRCULAR	NA	NO
5GA35	F14-A7	105	315	67	157	42	OVAL	NA	NO
5GA35	F14-A8	115	55	36	233	84	CIRCULAR	95	NO
5GA35	F14-A10	200	280	101	335	85	OVAL	NA	NO
5GA35	F14-A12	141	72	88	298	90	OVAL	NA	NO
5GA35	F14-101	118	22	82	189	51	CIRCULAR	NA	NO
5GA35	1	170	76	150	277	58	OVAL	NA	NO
5GA35	2	238	92	165	361	54	CIRCULAR	225	NO
5GA35	3	304	22	221	446	90	SEMI-CIRCULAR	315	NO
5GA35	4	197	108	142	240	96	SEMI-CIRCULAR	135	YES
5GA35	5	165	62	177	294	108	CIRCULAR	165	ND
5GA35	6	157	78	114	298	31	CIRCULAR	NA	NO
5GA35	7	200	94	143	290	43	OVAL	135	YES
5GA35	8	280	88	235	430	61	OVAL	NA	YES
5GA35	9	60	288	220	430	83	CIRCULAR	NA	NO
5GA35	10	150	142	170	240	40	CIRCULAR	45	NO
5GA35	11	170	46	150	310	53	CIRCULAR	NA	NO
5GA35	12	160	50	146	270	61	CIRCULAR	NA	NO
5GA35	13	180	150	110	330	47	OVAL	NA	NO
5GA35	14	225	12	130	320	59	OVAL	NA	NO
5GA35	15	190	352	158	305	51	CIRCULAR	NA	NO
5GA35	18	159	294	138	318	63	CIRCULAR	NA	NO
5GA35	19	202	99	103	355	63	SEMI-CIRCULAR	99	NO
5GA35	20	182	80	161	356	82	SQUARE	80	NO

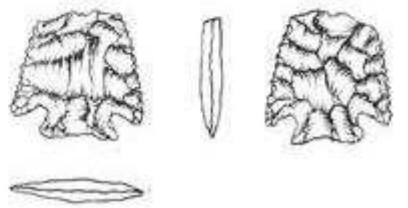
5GA35	21	190	320	86	310	85	CIRCULAR	NA	NO
5GA35	22	124	288	90	231	49	C-SHAPED	74	NO
5GA35	23	251	10	105	409	59	OVAL	NA	NO
5GA35	24	121	70	120	242	27	CIRCULAR	NA	NO
5GA35	25	102	25	85	300	80	SEMI-CIRCULAR	284	NO
5GA35	26	255	20	180	370	66	OVAL	340	ND
5GA35	27	178	172	128	390	46	CIRCULAR	116	NO
5GA35	28	195	166	135	370	68	CIRCULAR	113	NO
5GA35	29	143	183	71	300	59	SEMI-CIRCULAR	183	NO
5GA35	30	110	86	101	332	63	SEMI-CIRCULAR	NA	NO
5GA35	A	145	5	130	233	58	SEMI-CIRCULAR	5	NO
5GA35	B	235	106	115	331	66	CIRCULAR	NA	NO
5GA35	C	98	124	66	240	87	CIRCULAR	NA	NO
5GA35	D	116	250	82	198	54	CIRCULAR	NA	NO
5GA35	E	80	45	72	235	57	SEMI-CIRCULAR	270	NO
5GA36	B01	102	76	64	520	67	CIRCULAR	NA	NO
5GA36	B02	171	100	171	341	66	CIRCULAR	NA	NO
5GA36	B03	218	0	193	381	78.5	OVAL	NA	YES
5GA36	B04	160	190	120	350	95	CIRCULAR	80	NO
5GA36	B05	118	0	99	152	82	CIRCULAR	NA	NO
5GA36	B06	195	220	160	380	115	CIRCULAR	NA	NO
5GA36	B07	115	180	86	194	118	CIRCULAR	NA	NO
5GA36	B08	140	160	105	320	95	CIRCULAR	NA	NO
5GA36	B09	143	160	74	260	67	CIRCULAR	NA	NO
5GA36	B10	260	180	120	370	63	OVAL	NA	NO
5GA36	B11	148	230	115	230	88	CIRCULAR	NA	NO
5GA36	B12	220	310	70	280	130	CIRCULAR	NA	NO
5GA36	B13	150	270	70	320	95	CIRCULAR	NA	NO
5GA36	B14	160	280	80	250	75	OVAL	NA	NO
5GA36	B15	248	270	220	262	104	CIRCULAR	184	NO
5GA36	B16	124	320	66	253	105	OVAL	NA	NO
5GA36	B17	150	286	83	396	136	CIRCULAR	NA	NO
5GA36	B18	146	20	132	249	89	CIRCULAR	NA	NO
5GA36	B19	128	162	102	282	53	CIRCULAR	NA	NO
5GA36	B20	120	240	110	335	120	SQUARE	NA	NO
5GA37	F14-B1	130	20	60	227	62	OVAL	60	NO
5GA37	F14-B2	203	310	123	285	35	CIRCULAR	NA	NO
5GA37	F14-201	170	270	14	378	85	CIRCULAR	NA	NO
5GA37	F14-202	162	10	129	389	68	CIRCULAR	NA	NO

5GA37	F14-203	150	290	130	356	80	CIRCULAR	NA	NO
5GA37	1	237	154	180	370	54	CIRCULAR	NA	NO
5GA37	2	193	168	140	382	59	OVAL	90	NO
5GA37	31	182	140	100	311	46	OVAL	NA	NO
5GA37	32	180	356	123	375	75	CIRCULAR	162	NO
5GA37	33	130	184	100	344	88	OVAL	18	NO
5GA37	34	180	104	160	410	96	CIRCULAR	132	NO
5GA37	35	140	42	100	303	79	CIRCULAR	NA	NO
5GA37	36	171	228	106	294	68	SEMI-CIRCULAR	52	NO
5GA37	37	100	19	74	266	50	CIRCULAR	NA	NO
***ND = No data**									

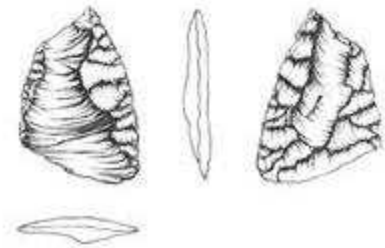
Cairns

Site	ID	Max Length (cm)	Max Width (cm)	Height (cm)	Comments
5GA36	1	59	59	47	Composed of 3 similarly stacked rocks
5GA36	2	84	79	20	Collapsed cairn of 8 stones
5GA36	3	130	72	47	
5GA36	4	127	66	57	
5GA36	A1	ND	ND	ND	Intact cairn composed of 2 stacked rocks
5GA36	A2	ND	ND	ND	Collapsed cairn of 3 rocks
5GA36	A3	ND	ND	ND	Collapsed cairn of 3 (4?) rocks
5GA36	A4	ND	ND	ND	Partially collapsed cairn composed of 2 fallen rocks and 2 stacked rocks
5GA36	A5	ND	ND	ND	Collapsed cairn of 3 rocks
5GA36	A6	ND	ND	ND	Collapsed cairn of 4 rocks
5GA36	A7	ND	ND	ND	Collapsed cairn of 1 fallen rock and 1 vertically positioned rock
5GA36	A8	ND	ND	ND	Partially collapsed cairn composed of 1 fallen rock and 1 in-situ rock
5GA36	A9	ND	ND	ND	Collapsed cairn of 4 rocks
5GA36	A10	ND	ND	ND	Partially collapsed cairn composed of 1 in-situ rock and 2 fallen rocks; 1 rock is bright colored in contrast to surrounding rocks
5GA36	A11	ND	ND	ND	Partially collapsed cairn composed of 1 in-situ rock and 3 fallen rocks
***ND = No data**					

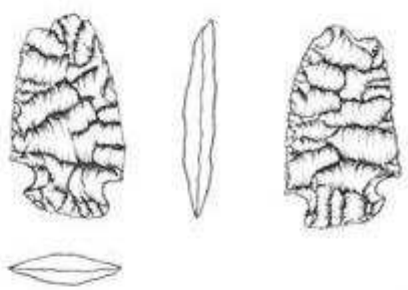
APPENDIX D - ARTIFACT ILLUSTRATIONS



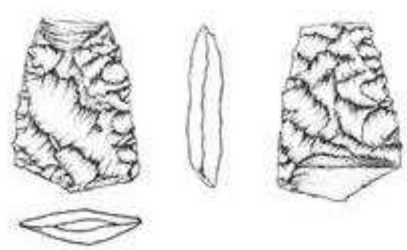
5GA35-85



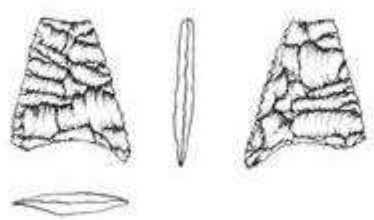
5GA35-87



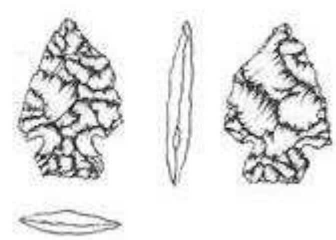
5GA35-89



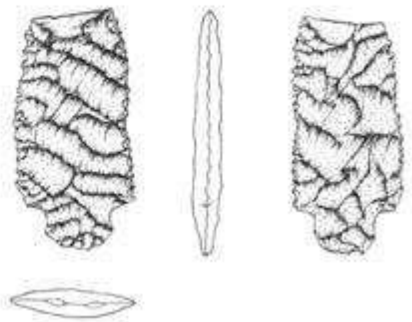
5GA35-90



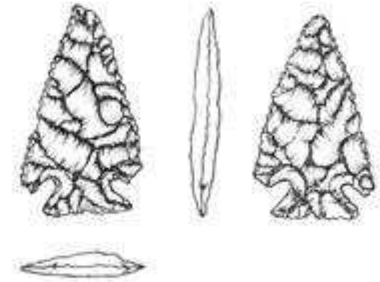
5GA35-93



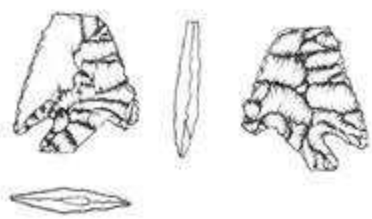
5GA35-96



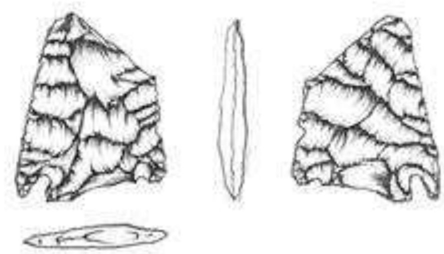
5GA35-99



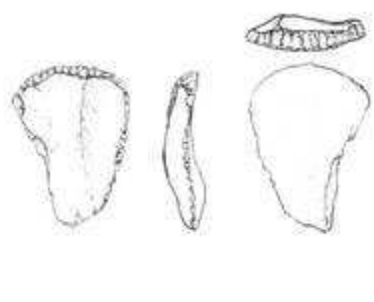
5GA36.3



5GA 36-7



5GA 37-3



5GA 48 .12

APPENDIX E - PROTEIN RESIDUE ANALYSIS REPORT

Protein Residue Analysis of 15 Artifacts from Sites 5GA35, 5GA36, 5GA37, and 5GA48 near Rollins Pass, Colorado

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(LAS-365)

Introduction

The use of chemical and molecular biological techniques in the analysis of archaeological materials can provide significant new information for the interpretation of their use. The identification of organic residue from lithic and ceramics artifacts, coprolites and soils have provided archaeologists with specific data regarding prehistoric exploitation of animals and plants. Although ancient protein residues may not be preserved in their original form, linear epitopes are generally conserved which can be identified by immunological methods (Abbas et al. 1994).

Immunological methods have been used to identify plant and animal residues on flaked and groundstone lithic artifacts (Allen et al. 1995; Gerlach et al. 1996; Henrikson et al. 1998; Hyland et al. 1990; Kooyman et al. 1992; Newman 1990, 1995; Petraglia et al. 1996; Shanks et al.1999; Yohe et al. 1991) and in Chumash paint pigment (Scott et al. 1996). Plant remains on artifacts also been identified through chemical (opal phytoliths), and morphological (use-wear), studies (Hardy and Garufi 1998; Jahren et al. 1997, Sobolik 1996). Plant and animal residues on ceramic artifacts have been identified through the use of gas-liquid chromatography, high performance liquid chromatography and mass spectrometry (Bonfield and Heron 1995; Evershed et al. 1992*;* Evershed and Tuross, 1996; Heron et al. 1991, Patrick et al. 1985). Serological methods have been used to determine blood groups in skeletal and soft tissue remains (Heglar 1972; Lee et al. 1989) and in the detection of hemoglobin from 4500-year-old bones (Ascenzi et al. 1985). Human leukocyte antigen (HLA) and deoxyribonucleic acid (DNA) determinations made on human and animal skeletal and soft tissue remains have demonstrated genetic relationships and molecular evolutionary distances (Hänni et al. 1995; Hansen and Gurtler 1983; Lowenstein 1985, 1986; Pääbo 1985, 1986, 1989; Pääbo et al. 1989). Successful identification of residues on stone tools, dated between 35-60,000 B.P., has been made by DNA analysis (Hardy et al. 1997), while recently, residues on surgical implements from the American Civil War were identified by immunological and DNA analysis (Newman et al. 1998). A recent study demonstrated the viability of identifiable immunoglobulin G in 1.6 million-year-old fossil bones from Venta Micena, Spain, (Torres et al. 2002). Horse exploitation was identified by immunological analysis of residues retained on Clovis points dated to ca. 11,200 B.P. (Kooyman et al. 2001).

The use of forensic techniques in the investigation of archaeological materials is appropriate as both disciplines deal with residues that have undergone changes, either deliberate or natural. Criminals habitually endeavor to remove bloodstains by such means as laundering, scrubbing with bleach, etc. yet; such degraded samples are still identified by immunological methods (Lee and De Forest 1976; Milgrom and Campbell 1970; Shinomiya et al. 1978, among others). Similarly it has been shown that immunological methods can be successfully applied to ancient human cremations (Cattaneo et al. 1992). Forensic wildlife laboratories use immunological techniques in their investigation of hunting violations and illegal trade, often from contaminated evidence (Bartlett and Davidson 1992; Guglich et al. 1993; Mardini 1984; McClymont et al. 1982). Immunological methods are also used to test the purity of food products such as canned luncheon meat and sausage, products which have undergone considerable degradation (Ashoor et al. 1988; Berger et al. 1988; King 1984). Thus the age and degradation of protein does not preclude detection (Gaensslen 1983:225).

Materials and Methods

The method of analysis used in this study of archaeological residues is cross-over immunoelectrophoresis (CIEP). Prior to the introduction of DNA fingerprinting this test was used by forensic laboratories to identify trace residues from crime scenes. Minor adaptations to the original method were made following procedures used by the Royal Canadian Mounted Police Serology Laboratory, Ottawa (1983). The solution used to remove possible residues is five percent ammonium hydroxide which is the most effective extractant for old and denatured proteins without interfering with subsequent testing (Dorrill and Whitehead 1979; Kind and Cleevely 1969). Artifacts are placed in shallow plastic dishes and 0.5 ml of five percent ammonia solution applied directly to each. Initial disaggregation is carried out by floating the dish and contents in an ultrasonic cleaning bath for five minutes. Extraction is continued by placing the dish and contents on a rotating mixer for thirty minutes. For large ground stone items, such as metates, stone bowls, etc., the ammonium hydroxide is applied directly to the worked surface, agitated periodically with a sterile orangewood stick, and allowed to sit for one half hour. The resulting solution is drawn off, placed in a numbered, sterile plastic vial and stored at -20ºC prior to testing. In the case of soil samples, one gram is placed in a vial and 0.5 ml of 1 M Tris buffer solution ($H_2NC[CH_2OH]_3$) is used instead of ammonium hydroxide. The vial is placed in a rotating mixer overnight. The resulting solution is drawn off, placed in a numbered, vial and stored at -20ºC prior to testing.

A series of paired wells is punched into an agarose gel. Approximately 2 µl. of antiserum is placed into one well and the same amount of the unknown sample extract is placed in the other. An electric current is then passed through the gel. The antiserum and unknown sample migrate through the gel and come into contact. If there is protein in the unknown which corresponds with the antiserum, an antigen-antibody reaction occurs and the protein precipitates out in a specific pattern. The precipitant is detected when the gel is pressed, dried and stained. Control positives are run simultaneously with all the unknown samples. Sterile equipment and techniques are used throughout the analysis.

The Samples

Fifteen artifacts were submitted for immunological analysis by Aaron Whittenburg at Colorado State University. Residue was removed from the artifacts as discussed above. The residue was tested against a suite of animal antisera (Table 1). Animal antisera provided by Cappel Research, Lampire Biomedical, and Cedarlane Laboraties provide family level identification only. The relationship of antisera to some of the possible species identified is shown in Table 2.

Results

Four positive reaction were observed (Table 3). Artifacts #35.90 and #35.93 both tested positive for bovine. Artifact #36.2 reacted with deer antisera. Finally, artifact #48.3 tested positive for pronghorn. All artifacts returning positive reactions are subjected to a repeat analysis to verify positive results. No other positive reactions were observed. The absence of identifiable proteins on an artifact may be due to poor preservation of protein, insufficient protein, or that they were not in contact with any of the organisms included in the available antisera.

TABLE 1: ANTISERA USED IN ANALYSIS

Animal Antiserum	**Source**
Pronghorn	Cedarlane Laboratories
Bear	MP Biomedical
Bovine	“
Feline	“
Canine	“
Deer	“
Guinea Pig	“
Horse	“
Rabbit	“
Sheep	“

TABLE 2: POSSIBLE SPECIES IDENTIFIED

Antiserum to:	**Reacts with:**
Pronghorn	*Antilocapra americana*
Bear	black, grizzly, etc
Bovine	bison, cow, musk ox
Canine	coyote, wolf, domestic dog, etc.
Cat	bobcat, cougar, lynx, etc.
Deer	deer, elk, moose
Guinea Pig	beaver, guinea-pig, porcupine, squirrel
Horse	horse, donkey, kiang, etc.
Rabbit	rabbit, hare, pika
Sheep	bighorn & other sheep

TABLE 3: RESULTS

LAS #	Site	Prov/ Inventory Code	Artifact	Results
1	5GA35	35.87	Biface	Negative
2	5GA35	35.88	Projectile Point Frag	Negative
3	5GA35	35.89	Projectile Point Frag	Negative
4	5GA35	35.90	Projectile Point Frag	Bison
5	5GA35	35.93	Projectile Point Frag	Bison
6	5GA35	35.95	Projectile Point Frag	Negative
7	5GA35	35.97	Biface	Negative
8	5GA35	35.99	Projectile Point Frag	Negative
9	5GA36	36.2	Projectile Point Tip	Deer
10	5GA37	37.1	Biface	Negative
11	5GA48	48.3	Projectile Point Tip	Pronghorn
12	5GA48	48.4	Biface	Negative
13	5GA48	48.7	Scraper	Negative
14	5GA48	48.11	Scraper	Negative
15	5GA48	48.12	Scraper	Negative

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APPENDIX F - USE WEAR ANALYSIS REPORT

Contract Publication Series: 15-447

RESULTS OF A HIGH POWER USEWEAR ANALYSIS OF A SAMPLE OF 15 LITHIC ARTIFACTS FROM A SERIES OF HIGH ALTITUDE SITES IN COLORADO

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Introduction

Cultural Resource Analysts, Inc.'s (CRA), Microwear Laboratory was contracted by Aaron Whittenburg to complete a high power use-wear analysis of 15 lithic artifacts from 5GA35, a high altitude surface site in Grand County, Colorado. The artifacts consisted of eight projectile points/fragments, three scrapers, and four biface fragments. Raw materials consisted of Troublesome Formation chert, Middle Park chert, Windy Ridge quartzite, Silicified wood (Jackson County), and Silicified wood (Middle Park).

The high power approach to lithic use-wear analysis is based on the work of such researchers as Semenov (1964) and Keeley (1980), who pioneered the use of magnification in the range of 80X to 300X to analyze tool edges for evidence of polishes and striations that result from specific activities. Both the action (e.g., cutting, scraping, sawing) and the material worked (e.g., hide, meat, wood, bone) can be distinguished at these levels of magnification. The technique can build on information gained from a low-power approach, which uses magnifications less than or equal to 80X, or can be used alone to provide a more detailed description of activities associated with a site or specific site component.

Methods

Artifacts were received from Mr. Whittenburg in individual plastic bags labeled with a sample number. Both sides of all items were scanned and placed on a data sheet for each sample. Each datasheet records item provenience, item number, internal project number, name of processor, and date of processing.

After datasheets are prepared, a three-step cleaning process insures that dirt, finger grease from handling, and other foreign materials are removed from each item before analysis. This process begins with a 15-minute bath in a heavy duty detergent (TopJob™) using a Branson 5510 sonic cleaner with an electronic timer. After washing, each item is rinsed with tap water, and then processed through a 15-minute acid bath using a 10 percent HCl solution. To neutralize the acid bath, the final step is to rinse each item thoroughly in a common basic solution (in this case, tap water). Items are then allowed to air dry prior to analysis.

The high power lithic use-wear laboratory makes use of a Bausch and Lomb MicroZoom metallurgical microscope with magnifications from 22.5X to 1,000X. For this project, most of the analysis occurred at 80X and 250X. Exceptions are noted below in descriptions of individual items. A Sony DSCW7 digital camera allows for the capture, manipulation, and zoom (up to 5X) detail of images of use-wear from the microscope. Due to a malfunction of the camera, no photomicrographs were taken. The laboratory maintains a reference collection of photomicrographs of use-wear examples and experimental tools produced from a variety of cherts for comparative purposes.

Results of Analysis

Use-wear traces were documented on 8 (53.3 percent) of the 15 items submitted for analysis (Figure 1). These 8 items produced 45 use-wear traces in the form of polishes and/or striations. In this section of the report, a description of use-wear traces is provided for each item (Figures 1.1–1.11; Table 1). Use-wear traces are summarized by materials worked, actions utilized, and activities (combining material worked with action) (Figures 2–4).

An examination of use-wear traces by material worked (see Figure 2) indicates that hide-working was a dominant activity at slightly more than three-quarters (77.8 percent) of all traces identified. This is followed by meat at 26.6 percent of traces, bone at 9 percent, and hafting at 13.3 percent (note that the total percentage is greater than 100 percent because some wear traces included more than one material worked [see Figure 2]). Hide, meat, and bone form the components of a single category of material—animal carcasses.

Actions are similarly limited, with scraping the dominant action at 60 percent of all wear traces (see Figure 3). Cutting, slicing, and hafting make up the other actions, which could be identified for wear traces. Action could not be determined for 2.2 percent of wear traces.

When materials worked are combined with actions (see Figure 4), a limited set of activities can be identified for the lithic artifacts from Site 5GA35 as a whole. Scraping fresh hide (31.1 percent), scraping greased hide (28.9 percent), and cutting hide/meat (15.6 percent) are the dominant activities, followed by mixed meat/hide (2.2 percent), slicing meat/bone (8.9 percent), and hafting (13.3 percent). Except for hafting, all activities are directed at processing animal carcasses.

Summary and Conclusions

The sample of artifacts (n = 15) submitted for analysis consisted of projectile points/fragments, biface fragments, and scrapers. Thus, it is not surprising that a limited set of activities was identified, based on an examination of microscropic traces of use-wear identified at high levels of magnification.

Of the eight artifacts with use-wear traces, four were projectile points/fragments (Samples 2–4 and 9), one was a biface fragment (Sample 1), and three were scrapers (Samples 13–15). The points/fragments showed evidence of fresh hide, cutting and slicing meat/hide/bone, and hafting wear. The biface fragment had evidence of greased hide scraping, as did Sample 15, a scraper. The other two scrapers had light wear traces of mixed meat/hide and fresh hide scraping. The artifact with the heaviest use-wear traces was Sample 15, the scraper.

The activities identified through the high power use-wear analysis of tools from Site 5GA35 are consistent with a short-term occupation(s) for the purpose of procuring and preparing animal carcasses for human consumption/use.

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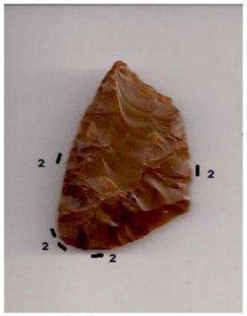

Figure 1. 1
Sample 1.

Figure 1.2
Sample 1, obverse.

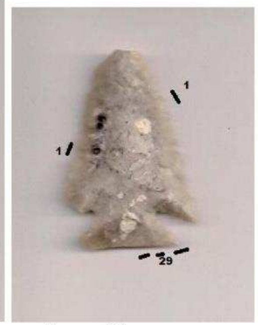

Figure 1.3
Sample 2.

Figure 1.4
Sample 2, obverse.

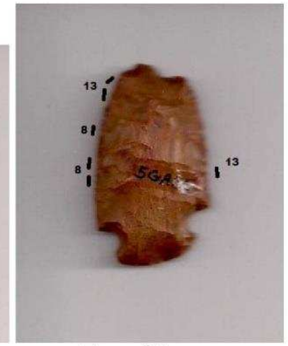

Figure 1.5
Sample 3.

Microwear Key:

1= Scraping fresh hide
2= Scraping greased hide
8= Cutting hide/meat
12= Mixed meat/hide
13= Slicing meat/bone
29= Hafting
↔ Direction of use-wear

Figure 1.6
Sample 4.

Figure 1.7
Sample 9.

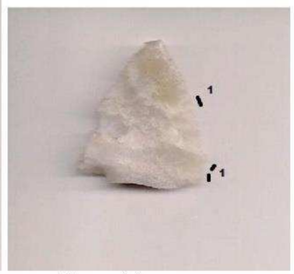

Figure 1.8
Sample 9, obverse.

Figure 1.9
Sample 13.

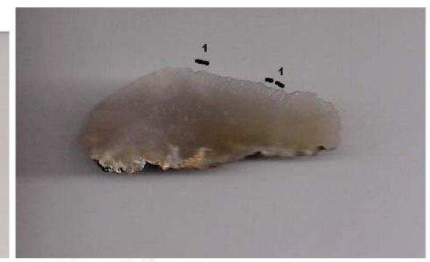

Figure 1.10
Sample 14.

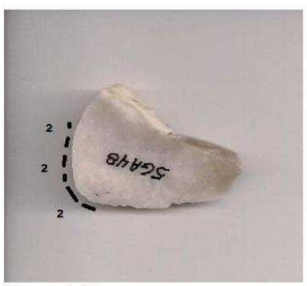

Figure 1.11.
Sample 15.

Figure 1.1-1.11. Microwear traces identified on a sample of artifacts from site 5GA35.

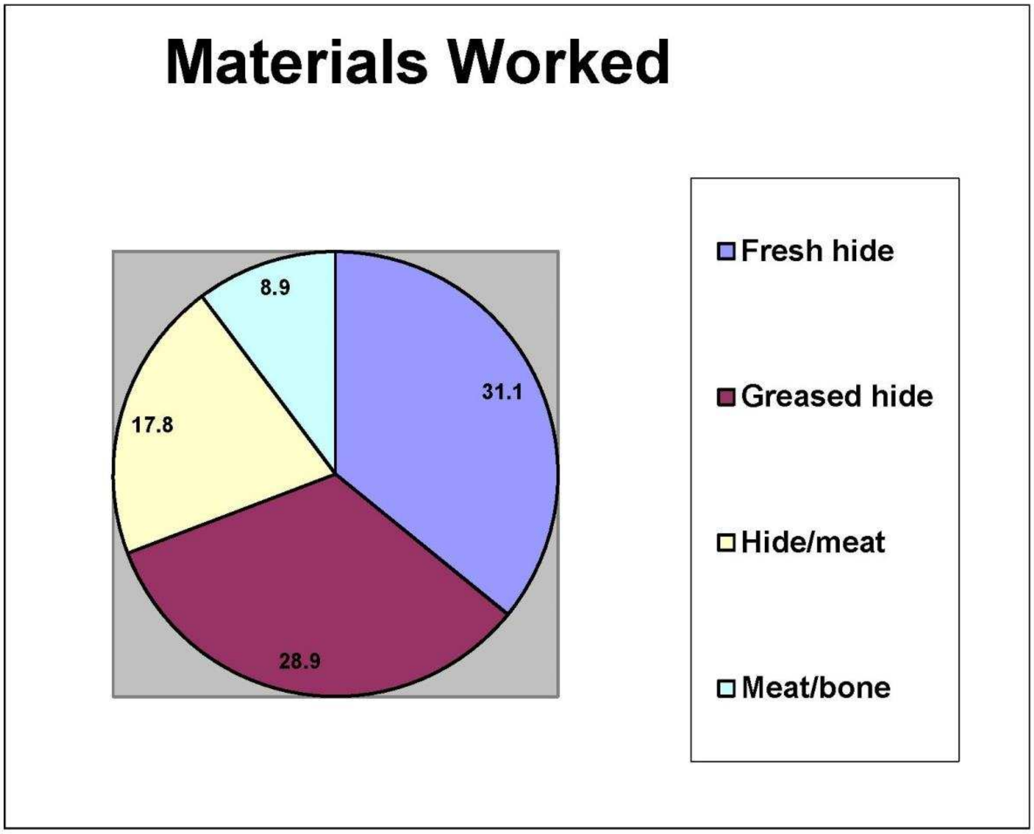

Figure 2. Materials Worked by Percentage.

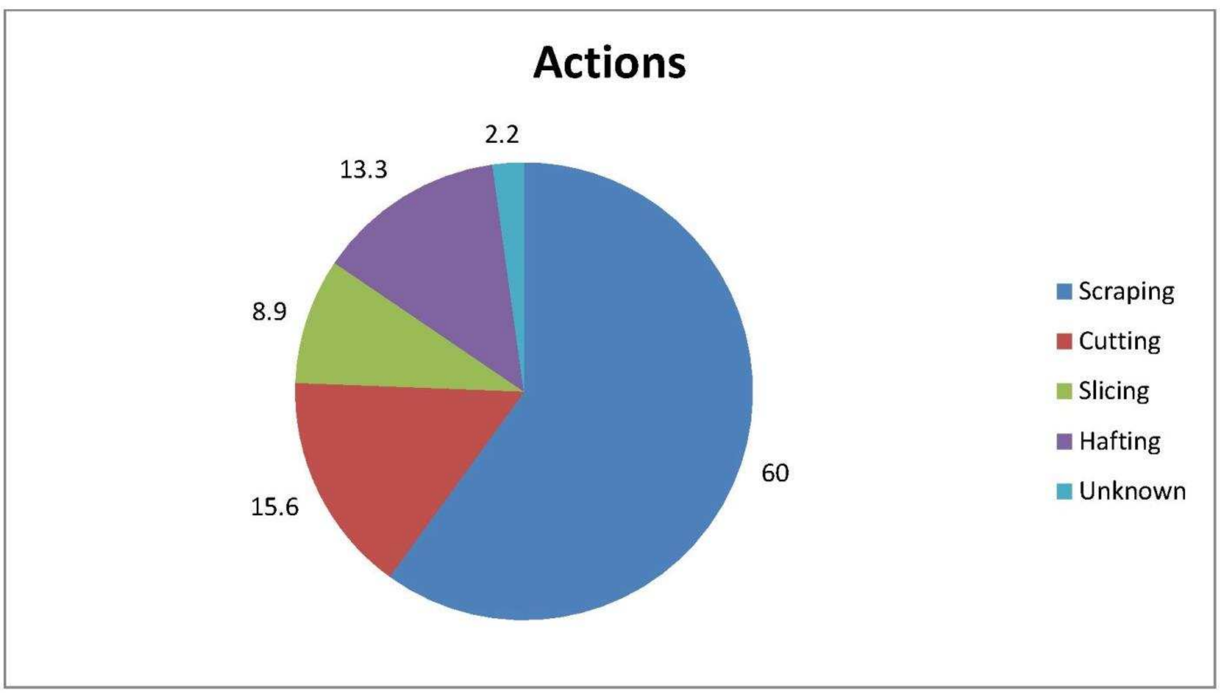

Figure 3. Actions by Percentage.

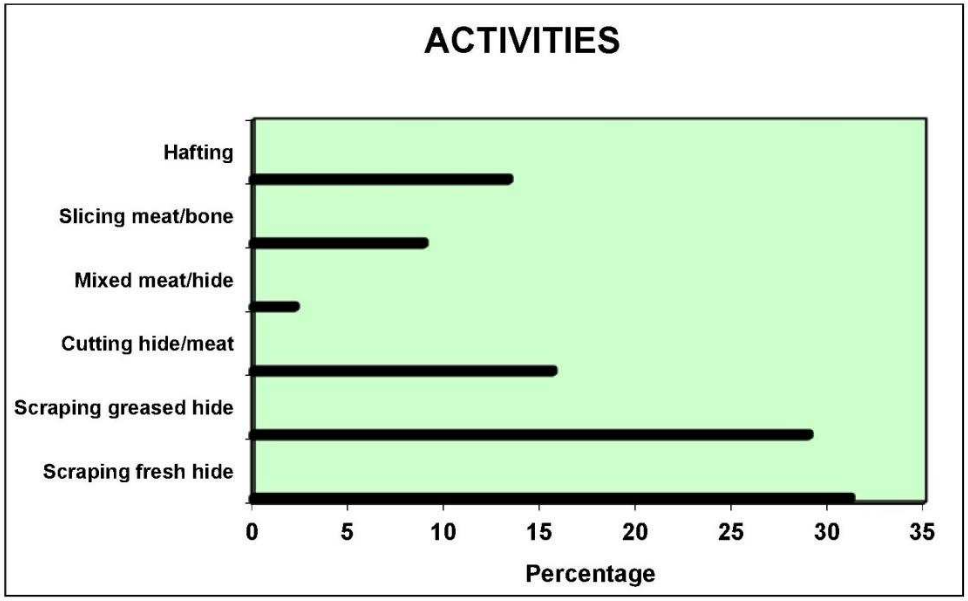

Figure 4. Activities by Percentage.

Table 1. Summary of Use-wear Traces for Sample of Lithics from Colorado.

Item #	Material	Artifact Description	Use-wear Documented	Magnification Level
1	Middle Park chert	Biface fragment	Scraping greased hide	80X-250X
2	Troublesome Formation chert	Projectile point midsection and base	Fresh hide; hafting	250X
3	?	Projectile point midsection and base	Cutting hide/meat; slicing meat/bone; hafting	80X-300X
4	Troublesome Formation chert	Projectile point midsection	Cutting hide/meat	80X-250X
5	?	Projectile point midsection	No wear traces	80X-250X
6	?	Projectile point midsection and base	No wear traces	80X-250X
7	?	Biface fragment	No wear traces	80X-250X
8	Windy Ridge quartzite	Projectile point midsection and base	No wear traces	80X-250X
9	Middle Park chert	Projectile point tip	Scraping fresh hide	80X-250X
10	Troublesome Formation chert	Biface fragment	No wear traces	80X-250X
11	Troublesome Formation chert	Projectile point tip	No wear traces	80X-250X
12	Windy Ridge quartzite	Projectile point tip	No wear traces	80X-250X
13	?	Scraper	Mixed meat/hide	80X-250X
14	?	Scraper	Scraping fresh hide	80X-250X
15	Troublesome Formation chert	Scraper	Scraping greased hide	80X-250X